Ref. Ares(2017)4764893 - 29/09/2017

YEAR 2 EVALUATION

Deliverable 6.4

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1 EXECULTIVE SUMMARY

1.1 ROLE/PURPOSE/OBJECTIVE OF THE DELIVERABLE

Deliverable 6.4 presents an evaluation of the first year of the ER4STEM project. The primary aim of this deliverable is to provide an evaluation of the activities implemented in the second year of the project, specifically the workshops and competitions. The secondary aim is to inform the final development of the Framework and Activity Plans. This deliverable presents data form 70 workshops implemented in six European countries by project partners. The evaluation is not intended to be exhaustive and analysis of year 2 data will continue in project year 3.

Analysis of data collected in year 2 occurs at three levels looking across competitions, individual workshops, country-level data and project level. From these findings, final recommendations for the Evaluation, Activity Plans, Repository and Framework are made for the start of project year 3.

1.2 RELATIONSHIP TO OTHER ER4STEM DELIVERABLES

Deliverable 6.4 draws on data collected from workshops (WP2) as well as conferences and competitions (WP3). Data were collected through the evaluation kit (D6.2) and a modified version during the competition. This report draws on information presented in D2.2 and D4.2, so as not to replicate information. While the primary aim of this deliverable is to provide an evaluation of the data collected in the second year of the project, the secondary aim is to inform the final development of the Framework (WP1) and Activity Plans (WP4). These developments should impact the design and implementation of workshops and conferences and competitions (WP2 & WP3) in the final year of the project, through which data will then be collected and evaluated with reference to the first two years. Ultimately these will all impact the design and use of the repository (WP5).

1.3 STRUCTURE OF THE DOCUMENT

Following a brief introduction to the report, an overview of the data collection and analysis approach is presented in the methodology. Analysis of the data occurs at three levels. The findings are presented in four areas: competitions, individual workshops, country-level and whole project. The discussion considers the findings in relation to the year 1 data and from this arise a series of recommendations for the Framework, Activity Plans and Evaluation for project year 3. The appendixes contain the detailed analyses reports which are referred to at various stages of this report.

DOCUMENT REVISION HISTORY

Version Number	Date	Description	Author
V1	23/9/17	First draft	Carina Girvan
V1 Review	27/9/17	Draft comments	Nikoleta Yiannoutsou
FINAL	28/9/17	Final version	Carina Girvan

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DISCLAIMER

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2 INTRODUCTION

This report is the evaluation of the second year of the ER4STEM project. It examines the outcomes of workshops and competitions completed in year two of the project, considers these in relation to the recommendations which emerged at the end of the first year of the project (D6.3) and makes recommendations for the final refinement of workshops, competitions, activity plan, framework and repository for the third project year.

This section recaps the key points which have informed the evaluation of year two, drawing on deliverables 6.1, 6.2 and 6.3.

2.1 RESEARCH QUESTIONS

The baseline questions identified in D6.1 provided the basis for the design of the evaluation pre-kit and the finalised evaluation kit (D6.2) which was implemented in year 2 of the project. These will are now treated as the main research questions and will be discussed and answered in this report. They are presented here for reference by project objective:

Objective 1: ER4STEM will approach and engage children by offering multiple entry points into creative STEM (STEAM) via robotics

- Are there multiple entry points facilitated through the ER4STEM framework?
- Do the activities allow learners to connect robots to their personal interests?
- Do children share their ideas with/through these tangible artefacts?
- Do they learn basic scientific concepts?

Objective 2: ER4STEM will offer educational methods for educational robotics to engage all young learners

- Do the activities encourage interest in STEM education?
- Do the activities encourage interest in STEM careers?
- Do the approaches/activities appeal to girls?
- Do girls engage with challenges or let boys 'take over'?
- Are girls interested in the STEM topics?
- Are popular gender stereotypes held? Are they changed?
- Did they participate in collaborative work?
- Were those who were not interested in STEM inspired by their peers?

Objective 3: ER4STEM will study real-world societal problems as perceived by each child and relate societal challenges to existing technologies and required innovations

- Did children identify and define problems that influence their lives?
- Were they equipped with the necessary skills to solve these?
- Do they have an opportunity to present their ideas and artefacts to each other as 'proper' scientists?
- Do they develop 'soft-skills'?
- Do they learn intrarelational (how well they know themselves) and interpersonal skills?

2.2 EVALUATION CRITERIA

In addition to the ER4STEM project objectives, a set of topics for consideration in relation to the aims of the framework were identified:

- Learner engagement
- Changing & sustaining attitudes to STEM
- Connecting STEM to society
- Creativity
- Collaborative working
- Entrepreneurial activity
- Questions for using specific tools
- Evaluate teacher use of ER repository
- What works, for whom and in what circumstances?
- Plans for further development of activities.

The intention was for these to be evaluated using the evaluation kit in years 2 and 3 of the project. As many of these are repeated in the recommendations from year 1 or the main research questions, they are not discussed in a discrete section of the findings. The evaluation of the teacher use of the ER repository can only commence once the repository is live (which is expected for the third year of the project).

2.3 YEAR 1 RECOMMENDATIONS

This section presents the recommendations for the ER4STEM project which emerged from the evaluation of the first year of the project (D6.3). Each is presented with a topic heading and specific recommendations for affected workpackages. It is worth noting that recommendations for both the Framework and Activity Plan would impact workshops directly and affect the competitions and repository indirectly.

1. Use 21st Century skills as a unit to encompass industry skills and soft-skills.
    a. **Framework –** develop a unit within the Framework on 21st Century skills which is sub-divided into sections on teamwork and collaboration, communication, creativity and critical thinking.
    b. **Activity Plan** – highlight the importance of teaching and developing 21st Century skills by including prompts and examples within the objectives, social orchestration, student productions, sequence of activities and evaluation.
    c. **Evaluation** – merge analysis of industry skills and soft-skills under the heading of 21st Century skills, adjusting research questions and focus accordingly; and sub-divide into sections on teamwork and collaboration, communication, creativity and critical thinking.

2. Consider creativity as leading to innovation and entrepreneurship
    a. **Framework** – consider how creativity can be fostered in different forms, through different activities at different scales and provide a frame.
    b. **Activity Plan** – provide examples of how creativity can be fostered using the year 1 evaluation findings.
    c. **Evaluation** – merge innovation and entrepreneurship in data collection and analysis.

3. Examine critical thinking through a focus on reflective thinking
    a. **Framework –** consider how critical thinking can be fostered in different forms, through different activities at different scales and provide a frame.
    b. **Activity Plan** – highlight the importance of teaching and developing critical thinking through reflection by including prompts within the objectives, social orchestration, student productions, sequence of activities and evaluation; provide examples of critical thinking activities using reflective tools; integreate reflection in student productions.

c. **Evaluation** – provide flexibility within the evaluation for a range of reflective tools to be used; work with WP4 and WP2 to develop tools which can be used to meet requirements and provide evidence of learning.

4. Provide evidence of learning
    a. **Framework** – explain how artefacts of learning can be used to evidence learning.
    b. **Activity Plan** – include examples of achievable and measureable objectives; provide examples of how student productions (artefacts of learning) and reflections (as a form of student production) can demonstrate achievement in a range of objectives, including domain, technical and 21st Century skills.
    c. **Evaluation** – collate examples of measurable objectives and how students can evidence their achievement of these objectives through their productions and reflections; use these to analyse learner engagement in subsequent years.

5. Differentiate activities
    a. **Framework** – consider how differentiation can be integrated.
    b. **Activity Plan** – within student productions, teaching methods and the sequence and description of activities, prompt activity designers to consider differentiation, providing examples of how this can be achieved in relation to sample objectives.
    c. **Evaluation** – review activity plans and wider workshop data to identify and analyse the use by tutors and uptake by students of differentiated activities; track students to questionnaire data to assess impact and compare with previous years.

6. Developing new entry points
    a. **Framework** – increase the types of entry point in the non-goal orientated domain; develop non-gendered activities; provide opportunities for a creative and/or fictitious elements; offer routes for students to rapidly develop their own problems to solve and to make the workshop personally meaningful.
    b. **Activity Plan** – highlight alternative entry points by including this aspect in the student learning process with examples; similarly include suggestions and examples within the first phase of the sequence and description of activities
    c. **Evaluation** – analyse future activity plans to identify the types of entry points; analyse them against the following criteria: goal or non-goal orientated; gendered or non-gendered activities; opportunities for a creativity and/or fictitious elements; routes for students to rapidly develop their own problems to solve and to make the workshop personally meaningful; analyse workshop data to find supporting or refuting evidence of these types of entry points and students' responses.

7. Develop approaches to the orchestration of teamwork, with particular consideration of mixed-gender groups
    a. **Framework** – develop a unit within the Framework on the orchestration of teamwork
    b. **Activity Plan** – develop tools to scaffold teamwork, collaboration and social interaction
    c. **Evaluation** –use the developed tools to provide a frame for the analysis of teamwork in future workshop

8. Evaluation of specific tools

    a. **Evaluation** – identify how data collection on the use of specific tools can be accomplished within a tool-kit which will be implemented by all partners

9. Changing and sustaining attitudes to STEM
    a. **Framework** – develop a unit within the Framework, explicitly on developing positive attitudes to STEM
    b. **Activity Plan** – identify points for discussions about the work of scientists (including who scientists are), experiences of STEM subjects and robotics in relation to STE(A)M subjects and careers.
    c. **Evaluation** – consider whether explicit opportunities to discuss issues alter attitudes to STEM.

10. Gender-balance the Draw-a-Scientist activity
    a. **Evaluation** – Find a solution to gender-balance, to prevent or mitigate imbalance in the presentation of the task.

11. Raise awareness of pedagogic strategies and their impact
    a. **Framework** – develop a unit within the Framework on different pedagogic strategies
    b. **Activity Plan** – identify effective pedagogic strategies, provide examples of how they can be used and why they are effective
    c. **Evaluation** – use the activity plans to evaluate tutor actions and student responses and identify what works

3 METHODOLOGY

A concurrent, mixed-method research approach was identified as most appropriate to the range of research contexts and the scale of data. These ranged from a single-day 8hr workshop to a workshop implemented over several lessons, to the same workshop implemented with multiple groups of students. Workshops would often be implemented in rapid succession and therefore there would be no opportunity to analyse the data between sessions to inform subsequent data collection in those workshops. Therefore, a concurrent approach was most suitable. Qualitative data and analysis are generally given primacy; however, a broadly pragmatic approach is taken depending on the research question being addressed.

This section briefly outlines the data collection approach, which is presented in detail in D6.2, along with an overview of the data collected. This is followed by the analysis approaches taken.

3.1 EVALUATION CONTEXT: WORKSHOP AND CONFERENCE OVERVIEW

In total 1570 students participated in 70 workshops in year 2 (as reported in D2.2). With 807 male and 763 female students spread across all partners. Students were aged between 6 and 19 years of age.

Of these students, 1558 (99%) students completed at least one of the pre or post questionnaires. This shows that the vast majority of children who participated in the workshops had parental informed consent to also take part in the research. 1248 students (80%) completed both questionnaires and this is a reflection of the nature of the workshops, which took place in school time over multiple days. As a result some children would not be present on the first or last day due to typical reasons for absenteeism. However it is also reflective of the fact that in some workshops there was insufficient time to complete all data collection – the (correct) decision to prioritise completion of work by the students over the evaluation was made. It is the view of the primary author of this document that successful educational and experiential outcomes should take priority over research, when research would negatively impact on student outcomes. It should also be noted that not all students answered every question and so where this varies from the numbers reported here, the total number of respondents (n) is reported separately in this report, as appropriate.

We see that on average participants responded positively when asked how many stars they would give the workshop that they attended, out of 5 (Table 1). At a surface level this suggests that, on the whole, students strongly enjoyed their experience.

Table 1 Average number of stars out of 5 by partner as reported in D2.2

Partner	Number of Participants	Average
TU Wien	198	4.33
ESICEE	375	4.92
PRIA	301	4.41
UoA	142	4.61
Across Limits	407	4.34
Cardiff University	145	4.11

While there were no significant differences between genders, as per the previous year, there were noticeable differences between age groups. Although all age groups were, on average, positive about the workshops, as shown in Table 2, the younger ER4STEM age group of 7-10 tended to give a higher rating for the workshops, with the exception of ESI.

Table 2 Average number of starts by age group, as reported in Appendix A.

Partner	Age Group	Total
Across Limits	**7-10**	4.65
	11-14	4.16
Cardiff University	**7-10**	4.50
	11-14	3.98
ESICEE	**7-10**	4.91
	11-14	4.97
PRIA	**7-10**	4.60
	11-14	4.18
	15-18	4.46
TU Wien	**7-10**	4.61
	11-14	3.76
	15-18	3.73
UoA	**7-10**	5.00
	11-14	4.59
	15-18	4.58
Project average		**4.50**

A further 38 student teams (of between 4 and 6 students) participated in the ECER conference and competition. At the conference 12 student teams presented a paper and 4 were invited to give an individual presentation.

3.2 DATA COLLECTION

As outlined in the pre-kit (D6.2) in detail, a mixed-method approach to data collection was identified as most suitable for this project. Qualitative data takes primacy as it allows for the necessary depth of analysis required to identify areas for the development of the Framework. A semi-structured approach to qualitative data collection was identified as the most suitable. This provided structure where appropriate to provide rigour, flexibility to account for individual research contexts and limited structure to allow for emergent outcomes. Data collection began before the workshops with a Draw-A-Scientist (at work) and throughout the workshops either written observations were recorded or video data was collected of the whole class and/or a focus group. Those students who returned from year 1 to participate in a second workshop (ESI) or who were involved in more than workshop (CU) in year 2 only completed the Draw-A-Scientist and pre-questionnaire once, as this provided baseline data. Mid-way through the workshop, students were asked to complete a reflective task and a final reflective task was incorporated into the post-workshop questionnaire. At the end of each session, the tutors were asked to complete a reflective form. After the final workshop session, a focus group (typically the same focus group in the observations) was invited to take part in a short semi-structured interview. At the end of the workshop artefacts of learning that were created by the students were recorded, this included images of robots that were created, copies of code, structured tasks and students' notes.

Quantitative data was collected through pre- and post-workshop questionnaires, to rapidly survey the opinions of students. The primary purpose of this data was to provide an overview of the background of participants and the outcomes from the workshops from the perspective of the participants. Both quantitative and qualitative approaches have acknowledged limitations but by using a mixed-method approach many of these can be countered.

Table 4 presents an overview of the data collected across the 70 workshops and 1553 students with informed consent.

Table 3 Overview of data collected

	Number of workshops	Number of participants
Pre-questionnaire		1458
Post-questionnaire		1354
Draw-a-Scientist		1234
Observations	64	
Interviews		184
Student Reflections	48	Varies (individual and group)
Tutor Reflections	59	Varies (all or some tutors)

Using the pre-kit (D6.1), evaluation data was collected during all 70 workshops. As described in D2.2. Of the 1570 students who participated, 1458 (92%) completed the pre-workshop questionnaire and 1354 (86%)

completed the post-workshop questionnaire. This data is used to gain evidence on students' experience, attitudes and assumptions. To complement this, 1234 (78%) completed the Draw-a-Scientist task.

To gain an in-depth understanding of the workshops to inform the development of the framework; observer, teacher and student perspectives were recorded through various instruments. In addition to those already mentioned, 64 of the 70 workshops (91%) were observed using a variety of tools including written observation schedules and video. This was a notable increase on the previous year, due to non-academic partners gaining experience and familiarity with the processes involved. To understand the workshop from the perspective of the teacher or tutor, reflections were collected from 59 of the 70 workshop tutors (84%). A sample of students who attended workshops took part in a small-group interview after the workshop. This sample represents over 11% of all participants in year 2. Additionally, 68% of workshops provided personal or team-based reflections on the experiences. The interviews and reflections, supplement the post-workshop questionnaires, observations and artefacts of the learning process, to provide detailed insight into the learner experience during the workshops.

3.3 DATA ANALYSIS

Concurrent, mixed-method data analysis often nests the data analysis of one form of data within another. In this project, the focus is on the development of the ER4STEM Framework and therefore the 'how' and 'why' questions are given primacy along with qualitative methods. While much of the data analysis was concurrent and split between different research teams, the three levels of analysis described below represent the varying depth of analysis and extent to which they take a post-positivist or interpretivist viewpoint.

Following this section, the findings are split into four sub-sections, reported in section 4 Findings, to provide a feel for the results produced by the four levels of analysis that were undertaken. More detailed data analysis reports that were created at workshop, competition and project level, are presented in the appendices. Following the analysis and interpretation of the data, the final phase of analysis requires the analysis of the findings in relation to each other and the identification of key recommendations. This follows in section 5 which presents the conclusions from the second year of the ER4STEM project.

3.3.1 Level 1: In depth case studies

As noted in D6.3, case studies provide a way to understand the complexity of anything from an individual's life to a series of events. Case studies explore a phenomenon situated within a bounded real-life context (Yin, 2009), resulting in a rich description of the case. Each case is a tightly bound system. In the case of this project, each workshop or competition is treated as a single case as it is implemented in a consistent location, by a consistent set of tutors, with a consistent group of children, engaging in a consistent task.

Stake (1995) presents three types of case studies; intrinsic, instrumental and collective. Intrinsic case studies are undertaken to understand a case of inherent interest to the researcher. The purpose of the evaluation is to understand the case rather than to test a hypothesis or build theory, although it does not prohibit this outcome (Stake, 2005). Unlike the first year of the project, the second year has a clear set of research questions and aims, which include evaluation of the recommendations presented in D6.3. Therefore, whilst each workshop or competition is of intrinsic interest, it is also instrumental. While the first-year evaluation had a strongly exploratory nature to the data analysis, this is less so in year two. Yet, while the analysis is more focused the researcher is encouraged to remain open to new and emerging themes and issues. However, in the case of the workshops run by Cardiff University using SLurtles (D5.2), these are treated as pilots of a new technology with a new group of users and therefore were more exploratory than instrumental.

Ideally case studies contain a wide range of data, to counter concerns about reliability and validity, through triangulation. As shown in Table 3, almost all workshops had multiple data sets collected and many had full data sets collected. Therefore, there were a variety of cases to choose from. Those with full data sets were analysed in the following way:

- Familiarisation:
    - Begin by familiarising self with activity plan and then workshop information for more specifics, querying tutors as necessary.
    - Review data from the workshop in chronological order:
        - Workshop video & observations
        - Teacher and student reflections
        - Interviews
        - Post-questionnaire
- Analysis Phase 1:
    - Begin with the activity plan– evaluating it through a pedagogic lens.
    - Identify important contextual information from the activity plan and workshop information.
        - Structured document analysis – looking for key information.
    - Interviews
        - Open coding
        - Structured analysis
    - Student reflections
        - Open coding of reflection at mid-point and reflective questions in the post-questionnaire.
        - Structured analysis
    - Teacher reflections
        - Open coding
        - Structured analysis
    - Pre- and post-questionnaires
        - Quantitative analysis
            - Frequencies. This sample is too small for statistical analysis.
        - Qualitative analysis
            - Open coding of open questions.
            - Structured analysis
        - Comparative analysis.
        - Identification of potential outliers
    - Observations
        - First create a descriptive account highlighting interesting events, room layout, teaching time vs student activity time and movement in the room.
        - Return to interesting events to unpick the actions.
        - Structured analysis
- Analysis Phase 2:
    - Triangulation
- Analysis Phase 3:
    - Counter evidence
- Analysis Phase 4:
    - Participant tracking
- Member checking

In each case, the activity plan was analysed through a pedagogic lens. This means that it was reviewed from the perspective of a teacher who would want to implement this activity with a group of students, to identify key information for the implementation and what was missing, to inform the activity plan and framework. This also informs the evaluation by showing what the workshop organisers are explicitly aware of, as it is very difficult to share tacit knowledge. Both should be visible in the video data. It will also provide opportunities for clarification with workshop organisers, allowing them to make explicit some of their implicit assumptions and actions which should improve their reporting and planning of future workshops. This analysis goes on to inform the structured analysis of other data sets, for example the videos are analysed for evidence of the learning outcomes, activities described and classroom orchestration.

Interviews and reflections were openly coded using the constant comparative approach. Within individual cases some tentative categories emerged which were used to inform the structured analysis of other data sets. The pre and post-questionnaire data was analysed by tabulating results for each quantitative question and the open coding of qualitative data. Again, the emerging findings from these results informed the structured analysis of other data sets. Observational data was treated in several ways. Where there was only video, a descriptive account was first written with notes/memos on 'interesting moments' or potentially 'critical episodes'. These were later returned to and the action was described in more detail, before being analysed.

As can be seen from the above description, although the data analysis process appears to be linear, it requires the researcher to return to earlier sets of data with a fresh eye to consider a feature which has emerged from another data set.

Following this first phase of in depth data analysis, the data is triangulated and then examples of counter evidence are sought. Triangulation seeks to provide validity to the findings from any one data set by using the findings of others to confirm or refute. Counter evidence allows us to identify instances where something may not occur as expected, for example in a case study where all students give the workshop 5 out of 5 stars, except for one child who gives it 2. While this does not refute the finding that the students enjoyed the workshop, it does point to a potentially interesting area for analysis, that will inform the Framework by allowing us to consider "What works for whom, when, how and why" by also understanding when things do not work. Therefore, the fourth phase of analysis 'participant tracking' is used to gain a fine-grained understanding of that participant's experience during the workshop and how it varied to the norm.

Finally, there is a process of participant checking, where the interpretation of the data is checked with members of the workshop. In these cases, only the tutors were available to comment. This involved queries from the researcher to members and sharing the report with members for comment. Where members of the case disagreed with the analysis, it was returned to and reconsidered.

Examples of the in-depth case studies are provided in appendixes C-H.

3.3.2 Level 2: Single country analysis

In this analysis, the data from a single country is treated as a multiple case study, with each workshop a single case. The country-level analysis focuses on answering the research questions (section 2.1) as well as the generic evaluation criteria listed in section 2.2.

The first stage was to collect and prepare all qualitative data from the country. The audio files of all interviews were transcribed and the qualitative responses from the pre and post questionnaires were collated. Where video was available, the video files of the focus groups were examined throughout and some parts of them were chosen to be transcribed. These were selected on the basis that they clearly depicted the activity that was going on or the interaction between the students. Finally, the photos and the text files with students' and tutor's reflections between the sessions were used in the analysis.

The data were then mapped, when that was possible, having as a key the students' ID in order to have a complete data set for each student. Then the data were coded according to the categories identified *a priori* based on the evaluation criteria and research questions. These clusters contained specific answers to open questions of the questionnaires or/and specific critical episodes of the transcripts which are dialogues or phrases of the students that indicate important terms in relation to the evaluation criteria.

Examples of the country-level analyses are available in appendixes I-M.

3.3.3 Level 3: Project level

The third level of analysis took one data set from all countries to review the activities of all partners in relation to the baseline questions. While the Draw-A-Scientist Test was implemented this year, in those countries where there are both male and female terms for 'scientist' there was a variance in which came first. Therefore, there is no project level analysis of this data this year, although we broadly observe from the single country analyses that the stereotypes observed in year 1 were repeated in year 2. However, the drawing of male versus female scientists, depending on gender prominence is, so far, unclear. The intention for the final year of the project is that in the appropriate countries, the female form of 'scientist' is first. Therefore, it is excluded from this year's report.

Activity plans were analysed as a single set to inform the development of the Activity Plans (WP4). Importantly they were analysed without knowledge of how the plans were actioned during the workshop, so as not to bias the evaluation. Additionally, they were analysed by someone who did not deign the workshops, so that an unbiased outside perspective could be taken. Analysis of the activity plans began with the pedagogic evaluation of the activity plans, reported in D4.2.

The pre and post-workshop questionnaires were cleaned before analysis. This included the removal of participants who had only completed one of the two questionnaires, for analysis of the change in attitudes to STEM. Following the tabulation of frequencies of Likert scale questions, the mean and standard deviation were calculated.

4 FINDINGS

This section presents the key findings of the data analysis from the competitions, workshops, country level and project whole. A selection of competition, workshop, country level and project level analyses can be found in the Appendixes. Within each section the key findings from these analyses are presented.

4.1 COMPETITIONS

The overall experience from the competition in year 2 (Appendix B) appeared to be rich and positive for both Focus Groups. Furthermore, the competition received a very high score in its evaluation not only from the FGs but also from participants of other teams. Both groups, even if they faced problems with their robots and they were not satisfied with their performance, they considered it a very good experience from which they learned a lot and they said that they want to participate again next year.

The analysis of our qualitative data mainly was developed and offered insights on the following aspects: a) The norms defining the competition as a learning space; b) the model of collaboration followed by the group; c) the focus and the character of the constructionist work; d) The lessons students felt that they learned during the competition e) the development and characteristics of resilience in the face of failure; f) student views on aspects related to Gender and g) student evaluation of the competition.

Norms: Similar to the 2016 ECER report (Appendix A) our data showed that in the competition, it was formulated an informal setting where students behaved more like when at home or when with their friends. However, some of the informal aspects like the volume of the music, the location of the speakers appeared to be distractive for FG1. Furthermore, the competition offered opportunities to the focus group to observe the work of others and of course being exposed in the observation of others. Furthermore, our analysis showed that students used their own cameras to capture their performance but also the performance of other teams. This behavior was also present in the 2016 competition but not in the FG1. The norm of observing others was more evident this year in the data that involved FG2, which participated in the competition for the first time. FG1 did not make such an explicit reference to these issues. It appears that the informal setting of the competition and the culture of sharing ideas exploring and observing others is very appealing to the students when they participate for the first time in a competition where as it becomes a given for the more experienced.

Collaboration: A central aspect of our analysis of collaboration was the division of labor. This aspect was prevalent in the discussion with the researchers during the competition and in the post conference interviews. Similar to the ECER 2016 analysis, both groups FG1 and FG2 adopted the co-construction model although there was evidence for vertical (skill based) and horizontal division of labor. The analysis showed that co-construction does not exclude division of labor but the interconnectedness of the vertical tasks (building and programming) requires that all team members have knowledge of and can contribute in all different tasks – at a different level of detail. FG1 placed special emphasis on organizational issues that involved the distribution of information and facilitated a decentralized model for decision-making and action. Both groups acknowledged the importance of all team members feeling free to share their ideas and opinions, which also contributes to the decentralized model of co-construction. Shared responsibility is another characteristic that is important for the de-centralized model to work, especially when demanding tasks (like robot constructions) take place in demanding contexts (like the competition) where the team has to be able to address challenges in specific time and space. The task and the context (competition) seem that they offer a fertile ground for the development of shared responsibility as the unity of the team is important to be preserved until the end.

Constructions: The focus of the construction process appeared to be different for the two groups. FG1 due to a backup problem engaged more with programming aiming to replace the work lost before the competition. FG2 appeared to be engaged more with their robots as the testing showed that they needed to perform some serious redesign of the robots. With respect to the challenges students faced during the competition those had mainly to do with the robot being mainly a physical construct consisting of many different parts. This property resulted in students to seeking solutions that ranged between practical (buying a new servo motor) and creative: working with the parts you have available. The other category of challenges involved the balance between the need for precision (i.e. testing in a table that simulated the actual game table) and avoidance of hard coding (using specific values instead of variables). This appeared to be a lesson learned for FG1 because they mentioned that they had very few hard-coded values in their program- whereas FG2 seemed to still struggle with precision (they even created a graph with the “misbehaviors of their robot”). A critical element of constructionism is the process of testing and refining the robot. It is mentioned in several parts of the data analysis report, that testing appeared to be problematic in the 2017 competition, as there was only one practice table and there was no time for free testing as it happened with the 2016 competition. Due to this fact, FG2 tried to transfer in their table and in the floor next to their desk one of the characteristics of the testing table (i.e. the initial square) using duct tape. Similar to ECER 2016, students intervened manually on their robot (movement, position) in order to be able to test the rest of their program and to check if alterations they come up with, are feasible or not (e.g. lowering the hand of the robot enough so that it does not touch the ramp and the center of the gravity allows the robot to climb up the ramp). Constructions in the context of the competition require the formulation of a strategy on which tasks to focus so that more points are scored. This characteristic, which is unique in competitions, requires a balance between team evaluation (what we can do), task evaluation (what is within our capabilities), and pushing our limits (so as to score more points). FG2 asserted that tactics in the competition is equally important with building and programming.

Lessons learned: Student reflective discussions in the post conference interview involved lessons they learned from their participation in the competition. It is interesting to see that most of these lessons involve soft skills and the social dimension of learning i.e. learning from others, the value of the team when someone is faced with complex and demanding tasks, setting achievable goals and then proceed to more demanding and complex goals. There were also lessons that involved domain learning (i.e. engineering) and meta-learning skills like learning from mistakes. The lessons learned from the students show that the structure of the competition offers a valuable structure for social interaction and exchange of ideas (see for example the role of the Alliances competition) but it is also a very good context for domain learning and for what we called “life skills”. The latter involved learning to travel and be autonomous in a foreign country for FG1; and taking initiative and using their skills to support the organization for FG2.

Resilience: Resilience was an issue discussed also in the ECER 2016 report. Our findings then showed that FG1, in the 2016 competition, demonstrated a set of behaviors that helped them to be resilient in the disappointment they encountered during their first participation in a demanding context (i.e. competition) with a Complex task (programming two robots). Our findings about resilience are derived mostly from FG2 who are now newcomers and less from FG1. This does not mean that FG1 did not demonstrate resilience. On the contrary: students were willing to take part to the next year competition although their performance was worse than their first year participation. The FG2 analysis showed that both groups share some common characteristics: like being persistent and adjusting their goals. Furthermore, FG2 also built their resilience upon shared responsibility, strong team spirit and hard work (i.e. practice and early preparation).

Gender: Gender issues were discussed mainly with FG2, which was a mixed gender group. Student opinions were similar to those of FG1 during the 2016 competition i.e. that competitions might be dominated by males however, what really matters is not your gender but what you can do. Background discussion with one of the ESI-CEE researchers revealed that the girls in the FG2 were more protected from their school and this resulted in girls pushing more with their ideas and undertaking less critical tasks (i.e. working with the sensors, watching the competition for ideas, making the presentation). FG1 changed from a girls only group in 2016 competition, to a mixed gender group with the participation of a new boy member who replaced one of the girls of year 2016. Researcher notes showed that the boy was somehow not that much included in the group but there is no evidence in the data that connect it with gender. To sum up, in the FG1 there were no gender issues observed. In FG2 the expressed opinions of the group appeared to support gender equality in STEM however, the practice of the group showed a gender – related discrimination in terms of task allocation.

Year 3 recommendations: The organization of the competition was evaluated very well by the students. One of the main aspects that were highlighted for reconsideration for next year was the time for practice and the number of available testing tables. In year 1, it was notable that the shared testing tables available to students fostered between-team interactions, including the sharing and discussing of ideas; observing others’ robot; gaining help and advice; and getting to know other students previously not met across age groups. Experienced teams offered help to new comers and other teams equally; New teams were able to observe and listen to the more experienced teams at work. This also helps to foster a sense of community within an otherwise competitive environment.

While there were opportunities for this again in year 2, we see that the layout of the room inhibited the extent of these behaviours, in addition to the fact that there was one less testing table. In year 2, the testing tables were roped-off as part of the competition area and we note less students ‘hanging out’ in this space, as well as less students taking the opportunity to use the ‘free testing’ time.

Another aspect that was captured by the lead researcher and seems that calls for further investigation is the large number of awards and the criteria they use. There were other smaller issues that involved the space, access to places for lunch, volume of the sound, frequency of the gong.

4.2 WORKSHOP CASE STUDIES

The case study analyses presented in the Appendixes represent the full range of ER4STEM ambitions: The workshop case studies involve students aged 10-15, therefore representing each of the three age groups identified in the ER4STEM framework. These include workshops which were implemented for the first time in this project year, such as the Introduction to SLurtles (CU) activity plan and Visualising Mathematics with

Mathbot (ESI), as well as workshops which had run in project year 1 and subsequently revised for year 2, such as the Construction and Operation of Legs for a Robot (UoA). The workshop case studies, as a whole, include the four STEM subjects as well as integrating meaningful creative arts activities. While the majority of workshops were held in co-educational schools, the first case study from Malta was implemented in an all-boys primary-level church school.

This section focuses on the workshop recommendations made at the end of year 1. As the country level analysis focuses on the research questions and the case studies form a part of the country level analyses, relevant information for these questions are presented in the following section (4.3).

4.2.1 21st Century Skills

The use of 21st Century Skills to encapsulate the wide range of soft-skills, including entrepreneurial skills and those relevant to industry partners was recommended at the end of the first project year. We can see from the activity plans analysed in the case studies, as well as the analysis of the activity plans as part of WP4 that there has been a clear emphasis on a range of 21st Century Skills in activity plans, specifically creativity, critical thinking and communication and collaborating. Each of these is discussed in the following sub-sections.

By making this an explicit recommendation from the 1st year of the ER4STEM project, we see the explicit promotion of these skills across the activity plans presented in the case studies. However, whilst mentioned in activity plans, there is not always any explicit direction of students within the lessons observed and in some of the TUW workshops there was no opportunity to engage in critical thinking through reflection.

However, we should consider that while every ER4STEM activity may provide an opportunity to develop a range of skills, not every skill should or needs to be directly targeted. As these workshops are typically designed to be completed in one or two sessions, it is not possible nor desirable to cover every skill. However the range of skills should be represented over the broad ER4STEM curriculum.

4.2.2 Creativity

Across the workshop cases studies we see students engaging in various forms of creative expression, from thinking of different ways robots could be used in everyday life (Bulgaria mind-mapping activity), to providing different craft materials for the construction of a robot (UK and Greece). In some workshops, students also found for themselves ways to add a creative art element to their robotic creations or customised their pre-built robots. We also see younger students naming their robots, speaking to them and waving.

Adding a creative, unspecified element to the construction of a robot or allowing students to customise their robot enhances a sense of ownership of the robot, providing an emotional connection for some and enhancing the sense of creating something personally meaningful. This type of activity can also enhance collaboration within the team as they discuss and agree on creative elements which all students can engage with regardless of their interest or ability in STEM subjects.

Another example of this is the creation of avatars in the virtual world. Here we see students working on a shared computer, creating a shared avatar. They agree on a name for their avatar and customise its appearance. In interviews and reflections, it appears that this is one of the easier tasks for students to discuss in relation to teamwork as it is a successful experience for all and provides an accessible initial reflective task to engage learners in introspective critical thinking.

In some workshops, we see the creative element introduced through storytelling. Here the robot can be programmed to tell a story or a story is written to match the actions of the robot. This appears to be a popular approach with young children and requires them to engage in complex abstract and creative thinking. It also has the potential to develop their argumentation skills.

These creative elements are all in addition to the creative exploration of possible solutions to problems, which is a key feature of ER4STEM activities, although it should be noted that many activity plans still rely on closed activities which provide limited opportunity for both creativity or critical thinking around possible solutions. However, by providing the additional creative opportunities described above and in the appendixes, students are able to engage in an increasing range of activities facilitated through their engagement with robotics.

4.2.3 Critical Thinking

The activity plans which were operationalised as part of each case study demonstrate a range of ways to engage students in critical thinking activities. Reflection was identified as one specific mechanism to engage learners in critical thinking about themselves and what they have learnt from the workshops. Across the case studies we see examples of students sharing and discussing ideas, often moving from a 'guess and test' approach to predicting what will happen, identifying problems in their constructions and codes, and making informed decisions about next steps.

We see one focus group which moves from a 'guess and test' approach to discussing their ideas, and predicting their outcome. This is a process for which there is no obvious mechanism through which the students develop their critical thinking skills, except through experience. Critical thinking in robotics requires abstraction and problem identification. Whilst each child may develop their critical thinking skills at a different rate and children of different ages may or may not be more cognitively able to engage in critical thinking, tutors can support students to make this transition by acting as a more knowledgeable other and scaffolding this experience. However, both in the standalone robotics workshop and typical classroom, this can require substantial time from a tutor to work with a single group. This emphasises the value of multiple tutors but also the difficulties for the implementation for educational robotics by individual classroom practitioners. Therefore, an environment in which students can share and discuss ideas, not only within their teams but also between teams is valuable, and is discussed below.

Another example of students engaging in critical thinking around problem solving can be seen in the Across Limits activity plan, when students have to develop multiple solutions to a problem, or where the parameters of the problem are changed (soldier patrol). These also provide students with a deeper understanding of robotics, programming, resilience, argumentation and prediction. These types of activities simulate the types of real-life issues with robotics, which are also seen in the competitions.

In the UK, primary school implementation of SLurtles we see children directly introduced to 'ways to think' when they encounter a problem. However, this is not repeated with the secondary school students, although it may be useful for them as students were observed becoming more reliant on the class teacher than each other when they encountered problems with their code.

4.2.4 Collaboration and communication

A key feature of ER4STEM activities is collaboration and the development of different approaches for the orchestration of teamwork (particularly for mixed-gender teams) was included in the recommendations from year 1. Strongly associated with collaboration is communication – within and between teams.

4.2.4.1 ORCHESTRATION OF TEAMWORK

As would be expected the orchestration of teamwork varied depending on the local context and the activity plan to be implemented. For example, across the Introduction to SLurtles workshops we see three main types of orchestration of teamwork:

- Working in fixed pairs, sharing a computer
- Working in non-stable pairs (may change from day to day), sharing a computer

- Working in pairs (sat apart from each other), individual computers, but sat with friends

The third of these appears to have been the most successful, allowing students to sit with their friends allowed them to stay in their comfort zone, ask for help from friends, give help to friends and express difficulties working with someone they didn't know. Yet, by working with someone in the room that they would not normally work with (all mixed-gender pairs except for one all-female group) they had an opportunity to meet and work with someone new, learn from and about them, develop their collaboration and communication skills.

The least successful was the non-stable pairs. In two cases we see students who started working on their own to create their avatars then had to form pairs working at one computer, sharing an avatar, due to technical problems. Then week-to-week some of the pairs would change due to absence. As a result, for some, there was no sense of a team or team identity and we more frequently observed one child choosing to exclude themselves from the activity by sitting back and, at most, simply observing the other. The concept of identity is discussed in the following section.

Across case studies we see both cooperation and collaboration within groups to complete a goal, as well as turn taking. This is sometimes dependent on the orchestration of teamwork by the teacher and the specific activities but we see multiple cases where teams work this out for themselves. For example, in the first Maltese case study, we see the focus group initially distribute roles (programming the robot and writing on the worksheet) which are swapped with each task so that each child has a turn at programming the robot. However, we quickly see them working together at the tablet to solve the same problem.

Where teams have roles distributed amongst the team and particularly where we see rotation of these roles between tasks (e.g. Greek case study) teams tend to have better cohesion. However, it is important that these roles are meaningful. In some cases we see disengagement of those students with less meaningful roles. For example, in the second case study from ESI, students in the team have one of four roles: 1 - writing the code; 2 - holding the cable and helping with the program; 3 - reading the task and making sure that everything is correct; 4 - making sure that the rules are followed. They were reminded to rotate roles in the first session but not in the second and some teams did not on the second day. As a result, we can see some potentially meaningless and repetitive roles within the teams, which may be the reason why some disengaged in the second session.

The number of students per group and the number of roles (explicit or implicit) is also important. In the Maltese case studies where students work in pairs sharing a tablet to write the code and have a worksheet to complete, student often share these roles and turn-take. However, teams of three rather than two tend to have more difficulties with at least one student disengaged as they have no specific task to get involved in. This also allows a student who is initially less interested not to exclude themselves and blame the activity.

While there is evidence of students being encouraged to take specific roles, there is no evidence across the case studies of teams being instructed to appoint a team leader. However, in a few cases we see team leaders naturally emerge. These teams work particularly effectively with the lead agreeing decisions with the team.

Another example of effective role distribution, we see students in one of the Greek workshops encouraged by the teacher to rotate roles as they start each new task. This ensures that each student, particularly in larger groups, has an opportunity to engage in all aspects of the workshop (programming, engineering, reporting, etc), develop their skills and gain knowledge. What we also observe with this rotation is increased collaboration within the teams, with the previous programmer supporting the new programmer or working with them to solve problems, as illustrated by the arrows between roles in Figure 1 as each person rotates to the next role.

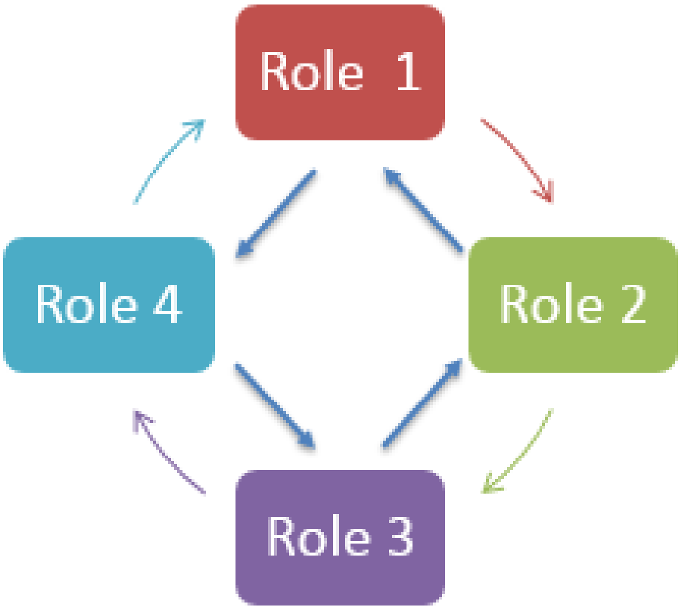

Figure 1 Illustration of the rotation of roles (to the left) with support from the last team member to have that role (anti-clockwise arrows).

Role rotation was also observed and supported by the ESI activity plan. Students kept their roles as domain of responsibility and they contributed on the main task at the specific moment (e.g. programming).

4.2.4.2 IDENTITY AND OWNERSHIP

Across case studies from different countries and age groups, we see workshops which provide opportunities for teams to develop a sense of team identity and ownership of their robots. We also see teams developing their own ownership activities.

In the first Greek case study students are asked to create a team name. These were placed in the team area and are considered to foster a sense of team identity, which promoted team cohesion. Some students also went further creating a logo for their team.

In other cases, where students are using a pre-constructed robot, such as Finch, some students are observed to personalise their robot by adding things to it or naming it. While this does not necessarily increase team cohesion, it strengthens ownership over their robot and we tend to see more collaboration rather than cooperation or disengagement.

In the SLurtles workshops, students must first create an avatar, which is named and customised by the students. This avatar represents the user in the virtual world and is seen by other users in the shared class islands. The creation of an avatar either for a team (of two students) or for an individual student provides students with a sense of identity within the virtual world and ownership of the avatar is seen as a potentially key issue in engagement. Those teams who work at one computer and therefore share an avatar were seen to actively engage in the activities throughout (although they may be excluded by their team mate). While one student controls the avatar, both are observed discussing possible solutions, sharing ideas and the one that is not in control of the computer is seen pointing at the screen. However, those who moved teams and had to use an avatar created by someone else were more likely to disengage by choice, isolating themselves from the activity. In these cases it would appear that the sense of identity within the virtual world through the construction of an avatar is a key component for sustained engagement with the robotics activities and positive collaborative experiences.

This concept of identity and ownership is important if we consider the constructionist idea that the development of knowledge is particularly strong when young people are involved in the construction of something 'personally meaningful'. Here we see students creating personally meaningful teams, robots and avatars, which appears to enhance engagement.

4.2.4.3 EXCLUDING, ISOLATING AND DISENGAGING

While there are many positive examples of collaboration within teams, we also see cases across case studies where students are excluded from activities by others, choose to isolate themselves from others, or simply disengage from activities. These are seen across mixed and single gender teams. While in mixed-gender teams the exclusion of others appears to be gender based, there is no consistency within or between countries – girls exclude boys and boys exclude girls. However, in these cases, as well as in single gender teams, there appears to be a recurring assumption by some children that others are less able and they are excluded for that reason. Similarly, a student who considers themselves to be more able may consider that the rest of the team will impede their ability to complete the tasks successfully and therefore try to isolate themselves from their team and take-over the activity. Gender may be one dimension along which assumptions of ability are drawn, but there will also be other factors and these may come from a conscious or unconscious bias. Whatever their source, assumptions about (in)ability are key.

The act of excluding others or isolating oneself is often achieved physically by moving and taking control of the robot and/or computer or the use of the body to block access to resources/tools. It is also more typical in students who identify in the pre-questionnaire that they do not like working in teams. However, this is less common where activities are complex, requiring all students to actively cooperate and take different roles for the task to be completed. It means that it is very difficult for one student to complete the activity on their own. In these cases, answers to the post-questionnaire question "what have you learned?" students identify that they have learned to work in a team.

We see students being excluded by others or isolating themselves whilst working in small pairs through to the largest groups of 5 or 6 students. Ensuring that tasks are complex and will require multiple students to be successful, providing sufficient roles for the number of students involved, providing multiple ways to engage in the activity and making explicit the need and how to collaborate are all important factors in avoiding exclusion and isolation.

Those students who experience exclusion from their group tend to report more negative impressions of teamwork in the post-questionnaire, stating that they didn't like team work; that they weren't listened to; they wouldn't like to do more activities like this one and giving a low star rating to the workshop. Once excluded, many students disengage from activities and a disengaged student is more difficult to reengage, than a student who has been excluded. The latter requires the tutor/teacher to help the whole team develop collaborative skills, whilst the former requires this as well as finding some way to reignite the robotic spark. However, we see instances where simply the teacher intervening, reminding the students that they should be working as a team is insufficient. Those who have been excluded need an opportunity to meaningfully contribute and for that contribution to be valued, as demonstrated in the first Greek case study and in the Bulgarian case study in Year 1 (D6.3).

It is also worth noting that it is very difficult to exclude or isolate if every member of the team is necessary for the competition of the task, as per jigsaw approaches to teamwork.

4.2.4.4 DISAGREEMENT AND COMMUNICATION

Unlike exclusion, isolation or disengaging, disagreement within teams is a positive aspect of collaboration. We see it across case studies and provides evidence of conceptual and knowledge gaps, misunderstandings and miscommunication, all of which must be addressed for the team to progress. Disagreements over the best 'next step' also demonstrates the complexity of the activities that the students engage in during educational robotics activities, where there are often more than one correct or appropriate decisions to make about the development of the robot to complete a given task. Thus, we see across the case studies students engaging in higher order thinking and expression of that thinking through argumentation, critical discussion, analysis and synthesis of problems and solutions, testing 'known' facts, the construction of knowledge and the application of new knowledge to the construction of their robots and code.

However, where students are unable to effectively express themselves or feel that they are not listened to, disagreements can leave students with a negative impression of teamwork. In these cases it is important to equip young people with effective communication skills, such as those described in Deliverable 4.2.

4.2.4.5 SHARING BETWEEN TEAMS

In various contexts we observe students sharing ideas, asking questions and providing help and encouragement between teams. In some cases this is mediated through the robot but in others it is the computer/tablet screen, which mediates this talk and form of interaction. Allowing the students the freedom to move around the classroom and visit others is an important part of classroom orchestration, which facilitates sharing. We see a good example of this in the second Malta case study where students are seen to exchange ideas and discuss problems between groups. This appears to be facilitated by the classroom setup. In this instance the workshop is held in the school gym and all children are sat on the floor with their robots and tablets. Each group has a designated space and these spaces are around the outside of the room, allowing groups to easily look across to other groups. There is also no explicit expectation that students must remain within their group at all times and we see individuals 'visit' other groups.

In some cases we students how have learnt a skill going to another group to share their knowledge. This is seen to work particularly well in one UK classroom where students who have learnt a specific skill in the virtual world are identified by the class teacher as 'lead learners' and can move around the classroom to help others. This was part of the existing culture of the classroom and one which could be fostered in robotics workshop across contexts. This idea was adopted in the UK primary school and provided an opportunity for two boys who has additional learning needs and typically asked others for help, to take a lead role in the classroom and show others how to do certain things in the virtual world, enhancing their sense of self-esteem.

Amongst these very positive experiences of between-team interactions, it is worth noting some less positive ones. In the first ESI case study we see children 'spying' on other teams, as part of an established classroom environment of competition, yet there was no designed competition within the workshop activity plan.

4.2.5 Evidence of Learning

Reflective activities, robot constructions, capture of code, completion of worksheets, creation of videos or blogs, final presentations and demonstrations all provided ways for students to identify for themselves what they had learned and share this with others. In the Greek and UK case studies, where class teachers implemented the activities, there was clear awareness of what was required in terms of national curricula and evidence the work completed by students.

One of the difficulties encountered with SLurtles was that each object constructed using the SLurtles required its own piece of code and capturing this consistently was difficult. Similarly the artefacts that were constructed were observable in the virtual world but difficult to capture as they could be quickly deleted, therefore we lose the attempts and only see the final product. Teachers in the two case studies were seen taking photographs of children's screens as they worked and completed tasks. However, another issue started to emerge. In both schools the students worked on a class island with no boundaries. Therefore, it was not easy to know who had created what – a student could move their avatar to another group's construction and claim that they had created it. To address this problem, students were provided with worksheets on which to record their code and teachers could easily question students about their solutions ("so how many degrees did the SLurtle have to turn each time?"). Here we see the use of verbal probing of knowledge which can provide evidence of learning.

However, where activity plans were designed and implemented by project teams without teachers, we see less clear evidence of learning. While students are able to identify specific things that they have learnt about themselves and working with others, they are more vague and non-specific when discussing domain specific learning.

4.2.6 Differentiated Activities

Although the introduction of differentiation was identified in the recommendations from year 1, there was little evidence in activity plans of this having part of the development of ER4STEM activities in Year 2. One exception to this is the Bulgarian workshops which included extension activities for those who finished early.

In general, although not explicitly identified in the activity plan, we can see that activities are differentiated by outcome. Either students do not complete all of the tasks (particularly where these had increasing complexity) or completed them to a different level to others (a robot that achieves all of the required elements, exceeds them or only achieves some of them). This form of differentiation may be a more natural fit with constructionist activities as the outcome should be determined by the interests of the child.

4.2.7 Evaluation of SLurtles

Year 2 of ER4STEM presented the first opportunity to pilot SLurtles with young people, presented in deliverable 5.2. SLurtles are robots in a virtual world which, when programmed, can move around the virtual world and create objects in the virtual world based on their movement. SLurtle Space was created in the OpenSim virtual world environment and provides an access controlled environment suitable for children in which they create an avatar through which they navigate and interact in the virtual world.

SLurtle workshops were implemented in six workshops with children between the ages of 8 and 13 years old in the UK and Republic of Ireland. Like other ER4STEM workshops, most SLurtle workshops required students to use one computer per team, however in one school where three workshops were completed, students worked one-to-one with a computer but worked in a pair with someone in another location in the same room. This meant that in some workshops students created a shared avatar and in others they created their own avatar. The outcome of this in relation to identity and ownership is discussed above.

SLurtles were implemented in multiple lessons per workshop and the workshops were designed by the researcher and class teacher. Unlike the majority of ER4STEM workshops, workshops implemented in the UK and Ireland had to be integrated with national curricula and the standard school timetable. Therefore lessons lasted anywhere from 50 minutes (secondary schools) to 2 hours (primary schools). This demonstrates that the activities are suitable for the typical classroom and met the curriculum requirements (as determined by the class teacher). However only having 50minutes per lesson, we see that the secondary school aged students only progressed at a similar rate to the primary aged children who had 2 hours per session, when we might expect them to advance through similar activities at an accelerated rate. While this occurred during SLurtle workshops, it is unlikely to be a technology related issue. Rather it suggests that when engaging in robotics activities, where students have to engage with and learn complex new ideas and activities, providing them with an extended time to work per session is beneficial.

As we observe students programming SLurtles we identify similar behaviours to those we might expect with physical robots, such as 'guess and test' strategies, sharing and discussing possible solutions, hypothesising outcomes, sharing what they have created with other groups, etc. However, as the robots are not physical we do not see students picking up the SLurtle and using it to explain their ideas. Instead, children are more likely to run the code in the robot, see what it does and discuss the outcome. The advantage that SLurtles have here is that by leaving a trail of objects as they move, students are able to discuss what the SLurtle has done, pointing to concrete objects.

The virtual world removes the 'messiness' of physical robotics. The SLurtle can be positioned at any height and will not fall (unless gravity is turned on). Students do not have to consider the effect of friction or motors turning at different speeds. This can be an advantage, as students are able to focus on the problem presented (creating a square) and the mathematical concepts of angles and lengths, without being distracted by friction and potentially developing inaccurate knowledge and becoming frustrated. However, by removing this messiness, we remove opportunities for unexpected and unplanned for conversations which stimulate young people's interests and passions. There is no clear cut 'best' solution, and in fact the virtual world presents its own opportunities which would not be found in 2D environments such as Scratch or Turtle Graphics, as a perfect script to create a square in 2D will create a square with missing external corners in the 3D and providing an opportunity for new mathematical conversations.

All age groups actively engaged with SLurtles, programming them to create increasingly complex objects. After creating their avatars and becoming familiar with the virtual world, the lessons typically began with structured activities to familiarise students with the process of programming and what SLurtles could do. In the workshops we see a tension between structured and open activities. While some teachers were keen to provide students with the freedom to create anything they wanted to, using SLurtles, we see that students often didn't have sufficient knowledge about what could be created so as to be able to imagine and design what they might make with their SLurtles. Similarly we see some teachers keen to provide structured progress, but children keen to expand beyond this "now we can draw a square, can we make a house?" (girl, 9). Where this worked best was in one school, which participated in 3 workshops with the same class. The first workshop focused on open exploration of the virtual world and what SLurtles could do. After a month, this was followed by a workshop where students designed a house for their avatar, which would be built by SLurtles. However, the students felt they had insufficient knowledge and quickly moved from using the SLurtle to construct the house to the general building tools available in the virtual world. So in the third workshop the teacher introduced structured tasks, with students programming their SLurtle to create a dancefloor and staircases for their houses. From the interviews at the end of the third workshop, we captured students expressing a wish to be given more structured tasks to build up their knowledge earlier on and once they know what is possible then have the opportunity to develop their own artefacts with SLurtles, in effect moving the creative element of construction to later in a series of workshops.

As previously mentioned, evidencing learning through the use of SLurtles due to their non-physical nature is problematic. During the lessons we see the class teachers taking photographs with their phones to use as evidence for school monitoring purposes. Therefore in year 3, it is important to identify approaches that can work in the typical classroom.

4.2.8 Pedagogic Strategies

Within the case studies we see examples of broadly social constructivist and constructionist pedagogic strategies. There is a lot of experimentation, guided discovery and directive instruction. Peer-learning is an expectation of group-based activities, but as previously mentioned, students may need to be introduced to the importance of listening and communicating effectively with others for this to occur.

Although described as constructionist activities, we might consider that some activities which involve construction by following a pre-prescribed guide is not a constructionist one but rather instructionist. One factor which influences is the duration of workshops. With the majority lasting up to only 8 hours, there is often insufficient time for truly constructionist activity throughout and this is often left to the programming activities in the workshop. Where students are already familiar with construction and programming there are more opportunities for them to engage in constructionist activities throughout.

Experimentation and guided discovery are the most prominent pedagogic strategies, which means that the role of the teacher is predominantly one of facilitator. While on the surface this sounds as if the teacher will do very little, we observe tutors actively engaged throughout each workshop. Tutors are seen helping students to identify problems; explore possible solutions; work with dysfunctional groups; provide technical support; explain new concepts; facilitate the sharing of ideas and new knowledge (particularly technical skills) across the classroom; and so on.

To support so many students with so many different needs at any one time, tutors are seen to employ different strategies. One of these that works well and is a common pedagogic strategy of experienced teachers is to pause the whole class and speak to them as a whole about a common issue. This works well where it is brief and students are not distracted by robots or screens. The interruption to their work with the robot is seen as temporary and useful. However, where we see students stopped for several minutes we also see negative responses from students, often expressed as boredom. It is worth considering that whilst engaged in group activities with robots, students are typically observed to work at a high pace, and when this pace drops, either because they have finished an activity and are waiting to start the next, or they have been stopped by the teacher, they quickly become bored, distracted and disengage.

4.2.9 Unexpected Findings

4.2.9.1 RESILIENCE

Across case studies and the competitions, we find evidence of students developing resilience. That is, as they engage in activities and encounter difficulties, they develop ways to cope with failure. That failure may be experienced in many ways - expressing an idea, experimenting, trying something for the first time, etc. It is important that students are encouraged to do these things, even though they may not be successful. This may require the support of peers or the class tutor. It can be addressed in a whole class environment or with groups and individuals, and may require the development of a supportive classroom or team environment.

The ability for young people to cope with failure is a growing issue for educators in Europe, with some governments focusing on the continued measurement of students throughout their education as a way to assess schools and teachers, students report growing levels of stress anxiety and depression from a young age, linked to assessment. However STEM fields require people to make mistakes and learn from these. Educational robotics activities provide learners with a relatively risk-free environment in which to make mistakes and learn, as it is widely acknowledged by those running the activities that this is a necessary part of the process. However, it is worth noting that this could change as non-specialist or inexperienced teachers attempt to introduce robotics activities within a narrowly defined and overly packed curriculum. This is one area which the ER4STEM framework, activity plan and repository could make an important longer term impact (beyond the time of the project), by making teachers aware of these issues, the reality of robotics from a classroom and industry perspective and providing realistic approaches for use in the classroom.

4.3 COUNTRY LEVEL

At the country level analysis, we aim to answer the research questions and address the evaluation criteria, as presented in section 2 above.

4.3.1 Research Questions

4.3.1.1 OBJECTIVE 1: ER4STEM WILL APPROACH AND ENGAGE CHILDREN BY OFFERING MULTIPLE ENTRY POINTS INTO CREATIVE STEM (STEAM) VIA ROBOTICS

- Are there multiple entry points facilitated through the ER4STEM framework?

Yes.

As mentioned in deliverable 4.2, some of the teacher designers provide an interesting view on this aspect. Specifically they recognize that mixed ability groups might support multiple entry points in the sense that students with low interest or with no experience with robotics can be supported by other students who are more enthusiastic and more familiar with the technology. Introducing authentic tasks or tasks related to real life is also considered as offering a new entry point for students to robotics activities. Another view involves identifying and making explicit to the students the different tasks involved in educational robotics: i.e. hands on activity (construction), programming, making calculations, giving names to the robot (upon which students build a sense of ownership), introducing argumentation activities where students present their work to the rest of the groups of their class. The rationale behind this concept is that students with different interests or inclinations can find an entry point to be involved with the robotics activity (e.g. make the calculations, perform the tests, take the photographs and write a short presentation of the robot to be uploaded in the online environment (e.g. Edmodo) for the rest of the class to see etc).

We also consider that multiple entry points to educational robotics activities can be found in activity plans with a multidisciplinary dimension. An important prerequisite for an activity to offer multiple entry points is to have integrated well in its main idea concepts from other domains. Furthermore, the activity plans constructed for the project during the second year, offer multiple entry points for students who might be interested in art: including video construction, in story telling – drawing, in mathematics, sustainability and biology.

The tasks of a "security guard" and a "lottery drawer" introduced in the activity plan of Across Limits can be considered as offering multiple entry points to the students in the sense that they do not focus on the concepts of programming or robotic construction. Instead, they bring in real life tasks and professions as a context to be analysed and modelled in terms of robot behaviour.

As mentioned previously, we also see the increasing opportunities for students to engage in various forms of creative activities throughout ER4STEM activities as supporting multiple ways for students to engage with robotics.

- Do the activities allow learners to connect robots to their personal interests?

  Yes

  Across the range of ER4STEM workshops, we see students being given explicit opportunities to connect robots to their personal interests, as well as finding ways to personalise projects and making them personally meaningful. For example at ESI workshops, students engage in mind-mapping activities where they explore the potential of robots to their own and future lives. We also see students asked to design a robot, which will help them in their daily lives. Students also become intrinsically invested in the creation and programming of their robot, or in the virtual world the constructions that their robots are programmed to make. For example, students are asked to programme the SLurtle to create a house for their avatar, this is a personally meaningful activity due to the connection the student has with their avatar.
- Do children share their ideas with/through these tangible artefacts?

  Yes

  Across partners we see examples of students sharing ideas and completed constructions through their robots as well as virtual constructions created by robots in the virtual world. Students use their robots to explain ideas and concepts to others within their groups, as well as formally (through presentations) and informally between groups. The artefacts provide students with something to talk about and through which they can express complex ideas.
- Do they learn basic scientific concepts?

  Yes

Across the activity plans we can see students engaging with STEM subject concepts. We also see them developing an awareness about the way to work as a scientist – exploring, hypothesising, testing and reporting.

4.3.1.2 OBJECTIVE 2: ER4STEM WILL OFFER EDUCATIONAL METHODS FOR EDUCATIONAL ROBOTICS TO ENGAGE ALL YOUNG LEARNERS

- Do the activities encourage interest in STEM education?

  Yes

  The pre-questionnaire demonstrates that children who participated in activities in UK/Ireland with Cardiff University, Austria with PRIA or TUW, or Malta with Across Limits were least likely to agree or strongly agree with the statement "I like maths" and, as it may be expected, these students were also less likely to state that they would like to study maths when they are older. Similarly these students were less likely than those from Greece or Bulgaria to express an interest in studying science, although their self-efficacy scores for science were higher than for mathematics. The tables presenting this data can be found in Appendix A. However we do not have a clear picture on the attitudes post-workshop.

  While the closed questions in the questionnaire provide insufficient insight, the open questions, observational notes and interviews reveal that by engaging in the workshops students attitudes to STEM subjects do change and are broadly positive. We see from some of the responses to the open questions and interviews that students liked learning STEM subjects through robotics.

  Some were not aware that they were studying or using their subject knowledge, although they clearly were. As one student said "are we doing maths?". This raises an issue for the evaluation – if students are not explicitly aware that they are being taught these subjects, their attitudes to these subjects are unlikely to change. It also raises questions about the ways in which these subjects are typically taught, often characterised in the UK and Republic of Ireland as a traditional instructionist approach with the teacher at the front of the room demonstrating and explaining, followed by the students engaging in drill and practice activities. Therefore it is perhaps understandable that students would not consider that they were learning maths as it does not fit with their existing schema of 'learning maths'.

  What we do see is that students identify that they have engaged with STEM and developed a sense of self-efficacy.

  It should also be noted that some students state that through these workshops they have realised that they do not like programming (for example) or that they would not like to be a computer programmer. While this may appear a negative result for a project which aims to increase interest in STEM subjects and careers, it should be considered as an important moment for a child who has demonstrated engagement throughout, learned about programming and come to the self-realisation that this is not an area that they wish to pursue.

- Do the activities encourage interest in STEM careers?

  Unclear.

  Across countries we see that some students who were previously not interested in STEM careers, identify that they would like a job which involves STEM and sometimes explicitly robotics, in the future. However we also see some students turn away from STEM subjects. Therefore the data provides us with no clear answer to this question. However we should consider the fact that these are relatively short interventions of perhaps 6 to 8 hours. Therefore it might be unrealistic to presume that such a significant change to career aspirations would be possible. It should also be considered that older students in these countries have typically already had to specialise in their chosen career path by selecting which subjects they will study at different ages. For example, choosing to attend a technical high school in Austria.

  What we can see from the workshops, through the interviews, is that through ER4STEM activities students become more aware of the soft skills that those working in STEM careers require, such as patience, perseverance, reflection, imagination, creativity, a willingness to accept help from others and acknowledge that they might be wrong. This is likely to be reflective of the new emphasis on 21st Century skills in activity plans. By making these things explicit students become more aware of them.

It is also worth noting that where workshops are completed in just a few days, some students were heard asking "why are you asking me this again" or "I already answered this question" in reference to the post-quetsionnaire question 'what job would you like to do in the future?'. This highlights that to answer this research question is not as simple as asking students about their aspirations as these are unlikely to change in the short term but recognising that they may express new interests which relate to STEM as the result of ER4STEM activities.

- Do the approaches/activities appeal to girls?

  Yes

  Across data sets and across countries we clearly see girls of all ages actively participating and expressing enjoyment in the activities. One thing that can be noted is that the girls may be more vocal about having more creative opportunities liked to art and design of their robots than boys. Also we can see that teamwork is an effective approach for girls.

- Do girls engage with challenges or let boys 'take over'?

  Girls engage

  Again, across data sets we see girls actively engaged in activities, whether in single or mixed-gender teams. Where boys take over, it is often with protest from the girls. Boys also take over in all-male teams.

  It is also important to note that boys engage and sometimes girls take over, with protest from the boys. Girls also take over in all-female teams.

- Are girls interested in the STEM topics?

  Yes

  In much the same way that the activities and approaches appeal to girls, we see them interested in the topics that they are presented with.

- Are popular gender stereotypes held? Are they changed?

  Yes

  From the draw a scientist test we can see that overall gender stereotypes, such as a scientist being male, hold true at the start of the workshops for both boys and girls. Although changing the prominence of the gender (where linguistically relevant) appears to have some effect on the gender of the scientist drawn, initial findings suggest that this is only true for girls. However, as not all partners changed the order of the instructions presented, this finding is yet unclear and will be further explored in year 3.

  During the workshops we see boys excluding girls and this may be due to gender stereotypes. This explanation is more likely in a larger team of 2 boys and 2 girls, where both girls are excluded. However we also see exclusion across all types of groups. Whether or not these are to do with gender stereotypes, it could also be argued that this is due to students existing assumptions about their peers' abilities. Regardless of reason, these attitudes are difficult to change and as discussed in the case study analysis requires students to demonstrate that they are able AND to be given an opportunity to demonstrate this.

  At the end of the workshops, children, particularly girls express an awareness that they "can be scientists too".

- Did they participate in collaborative work?

  Yes

  Across all ages and genders, we see children participating in collaborative work as part of ER4STEM activities. Whilst there may be some cases of isolation or exclusion, these are typically resolved either by the students in the team by themselves or with the intervention of the teacher.

- Were those who were not interested in STEM inspired by their peers?

No evidence

Whilst the data allows us an in-depth analysis of individual workshops, we are unable to track individuals to this level unless they were involved in the focus groups. Those students who are not interested in STEM careers or subjects and who have been included in the focus groups by chance (providing a more detailed collection of data throughout the workshops), we are unable to discern whether these students are inspired by their peers.

What is clear from observations, interviews, reflections and questionnaires is that students worked with and learned with and from their peers. Students who were not interested in STEM participated equally well and enthusiastically as their peers. Whether this is due to their peers or the activities is unclear.

Through data collection and analysis it is clear that it is not possible to clearly answer this question, and therefore the recommendation is that this question is removed from the third year of the project.

4.3.1.3 OBJECTIVE 3: ER4STEM WILL STUDY REAL-WORLD SOCIETAL PROBLEMS AS PERCEIVED BY EACH CHILD AND RELATE SOCIETAL CHALLENGES TO EXISTING TECHNOLOGIES AND REQUIRED INNOVATIONS

- Did children identify and define problems that influence their lives?

Sometimes

There are examples of ER4STEM workshops in which children identifying and defining problems that influence their lives (see deliverable 4.2). For example, the PRIA workshop where students are asked to think about how to 'save the world' in the Hedgehog activity plan. However this is not common across workshops. One of the reasons for this is that many workshops are an initial introduction to robotics, or focus on developing specific STEM knowledge or 21st Century skills with robotics as the vehicle for this learning. However we do see in some of these workshops opportunities for students to collaboratively identify and define problems that are relevant to context of their work.

What is less apparent are opportunities for students to engage with wider societal problems as perceived by them. Here robotics needs to be a vehicle through which students engage with these wider issues or use robots as a stimulus to discuss real-world problems and potential solutions. This will be considered in the Year 3 evaluation.

- Were they equipped with the necessary skills to solve these?

The notion of solving a problem suggests successful completion of a problem. However, problems that might be identified by children are likely to be complex and it is unlikely that children will have or be able to develop sufficient skills to completely solve a problem. Yet, if we consider that solving a problem includes imagining possible solutions and creating prototypes, then **yes**, the children were supported to solve the problems that they identified. These skills include not only STEM knowledge but also 21st Century skills. We see that in the second year of the project the workshops provide students an opportunity to develop these skills. So whilst it is difficult to definitively state, we can see evidence of children developing necessary knowledge and skills to solve the problems they identify.

- Do they have an opportunity to present their ideas and artefacts to each other as 'proper' scientists?

Yes

Some workshops include a specific session for students to present what they have created, how it was created, etc to others as 'proper' scientists. The ECER competition also includes students presenting their scientific papers to each other and a selection of these are presented at the academic Robotics in Education conference which runs in parallel.

We also see examples of less formal presentation of ideas and artefacts to others during workshops with students explaining what and how they have done something to other groups

- Do they develop 'soft-skills'?

  Yes

  With the focus on 21st Century skills recommended in year 1 of the project, we can see that across workshops in year 2 that students have more explicit opportunities to learn and develop 'soft skills'. These tend to focus on collaboration, communication and creativity, however we also see students developing their critical thinking skills through a range of activities, as previously described.

- Do they learn intrarelational (how well they know themselves) and interpersonal skills?

  Yes

  Awareness of themselves, what they are good at and need to develop, is often liked to interpersonal skills. Through reflection activities, including the post-questionnaire, students have an opportunity to critically think about their experience of working in a team and what they need to personally improve on and we often see that these are linked with statements such as "I need to listen more". As stated, there is typically an emphasis on collaboration and communication in workshops which enhances students' awareness of the principles of good team work.

4.3.2 Unexpected Findings

4.3.2.1 WORKSHOP COMPETITIONS

Other than the ECER competition, a competitive element is unusual in ER4STEM workshops. For the first time in Greece, three workshops included a competition. In all three workshops the winner was the team whose robot completed the task faster than the others. This was observed to foster collaboration within teams, was highly motivational and led to high levels of engagement, including teams extending activities beyond the minimal requirements to complete the task. We also observe a class or group-generated sense of competition in some focus groups where the workshop did not explicitly involve competition, where students want to be demonstrably better than others or want to show that they are as good as others. This can be a positive implicit and sometimes explicit motivator.

While competition or a sense of competition can have many potential benefits, we see in the example of classroom culture of competition from Bulgaria described earlier and also in the Greek data, the potential for competitions to be a negative experience for some, potentially discouraging students from participating in robotics activities and thus removing the potential of robotics to ignite and change attitudes to STEM for these students. In both countries, we see that the competitive element or culture prevented between-group collaboration and support, and encouraged rivalry and hostility between teams.

In Greece, we observe that students who were older (14-16) and had previous experience of robotics found competitive elements highly positive. However younger students, specifically those in primary school who had no previous experience of robotics had a much less positive experience. Specifically, those whose first experience of robotics was a competition which they lost, had a negative attitude towards robotics and STEM in a follow-up activity, even though it contained no competition. A key factor in this may have been the decision of the teacher in this workshop to announce not only who had won but also who had lost, resulting in public shaming. Therefore we should consider the importance of the actions of the teacher along with developing resilience, possibly through familiarity with robotics activities, ahead of the introduction of competitive elements.

4.4 PROJECT LEVEL

The pre and post-questionnaire data analysis is presented in Appendix A.

Although all age groups were, on average, positive about the workshops, as shown in Table 2 (section 3.2), the younger ER4STEM age group of 7-10 tended to give a higher rating for the workshops. This age group was also more likely to identify the workshops as fun. We can see this in the case studies and country level analysis - there is a clear appeal for younger students. However there is also a strong appeal for older students, who, although already specialising as they progress through their education find robotics activities both challenging and interesting.

Here we pick out two key issues from the questionnaires which haven't been discussed elsewhere: past experience and language.

4.4.1 Past Experience

We can see quite clearly in Table 4 that in the majority of workshops, students report no previous experience with robotics before the workshop. However in Greece and Bulgaria students are more likely to have previously participated in robotics workshops (Figure 1). In Bulgaria these experiences were gained in workshops implemented in year 1 of the project.

Table 4 Previous experience with robotics – have you ever created a robot before? Number of participants per partner.

Partner	No	Yes	Total Participants (n)
AL	301	95	402
CU	89	12	103
ESI	136	204	346
PRIA	183	84	271
TU Wien	120	61	182
UoA	62	56	120
Total	**891**	**512**	**1424**

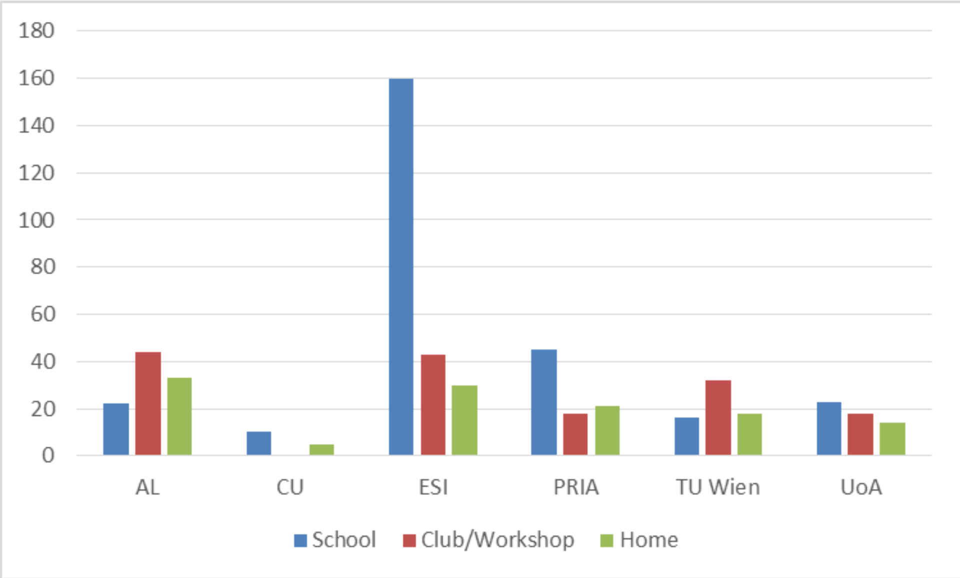

Figure 2 Location of previous robotics activities.

When we look at students' past experience of programming, we see a slightly different picture. Children are much more likely to have gained experience of programming ahead of the workshops than created robots. As shown in Figure 2, this experience has typically been gained in school. This is likely to be because of the growing international interest in programming in schools and various governments deciding to introduce programming/coding/computational thinking and so on into the national curricula.

Table 5 Previous experience of programming.

Partner	No	Yes	Total participants (n)
AL	185	208	402
CU	37	60	103
ESI	131	205	346
PRIA	137	127	271
TU Wien	97	83	182
UoA	37	82	120
Total	**624**	**765**	**1424**

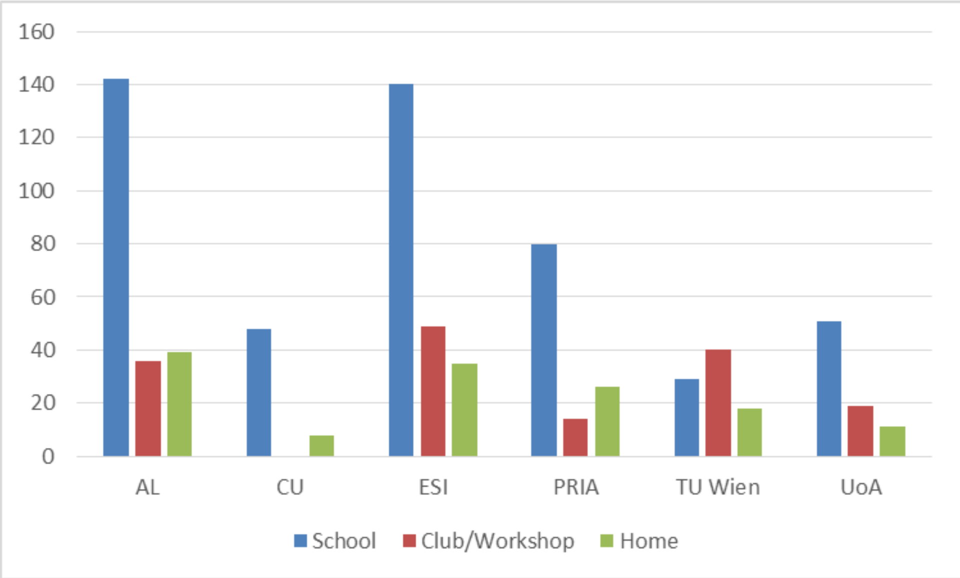

Figure 3 Location previous programming experience gained.

4.4.2 All Young People

The project proposed that ER4STEM workshops should appeal to <u>all</u> young learners. While the main focus of the project has been on the gender dimension, we should also consider intersectionality. For example, the girl who has an additional learning need, or the boy who is a non-native speaker.

We see in the activity plans that most workshops are designed without specific considerations of additional learning needs, although partners and teachers report students with dyslexia and dyspraxia, those on the Autism Spectrum and students with moderate to severe behavioural issues as present in the workshops. While it is not the focus of this research, what we see is that all young people engage with the workshops.

As we might expect, most students who participate in the workshops speak their local language and Malta and the UK have the highest percentages of English speakers. The significance of this for ER4STEM is the programming languages students use in the workshops. For example, in Bulgaria a graphical-block language is used which is mostly in Bulgarian but also contains English words (Figure 4).

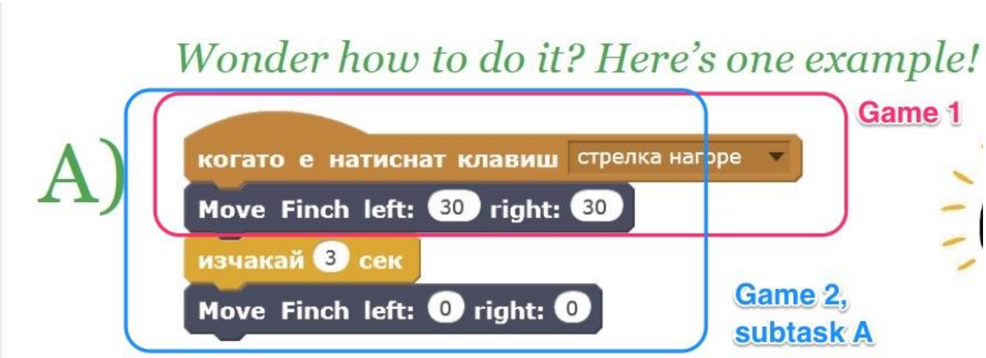

Figure 4 Example of programming language from game.

In other workshops and in competitions students use a textual programming language which is based on English. Similarly English is the language that students are expected to speak during the ECER competition and presentations. Clearly there is a tension between engaging children in robotics activities who have no previous experience, particularly when learning programming concepts, and doing so in the local language or English.

There is no clear-cut answer or solution to the question of whether to introduce non-English speakers to an English-based programming language when they begin to programme. However, to lower the cognitive load it would be logical to begin (where possible) in the local language and once key concepts are understood to change to an English programming language. The only instance where this becomes more complicated is for non-native speakers of the local language for whom it may equally difficult to learn language and concepts in the local language as it would be for them to learn it in English. In these cases we might consider that where a class is comprised of predominantly non-native speakers that an initial introduction to programming could be through an English-based programming language.

5 DISCUSSION OF FINDINGS

Overall we can see that the majority of recommendations from year 1 (D6.3) have been considered and implemented during the workshops in year 2. The introduction of creative activities has been particularly successful and this has substantially increased the number of entry points into robotics. We also see a growing number of approaches to collaboration and teamwork with the innovative use of jigsaw approaches to teamwork in TUW and UoA workshops. While further work in capturing evidence of learning (as part of the workshops, as opposed to the evaluation) and considering assessment (as mentioned at the end of the Activity Plan template), as well as differentiation of activities; overall there is good progress by all partners.

Across the ER4STEM project we can see that competition, whether part of the organised competitions in WP3 or as part of the workshops in WP2, can have both positive and negative effects on learner outcomes. A key issue is the fostering of a supportive community, with teams supporting as well as competing against each other. Shared spaces and opportunities to observe and discuss the work of others are important. Also, we see from the ECER competition the celebration of success, in whatever form, is important; as opposed to pointing out failure. Through competitions, students are encouraged to take risks and in extended competitions the use of the 'Alliance Round' also helps to develop a community of support.

In the first project year it was noted that mixed-gender teams were more likely to have problems with collaboration than single gender teams. This is a repeated finding in year 2. That is not to say that single-gender teams do not have problems – we also see exclusion of others, or one child taking over in single-gender teams – however mixed-gender teams, particularly those where one gender is dominant in number can result in exclusion or over-dominance and require both monitoring during the activities but also whole-class work to address some of the stereotypical assumptions. We can highlight this as a particular issue as there is a tendency for children to choose to work in friendship groups of a single gender and if stereotypical assumptions about boys and girls in relation to STEM are to be challenged, young people need to have experience of working with the opposite gender. Additionally, beyond school in the workplace, adults are expected to work effectively in teams, which may not be of their choosing and are likely to be mixed gender.

We see that on average participants responded positively when asked how many stars they would give the workshop that they attended, out of 5 (Table 1). By comparison to year 1 (D6.3, Table 1), there is no significant change in the workshop ratings, although all partners except Across Limits and Cardiff University showed a small increase in their average star rating (Cardiff University didn't implement any workshops in year 1). As described above (section 4.3), the older students in Malta were less likely to give a strongly positive evaluation of the workshop, by comparison to the younger primary school children. As only primary school children participated in Across Limit's workshops last year, the workshops for this older group of children is the reason for the decreased star rating, highlighting the importance of revising these workshops next year.

It is worth highlighting that even in a reasonably universal rating system such as stars, which are likely to be familiar to students from playing games at home as well as school activities, students may misinterpret or misread the question (as they might any question on a questionnaire). One example of this is where a student in the UK has given the workshop 1 star and in her explanation refers only to her own inadequacy and that she needs to practice. It therefore appears that the student is giving herself, rather than the workshop a 1 star rating. Issues such as these are most likely to impact partners with small numbers of participants.

5.1 RECOMMENDATIONS

Given the above comments and findings, the following recommendations are made for the final year of the project. It should be noted that these recommendations are about refining existing practices and identifying key issues, rather than making radical changes, as appropriate for this stage in the project. In the case of recommendations relating to workshops, it is not expected that every activity plan will include all of these elements, however we would expect to see all of these emerging across the workshops provided within the curriculum (WP2).

1) **Teamwork**: Activity plans should include specific tasks to explicitly introduce and engage students to/with relevant aspects of teamwork (e.g. involving everyone in the completion of a task, how to effectively communicate ideas).
2) **Team roles**: Where teams are expected to distribute roles amongst the team, it is important that all children get the opportunity to take each role, that roles are specific, required and not repeated. More than one child may take a role (e.g. programmer) at any time.
3) **Teamwork, exclusion and disengagement:** Where students are seen to be excluded from activities, students need to be reminded about how to work in a team and be supported to develop collaborative/cooperative working practices. Where a student has also disengaged it is also important to reignite the spark of interest in robotics. This will take time and is more practical in workshops with multiple tutors.
4) **Teamwork and exclusion:** Students who are excluded need to be provided with opportunities to demonstrate to their team or the wider class their ability and potential to contribute to the team. This may be more effective than the teacher telling the team to work together.
5) **Teamwork and gender stereotypes**: Activities to raise awareness of implicit and explicit gender biases in relation to STEM should be part of the wider ER4STEM curricula.
6) **Teamwork, identity and ownership**: When teams are first formed, provide ways for them to develop a sense of team identity (e.g. creating a team name) and ownership (e.g. allowing them to customise a pre-built robot).
7) **Supporting between-team interactions**: Provide shared spaces for students from different groups to meet and encourage the sharing of ideas/supporting others (e.g. a shared resources/testing table)
8) **Competition and community**: Foster and develop a sense of community and peer support in otherwise competitive environments.
9) **Creativity**: Continue to develop multiple ways for students to incorporate a creative element within robotics workshops.
10) **Critical Thinking:** Develop ways to introduce students to ‘ways to think’ when they encounter problems.
11) **Developing resilience**: The ER4STEM framework, activity plan templates and repository should draw attention to the need to develop resilience and provide recommendations for non-specialists
12) **21st Century skills**: Should be gradually developed across the ER4STEM curriculum.
13) **Evidence of learning:** Develop ways to evidence learning as part of activity plans.
14) **Evidence of learning with SLurtles**: Identify achievable routes for teachers/students to evidence learning in the virtual world.
15) **Differentiation**: Develop approaches to the differentiation of activities for learners.
16) **ECER Competition**: Provide at least two, easily accessible practice spaces and encourage the use of free testing time.

17) **Evaluation:** Draw-a-scientists gender to be reversed (language dependent) – female form first for all partners.
18) **Evaluation:** Remove inspiration question from research questions.

6 CONCLUSIONS

At the end of project year 2, we see ER4STEM activities maturing. Through implementation of the recommendations non-pedagogic partners are developing substantially improved activity plans. This is in time for their integration in the ER4STEM repository (WP5) in the final year of the project. While there are further recommendations for activities in year 3, these are about refinement of existing practices, rather than the introduction of anything substantial.

Overall the project is on track to meet its aims and objectives. We see that most research questions are answered in the positive and where results are unclear, this identifies areas for further analysis.

7 SUMMARY

This deliverable has reported on the analysis and evaluation of the ER4STEM project in year 2. Data collected using the evaluation kit (D6.2) in workshops implemented in year 2 (WP2; D2.2) and a modified evaluation for the competitions (WP3), were analysed using a range of approaches. Findings have been presented at 3 levels of analysis. The findings demonstrate progress on year 1 and recommendations and the project objectives. A further 18 recommendations have been identified to further refine the work of ER4STEM in year 3.

8 GLOSSARY / ABBREVIATIONS

AL	Across Limits (project partner)
CU	Cardiff University (project partner)
EC	European Commission
ER4STEM	Educational Robotics for STEM
ESI	European Software Institute (project partner)
PRIA	Practical Robotics Institute of Austria (project partner)
REA	Research Executive Agency
SLurtles	Programmable robots in a virtual world
STEM	Science, Technology, Engineering, and Mathematics
TUW	Technical University of Vienna (project partner)
UoA	University of Athens

9 APPENDIXES

9.1 APPENDIX A: ECER COMPETITION YEAR 1

This report was missing from D6.3 and so is included here for reference. It begins with an overview of the competition, followed by analysis of the data.

9.1.1 Botball European Regional Tournament

Age: Middle- and High-Schoolers

Set for building the robots: Official Botball set consisting of Lego parts, metal parts, 2 controllers, servos and motors and one modified vacuum cleaning robot. No additional parts are allowed for building the robot.

Game: official Botball gametable where there are many different tasks to do (see attached picture and rules)

9.1.2 PRIA Open Tournament

Age: no restrictions

Set for building the robots: no restrictions

Game: official Botball gametable where there are many different tasks to do

9.1.3 PRIA Aerial Tournament

Age: no restrictions

Set for building the robots: no restrictions, any kind of (ready-made) drone can be used

Game: official Aerial arena - task this time: land on moving ground robots

Botball and PRIA Open are very similar, except that in PRIA Open you can use your own controller and don't have to use the one provided in the official Botball set. Some of the teams competing in PRIA Open this year used the Hedgehog controller developed by us, PRIA, for example.

Botball and PRIA Open are scored based on several factors. There are different kinds of tournaments within Botball and PRIA Open

9.1.4 Types of competitions within ECER

9.1.4.1 SEEDING ROUNDS - BOTBALL & PRIA OPEN

One team competes on one table on their own. They try to score as many points with their two robots as possible. Three rounds, the average of the best two ones makes the final Seeding score.

9.1.4.2 DOUBLE ELIMINATION - BOTBALL & PRIA OPEN

Two teams compete against each other on one table. The team scoring the most points wins the match. For example a score of Team A: 1 point and Team B: 0 points would mean that Team A wins. So trying to do as many tasks as possible with your own robots might not actually be the best strategy. You can also try to block the other team's robots of scoring points.

Double Elimination: You have to lose two matches to be out of the tournament.

Since there were more teams competing in Botball than in PRIA Open, Botball Double Eliminations are split in two sessions: "regular" Double Eliminations and the Finals of the Double Elimination. The regular DE rounds are played until only 8 teams are left in the tournament. These teams then compete against each other in the Finals of Double Elimination, which are usually held the next day.

In PRIA Open, the Double Eliminations are played in one session only. So there is no separate "finals" part, but the DE matches are played until there is one winner.

9.1.4.3 ALLIANCES - BOTBALL

In order to not frustrate the losing teams of Double Elimination (the ones not able to compete in the finals), Alliances are held. This tournament is similar to the Seeding rounds: you try to score as many points as possible. However, you get assigned to a second team and try to score as many points as possible together. Usually, each team puts one of their two robots on the table. The two assigned teams now compete as one team. Again: Three rounds, the two best ones count.

The Alliances are held at the same time as the Finals of Double Eliminations.

The points you score in Seeding, the rank in Double Eliminations and the paper score (and the Documentations score in Botball) make the Overall score in Botball and PRIA Open. The Overall winner however is usually not that important to the audience and to the other teams. Much more important (and therefore: more famous and respected) are the winners of Double Eliminations. Usually, all of the teams watch the final match of DE, cheering and clapping for their favourite team. The atmosphere during the final match is amazing.

9.1.5 Spatial Layout of the conference

9.1.5.1 MAIN ROOM – COMPETITION AREA

At the ‘Front’: there is a wide desk for minor tech support. Here the ECER team runs/organises the groups. The competing/practice teams are listed and the next teams to be called are listed. On the opposite side of the room are two competition tables, roped off.

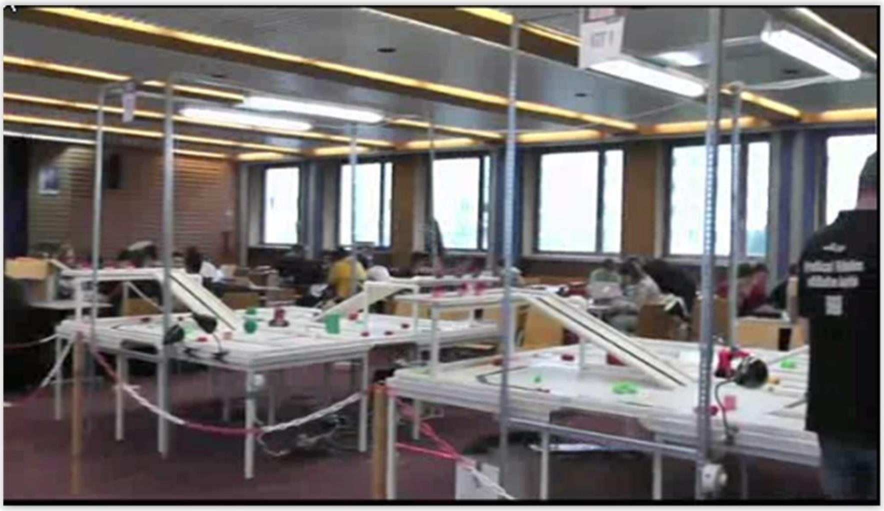

Fig 1. Competition area

9.1.5.2 WORKING AREA

In the competition each group had a desk where they normally spend much of their time programming, listening to musing, eating, discussing, programming, assembling their robot. This is the area where students spent most of their time when they were not competing, watching a competition or participating in a competition. The working area is part of the main room

Fig. 2: Working area

9.1.5.3 TESTING AREA – TESTING TABLES

Apart from the competition and the working area there is a second room with two testing tables. Testing tables have the same layout with the competition tables (ie. Same obstacles and objects). In each table there are two layouts which can be used by the students. Thus two groups can be testing in each table. Students can practice in the competition tables in specific times and for specific time each day.

Fig 3. Testing Area practice tables

9.1.5.4 AREAL COMPETITION AND FREE TESTING

In the second room, on the right-hand side is the aerial competition area. Next to this is a standard competition table, which is available for open practice at any time. It has exactly the same layout as the main competition tables with all the same obstacles and objects.

1.1 DATA COLLECTION

The data reported here involve a Focus Group (FG) consisting of four girls (first graders of a technical school) which participated for the first time in the competition. Three of the members of the group belonged to the same class and two of them were friends (see section on Group composition). One of the students came from the same school, different class, because she was rejected from another group (according to her statement). The sources of our data are two interviews and videos from the competition. The first interview with the Focus Group was held before and the other was held after the conference. The girls participated in a workshop with a focus on preparation for the competition. The first interview (pre-conference) is conducted right after the completion of the preparation workshop. The video data were collected with a go-pro camera which was handed to the focus group by the researcher with the direction to use the rec and stop button according to their will. Thus, the data collected are not based on continuous video recording of student activity instead it is based on student decisions when they want the camera to record their activity. The competition lasted four days and the students used the camera throughout the four days to record their collaboration and work.

1.2 ANALYSIS OF THE LEARNING EXPERIENCE

In this section we report an analysis of the learning experience of the Focus Group during their participation in the competition. Our analysis has focused on the following dimensions. We refer to the competition Norms, to describe the context of the learning experience and the way the competition is differentiated from other learning environments like the school. An important part for Robotics education is Collaboration as in most cases students work on robotics not isolated but as groups. So in this report we describe the model of collaboration formed between the members of the group and we tried to identify the shaping forces. The other dimension of our analysis involves the focus of student constructions (programming and configuration of the robot) during their participation in the competition. A major focus of this analysis is the development of resilience as students participated for the first time in the competition and they managed to have some small achievements and several failures. Last we analyse the skills which students emphasize as important for STEM and for participating in a competition as well as students' view on the role of gender in participation and performance in Robotics competitions.

9.1.6 Competition Norms

When we discuss about norms we mainly refer to established interactions and behaviors which are acceptable in an non formal learning environment such as the competition and which make it quite different from the formal educational setting. As we will show next the competition norms seem to play an important role in facilitating social interaction and learning from others (see next section)

9.1.6.1 INFORMAL SETTING

The setting of the competition although it involves a demanding learning experience it is quite different from the formal learning environments (i.e. schools) as there is music playing in the background, students can eat or listen to music, they can stand on the tables in order to have a better view on the competition table (see next picture).

Fig 4. Standing on the table during the competition

Furthermore, practicing on the testing table or standing next to each other to watch the groups competing, have the opportunity to discuss with other students or other groups. Especially in the testing table interactions and discussions can be also triggered by the unexpected behavior of the robot or by the successful behavior. Discussions and interactions among the students of the Focus Group (FG) and the students of other groups were observed more in the videos of Day 3 and Day 4. Specifically, in the table below, interaction with others was identified in five sources (three video extracts in Day 3 and 2 Video extracts in day 4) 3 of the seven references were encountered in Day 3 and the rest were encountered in Day 4

Type	Name	Sources	References
Tree Node	Interacting with others	5	7

An interpretation of this unequal distribution is that the FG participated for the first time in the competition and as they mention when they discuss time management and collaboration they needed some time to adjust in the context, the functioning and the requirements of the competition.

The competition is not structured as an intensive only event because it includes slots where students cannot practice or compete, as they have to wait for their turn on the testing table. This structure seems to have an important impact on the development of social interactions:

> *Child 3:We also got to know other people from our school. We played a card game with them called "Lie"*

Post ECER 2016 Interview

Extract 1

Playing card games in the waiting slots of the competition, although unusual, seem to have an important role in socializing (see next section about the skills) and interacting with other groups. This is something that can be connected to the informal setting of the competition where students behave the way they would behave on their break or when they hang out with their friends.

9.1.6.2 "BEING OBSERVED" AND "OBSERVING OTHERS"

These are considered two related but different norms, which are encountered in the competition context. During the testing of the robot students are observed by other groups waiting for their turn or groups who have completed their testing. Also the group has the opportunity to do quite the same i.e. to observe other groups. Furthermore, this is a behavior that it is not normally encouraged or encountered in other learning settings – however as we will show in the section where we discuss resilience, this slot of waiting and observing others in the testing table plays an important role in resilience as it offers valuable information and living examples.

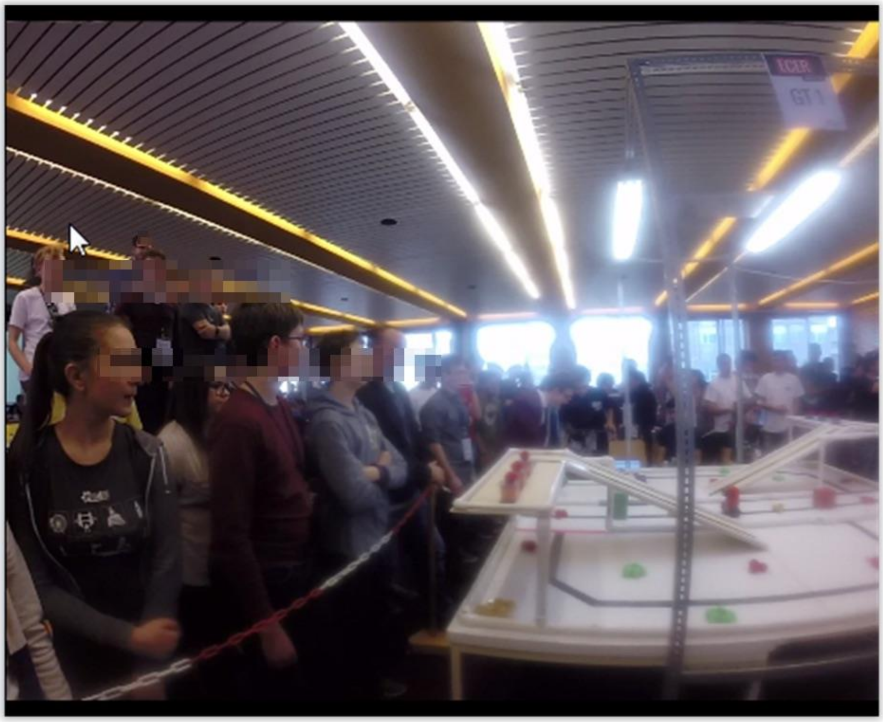

Fig. 5 Being observed during the competition

Being observed and observing others during the competition and presentations are related to aspects of exposure, how students behave when something good, interesting or disappointing happens in the competition area. How other students handle the tasks of the competition. For example the camera captured an instance where a group of students had completed only one part of the task and then they indicated with a gesture to the organizers that this was it, so that they evaluate the performance of the robot. This behavior is an example that one can compete and gain points by focusing on specific things and not trying to do everything. From the point of view of the norms we discuss here, such observation is important because exposure is demystified (i.e. you do not have to be perfect in order to compete) and students become acquainted with behaviors and strategies while observing others compete.

9.1.7 Collaboration

We mentioned earlier that the FG consisted of four girls and during the competition they had two robots they were working with. Their collaboration had a set of interesting characteristics some of which were identified during the analysis of the video data and some of which, were explicitly described by the students.

9.1.7.1 GROUP COMPOSITION

The students as they declare in the pre conference interview they come from the same school. Three out of the four girls are from the same class. One of the girls who is from different class, says that she ended up with the specific group because she was excluded by another group:

Child 1: *At first we did it by class.*

Child 3: *Yes, but …*

Interviewer: *Are all of you in the same class?*

Child 1: *No, well, she …*

Child 3: *I joined them because the other team didn't want me.*

Interviewer: *And you're in the same class?*

Child 1: *Yes. And Andjela, too.*

….

Child 2: Uhm, actually, well, [says name of the teacher] has asked us. And then I informed myself about it and [Child 1] also said that it's cool and then we signed up for it.

Pre-ECER 2016 Interview

Extract 2

From the extract above it seems that we have in general a group with some common characteristics in the sense that three of the four students know each other because they are in the same class. Based on Student's2 last remark it appears that they have a closer relationship between them as the participation of one was in a sense linked to the participation of the other. It is interesting that Student 3 says plainly that another group did not want her. However as we will see in the analysis performed in the next sections all students managed to collaborate well and they got to know each other well.

9.1.7.2 ROLE ALLOCATION AND DIVISION OF LABOR.

In this group we observe an interesting scheme regarding role allocation and division of labor. We chose the term co-constructing to describe a situation where all group members work on the program and the same happens with the work on the robot. This means that although there are different tasks and there could be different roles, there is no allocation of one role to one person. As a result all group members are involved in all tasks in most cases simultaneously (i.e. they do not take turns in the different roles). This seems to be a characteristic of the maker culture where all contribute together to the same task according to their knowledge and skills. From a learning perspective this means that group members gain knowledge from all the different tasks involved –as opposed to situations where a group member is responsible for a task and at the end has learned things that involve the specific task. This seems to be a mode of work that is related to the task and the circumstances as in other tasks – such as the presentations- students claim that they divided the work and allocated roles. Furthermore, students acknowledge that they realized through their collaboration that they have different skills and competences. However, this does not seem to contradict the co-construction model as all students contribute to each task according to their knowledge and skills.

9.1.7.2.1 CO-CONSTRUCTING

The analysis of the video data showed that students were divided in two subgroups the synthesis of which did not change during the competition (i.e. the two girls consisting subgroup 1 in the green rectangle remained in this subgroup through out the competition the same happened with the other two girls consisting subgroup 2 in the red rectangle)

Fig.6. Focus Group and subgroups

Each subgroup worked with one robot: i.e. programming and configuring its parts. Although we captured instances where the same students were testing the robots or putting them on the competition table in the sense of representing the sub-group. We also captured instances where another pair of students represented the subgroup on the competition and the testing table.

So it appears that there is some division of labor but the roles are not person- specific in the sense that all students take all roles. Specifically, the camera captured a several instances where students in each subgroup were sharing the screen or were looking over the robot. We considered this an indication of co-construction where no discrete roles exist i.e. one student responsible for the robot and the other for the program, which was encountered in other settings (i.e. see PRIA workshops). Such an approach in allocation of roles makes sense as students during the competition focused mainly on programming and less on assembling the robotic parts (see section “Constructions: Robots and Programming). This configuration appears to be more effective in terms of collaboration as all members participate in all activities of the group and they all share and shape the knowledge involved in programming and working with the robot. This image was also depicted during the student interviews:

Interviewer: *Was there anybody specialized in building or programming?*

Child 1,2,4 : *[No*

Child 3: *[No, we had divided everything beautifully*

Child 4: I was not the case that we said to someone "you are building this" and then we programmed. Instead we built together the robot and then we programmed it together

Interviewer: Did you plan to work this way or has it developed?

Child 4: It has [developed

Child 1: [Laughs … It simply has developed, we simply continued working on the demo bot from the workshop and we tried to improve it, and we succeeded somehow on this.

…..

Child 4:Well the persons who were present continued to work, and one person thought of this and the other person of that, and then it was mixed to getter and well

Post ECER 2016 Interview

Extract 3

The description provided above shows a very good collaboration scheme where individual contributions are integrated in the final product in a way that group members cannot recognize anymore their individual contribution because it is transformed by the group. A similar approach was evident in the Pre Conference Interview with the three of the four students:

Interviewer: All clear. And who did what? Did you have a division of labour?

Child 1: Actually no, actually everyone did everything, although, well, our team leader did almost… NOTHING.

[Child 2 and 3 laugh]

Child 2 and 3: Yes!

Child 1: But yeah, I guess everyone knows that by now.

Child 3: Actually, we split more or less in two per robot…

Child 2: Yes, it kind of developed this way, because some girls were there on Wednesday and then there were some on Friday…

…..

Child 3: Most of the time it works.

Interviewer: And who of you is going to do that? Who will take care of that?

Child 1: Uhm, I don't know?

Child 3: Well, we'll see, probably on Monday both and yes. Also, (Student no. 31001) said that she will be there tomorrow, so …

Pre ECER 2016 Interview

Extract 4

Pre-conference data refers to the student participation in the preparation workshop organized by PRIA. There, students explain that no division of labor was present in their collaboration. One interpretation is that student collaboration emerged this way due to the time schedule of the students participating in the workshop. In any case this emergent division of labor was kept during the competition where the time schedule restriction was not present. In the extract above we do not have enough evidence to interpret the comment about the group leader who did almost "Nothing". It is not clear if this is just humor or not. Also it is not clear who of the four girls was considered to be the leader in the group. The analysis of the video data did not provide evidence indicating that one of the students undertook the leading role for the group during the competition.

9.1.7.2.2 TOWARDS SPECIFYING ROLES

With respect to the division of labor and the roles emerged there are some more data from the interviews which indicate that depending on the task and the circumstances, students might have formulated concrete roles and distributed them in the group:

> *Child 2: For the presentations we had a work-sharing, so that everybody does a part, and we had these 2 different presentations and there we divided in groups of 2 and 2*

Post ECER 2016 interview

Extract 5

In this comment offered by student two it appears that students follow the division into subgroups and they refer to work sharing which might involve more concrete roles. If this is the case we need to mention that at least one of the presentations had to be done in English and most of the students in the group (at least 2 out of the four) did not feel very comfortable with it. On the other hand there was in the group a native speaker (as she stated that her mother is British). Thus division of labor here might involve allocating the presentations to those who were more confident in English and the rest of the students working on the presentation or on the paper.

9.1.7.2.3 SELF AND GROUP MEMBER ASSESSMENT

We mentioned at the beginning of this section that in the interview students mentioned that through collaboration they got to know what they are good at and which tasks suit them

> *Interviewer: What did you learn about yourself?*
>
> *[whisper, laughter]*
>
> *Did you learn something about yourself?*
>
> *Child 3: I have not learned something especially about me but also now we know what we can put past every team member, and I think we have learned about ourselves we got to know each other in the team pretty well and what someone is able to do better and what someone is not so good at, what tasks are suited for someone.*
>
> *Child 4: Eeehr, no clue*
>
> *Interviewer: What have you learned about yourself?*
>
> *Child 4: What you can better and what you are not so good at, you realize what tasks suit you and what tasks don't, well.*
>
> *Child 2: Mainly that speaking in English is not as bad*
>
> …..

Child 2: … I know from other group assignments, when you don’t know each other well from the start, that it fails totally, but we have managed quite well

Post ECER 2016 interview

Extract 6

Despite the fact that this question did not refer to collaboration, its content is critical to the way students worked and learned together. From this extract we observe the following interesting points: a) when students are asked what they learned they do not focus on plain cognitive aspects i.e. I learned how to programmed or I learned how to use the sensors etc. Instead they seem to focus on a set of meta-cognitive aspects, which are related to self-assessment (i.e. what I am good at) and to the assessment of other group members; b) this knowledge is crucial for smooth collaboration: i.e. if we know what we are good at, then we can identify the tasks which suit us better and this way we can contribute our maximum to the group. This is also highlighted in Student’s2 last comment, where she points out that when group members do not know each other well from the start then there are chances that collaboration will fail.

A crucial question comes up at this point. Does this comment based on self and group assessment contradict the model of co-construction? The answer here is that it depends what are the tasks students refer to. The idea is that different tasks (i.e. presentation, programming, setting the table for the competition, etc.) might request different models of collaboration. For example during programming students could follow the co-construction model where all contribute according to their knowledge and skills in the same task. Furthermore, this setup might be meaningful for programming because students come from a school with emphasis on technology (they all have taken programming courses) and this means that they all have something to contribute in this task. One the other hand, group skills with respect to the task that involved making a presentation in English, were more distributed across the two ends of competence. Thus, the task and the group competence can be determining factors of the division of labor model, followed by the group.

9.1.7.3 PLANNING AS A GROUP AND SHARING RESOURCES

A very interesting aspect that was raised by the students in the post conference interview involved the sharing of resources between the two subgroups:

Child 1: And we have planned as a group the robot has to do this next, in order that we don’t do something twice and that everybody knows what we do, so that we can continue, so that everybody has an idea what the robot should do principally.

Inteviewer: How did you organize the exchange? How did you relay the [information

[Many voices]

Child 2: () the ideas, we just spoke to each other so that we can propose the ideas

Child 4: and then photographed and per whatsapp how far I have come.

Pre ECER 2016 Interview

Extract 7

In this extract we identify two aspects of interest: the first is that all four students planned as a group. This means that the grouped analyzed the challenges of the competition and then it (i.e. the group) formulated a strategy and a working plan for both robots. To this end students discussed and exchanged ideas. The other important aspect is that students made sure that they did not do the same things twice (i.e. each subgroup programming the same things) thus it appears that they were formulating a sort of shared library so that working pieces of code could be used by the other subgroup which might have been involved in something else. To this end, students apart from discussion, used their mobile phone camera and whatsapp to inform the others about their progress. This is a very clever strategy for saving time and resources in the group. We do not know if this a wide spread strategy among the groups participating in the competition taking advantage of the mobile technologies widely available (camera and free communication apps) or it is a strategy devised by the focus group. In any case this is considered as a very good collaboration example grounded on strategic thinking about the goals of the group and the resources available.

9.1.7.4 TIME MANAGEMENT

Time management is an issue that students brought up during the reflective discussion in the Post conference interview.

Interviewer: *… Okay, so what have you learned through the robotic competition, where have you improved*

Child 4: *time management?*

[Laughter]

Child 4: *yes, at the beginning we didn't have the time management under control, but we got better and better and we managed it better.*

Child 1: *But it was also the case that we began rather late with the robots, because we first had to wait for the workshop because we didn't have a clue and the sets and everything, we had a bit of a time pressure, that I must say, next year we hope we have the time better under control*

Post ECER2016 Interview

Extract 8

Time management is a crucial factor in successful collaboration and it seems that it played an important role in the context of competition. Students bring this up on their own initiative when discussing what they learned from the competition. It appeared that time management was difficult for the students due to the fact that this was their first time in a competition. Students highlight that it was difficult to plan how to manage time at the beginning because they did not know the specifics of the competition. Again it is important to stress that students acknowledge learning of metacognitive skills, which play a crucial role in good collaboration.

9.1.7.5 ISOLATION AND CO-EXISTENCE

In the previous paragraphs we outlined a picture of a very good collaboration between the members of the focus group. However there were moments where students worked on isolation or seemed to simply co-exist in the table. These moments were captured in what we called working area where students were seated in their tables and usually this is where students waited for the testing or for the competition. Furthermore, there were instances in which students took some time alone to look at the program of the robot, or to change something in its construction or to revise the competition tasks for the day. These moments do not diminish the quality of the collaboration, instead they could be considered an integral part of it- as students probably needed sometime to gather their thoughts and ideas in order to contribute to the group. Furthermore, the structure of the competition is not identical to the way a school operates, thus it makes sense that students took sometime for themselves while waiting.

9.1.8 Constructions: Robots and programming

In this section we discuss student engagement with the actual robotic construction. Specifically we describe what was the emphasis of student activity

9.1.8.1 EMPHASIS

During the competition the FG worked more with programming the robot than with constructing the robot. This is represented well in the next table, which shows that the captured instances that involved the configuration of the robot were only 4 as opposed to the 14 instances that involved programming.

Type	Name	Sources	References
Tree Node	Programming	9	14
	Robotic Parts configuration	3	4

Table 1. Emphasis of student activity with robots

Students, in the POST-ECER2016 interview confirm the above metrics:

Child 1: *So we spend most of our time improving our robot, not from the build but from the programming, so that it does the thing right, which it should do, because the tables were always different and we tried to adapt our robot, and we tried to … even when our programs were not the longest ones we tried to execute that what we should have done. And we succeeded … most of the times*

Child 2: *I would say at the beginning we lagged behind with the programming of the robot and we lost the time, but at the end of the week it was a bit more relaxed, since the program already worked.*

Post ECER2016 Interview

Extract 9

As students explain in the above extract their activity focused mainly on programming as this appeared to be a great challenge during the competition. The difference in the tables they mention involves testing and competition tables, which were supposed to be identical. However, as students point out there were differences between the tables and while their robot seem to work in the testing table it did not behave accordingly in the competition table.

9.1.8.2 UNPACKING PROGRAMMING

The programming activity during the competition appeared to be a complex activity integrating more aspects than the mere writing of code.

9.1.8.2.1 TESTING THE ROBOT

Testing in the competition was mainly taking place in the practice-testing tables, which were supposed to be identical to the competition tables. In the context of the competition each group had specific time on the testing table. In ECER 2016 there were three testing tables. So each group was testing along with others in the different tables and in several occasions there were group overlaps in the same table (the previous and the next group). There were no conflicts observed in claiming the table during these circumstances, instead the groups were observing each other and as the FG has pointed and it is latter analyzed in the section on resilience, this proved to be a very useful experience. Furthermore, one group might be making use of one side of the table or their robot could start after the robot of another group and perform its task without a problem.

Testing was the most recorded activity in the video data analyzed (see table 2)

Type	Name	Sources	References
Tree Node	Robot testing	13	34

Table 2: Frequency of Robot Testing activity

At this point we have to mention that testing quite often involved changes in the program as students would change the program on the spot and try their robot again. To this purpose there were tables next to the testing tables but quite often students were holding their laptop and were making changes while the robot was moving on the table or right after it finished.

Apart from testing tables the camera captured two instances where students tried the floor. One is with one of the girls of the focus group (see fig.7), which during the discussion with the researcher said that it is not very useful to try the robot on the floor, as it is quite different from the table. In another occasion three boys from another group have been creative as they found an empty space outside the competition area where they tried to simulate the competition table on the floor, using duct tape (see fig. 8)

Fig 7: Testing on the floor

Fig.8. Improvising to test on the floor

Testing on the plain floor (like in fig 7) could be meaningful under circumstances providing feedback for specific actions (like moving or turning). The simulation of the testing table on the hall floor can provide feedback that is closer to the one provided when testing on the practice table (although parts of the testing table like the ramp are not simulated). However, it is questionable if this creative action is legitimate or can be considered as cheating. From a learning perspective this action is considered very interesting as it combines creativity and strategic thinking.

9.1.8.2.2 ROBOT CENTRIC – TABLE REFERENCED PROGRAMMES AND THE IMPORTANCE OF MEASUREMENTS

The robot's successful performance depended very much from positioning the robot in the right place. Small deviations in initial distance or angle could lead the robot quite off the route because its programming was – as students call it- static (see extract 10).

Child 1: *We had 2 sensors at the beginning for following the black line, because we thought that would be the best way, but it hasn't worked*

Child 4: *Because there was a stupid corner and the shadow of the robot was cast over this corner and the robot has identified this as black and run there ()*

Child 1: *And it didn't recognize it really good and it didn't go that fast, because he needed to find the line and went there step by step. And therefore we did it static*

Child 2: *I think we need to wish for lights for the sets so we can illuminate it*

Post ECER 2016 interview

Extract 10

Our interpretation is that the programmed behavior was in a great extend robot centric. This means that the robot for example would move forward 100 steps at the beginning no matter where it is placed. A table related program would take into account the edge of the table would move there, turn 90 degrees and then move forward 100 steps. Students initially tried to create a table -referenced program with the sensors but since it did not work out they did what they called static which required from them to be very careful in the measurements during tests and competition (See fig. 6,7)

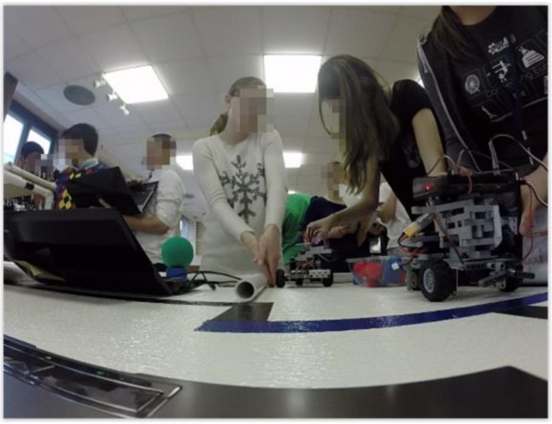

Fig.9. Measuring with hands

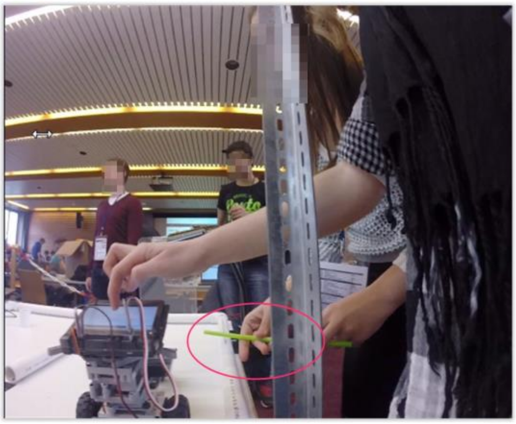

Fig.10. Using a "straw-like" measurement instrument

As we can see in the pictures above, the students invented various ways to perform their measurements using a reference point on the table and their hand, a wrench in another instance and a green straw (or straw like stick) with a mark to make sure that the robot starts from the correct point. Even when the positioning of the robot was correct at the beginning, the robot could go off-course after the first one or two turns.

Child 2: *I find especially the building part fascinating because when you really build something with robots, you need to consider so much more in contrast to when you use the Java-hamster[1] the hamster does always a 90 degree turn, but the robot doesn't.*

….

Child 4: *The hamster does everything exactly like you want him to do, it the robot on the other hand not sure sees there is a shadow and then he does the exact opposite of what you want him to do, so that you (want) to try often (until it works)*

Child 3: *The hamster is more precise than the robot*

---

[1] These students were introduced to programming with a simulator environment called java hamster model, where you can pilot a hamster with java programming statements in a grid to solve tasks.

Child 2:	*But I think that it is more fun with robots and more interesting because you see that it is not always working as intended like it is in real life*

Post ECER2016 Conference

Extract 11

The Java-hamster mentioned here, apart from the programming has a robot simulator, which as students indicate offers a very different experience in relation to the robot. This is because the robot might behave quite often very different than expected. Some of the reasons for this behavior relate to the analysis presented before (initial position, type of programming etc). Such a situation is depicted in the picture below where one of the FG members in discussing with researcher states that while the program is right the robot does not behave as expected and the group did not now why this unexpected behavior occurred:

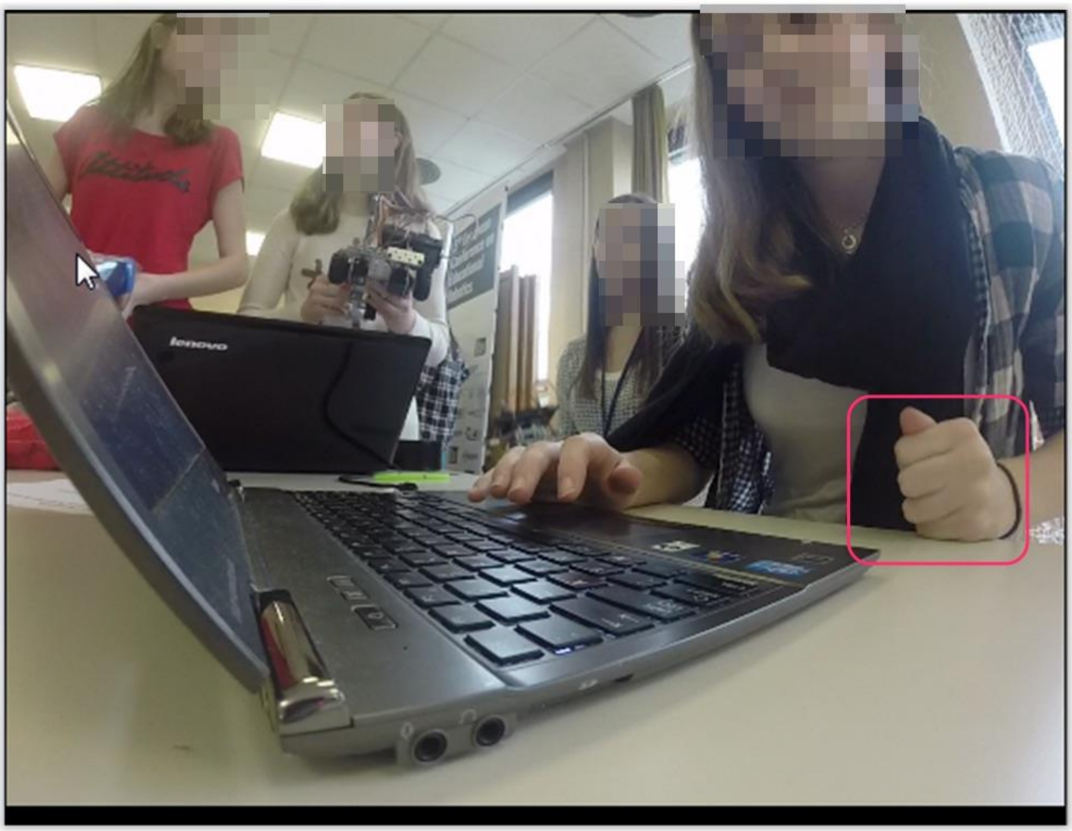

Fig. 11: The program is right but the robot behavior is wrong. “We don’t know why”

In the picture above we observe the fist on the table of the student who works on the program. This can be interpreted as determination to continue or as “strong objection” to the fact that the robot behaves in a way that it was not supposed to.

9.1.8.2.3 REPEATING THE TEST

The importance of the initial positioning and the fact that the robot could be led off route quite easily, students engaged in trying their robot more than once even if the first trial was successful. This is a way for the students, along with the strict measurements, to address the non-deterministic parameters that influence robot’s behavior i.e. that after one turn which was ok the first time the robot might turn a little bit more and then it can end up off the ramp. This is more or less what happened in several cases in the competition:

Child 4:	*It is frustrating, when it worked at the test run and then when it counts it falls off and this was frustrating but yes ()*
Child 2:	*I too thought it was frustrating, that it always failed at the competition runs and at the last run we were allowed to repeat it and then it worked and I was so happy an I think if we weren't allowed this last run and so wouldn't be able to show that it actually works then I would have been much more sadder*

POST ECER2016 Interview

Extract 12

Students in the extract above highlight how their robot was performing well in the testing tables but it failed in the competition table. A second run in the competition gave students the opportunity to show that their robot was actually working and gave them a wining score for the specific task.

9.1.8.2.4 MANUAL INTERVENTION

An analysis of the video data showed that students in several cases while testing their robot, they used their hand to help the robot complete part of a task. For example students were captured to push a little bit the robot with their hand after a couple of turns so that it does not climb off a small white tube and in order to continue straight ahead to climb up the ramp. After several trials they appeared to have integrated in their program a little correcting behavior which aligned the robot in relation to this white tube and which ensured that the robot would drive straight up the ramp. However, after this program run successfully for several times there was an instance where the robot climbed up the tube (see Fig 9)

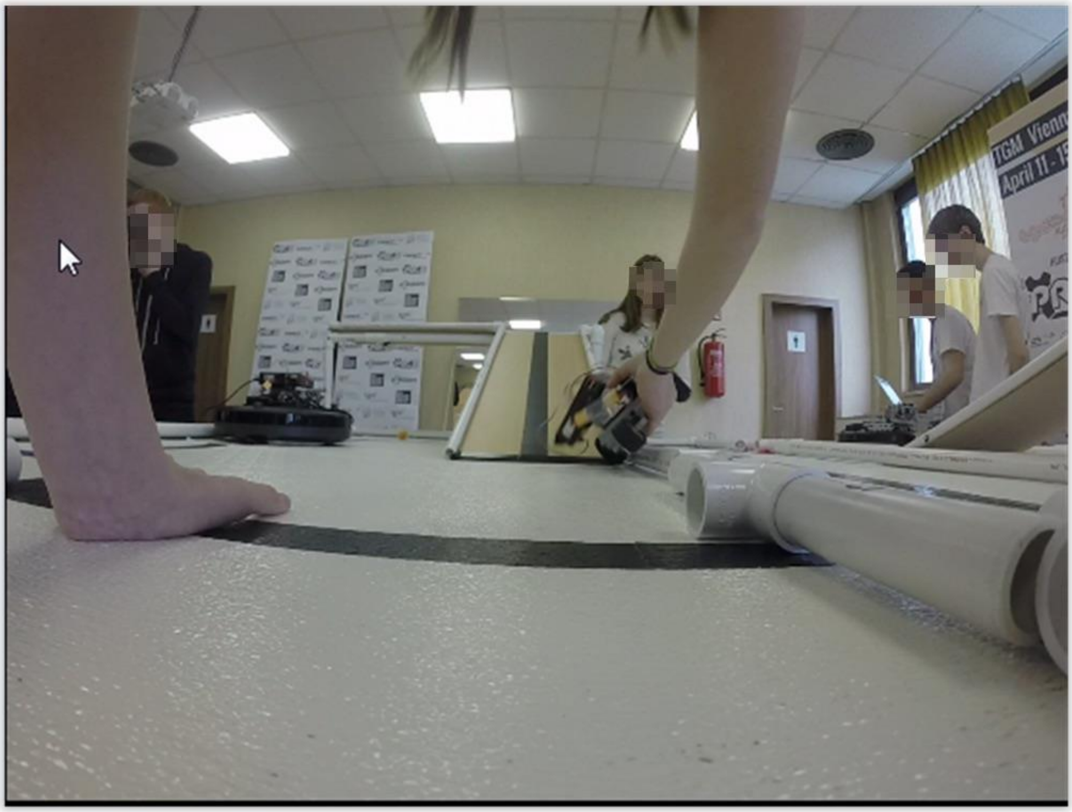

Fig 12: Robot driving off the course

So, this instance shows that even when more complex programming is used where the characteristics of the table are taken into consideration there are chances that the robot might not behave as expected.

Manual interventions seem to play a role in robot testing. Our interpretation is that this is part of a problem solving and constructing strategy. Specifically, this action could be due to a to break down of the problem in two major categories: i.e. making the robot to follow successfully a specfic route and making the robot to perform tasks like moving its hand and pushing the softballs.

9.1.8.2.5 FEEDBACK BASED ON VIDEO RECORDING

Another interesting aspect observed in the competition involves the use of other digital media like the camera of the mobile phone. Video recording the robots competing seemed to be something that some participants – apart from the conference organizers who did this for all competing robots- did (see fig. 10).

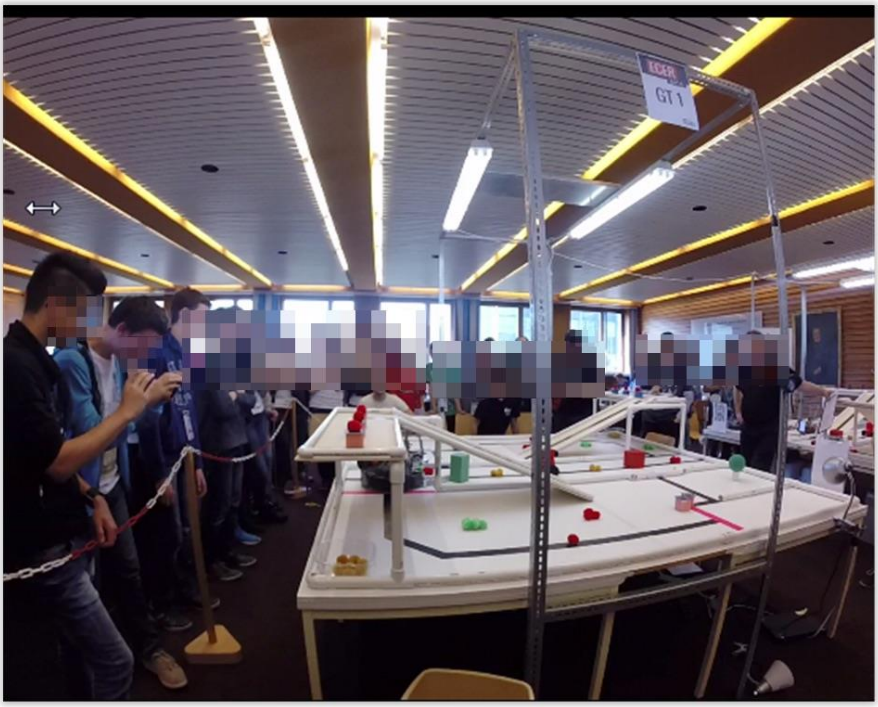

Fig 13. Video recording the robot on the competition

A similar practice was followed by the members of the FG and it is captured in the following extract

R: Did you video it?

St3: What?

R: Oh you video it (she points at st2 . St2 used her mobile phone to video their robot). So you know when it goes wrong and you can analyze ... yeah? [St2 holds her phone, St3 works on her computer and St1 holds one of the robot's cables]

[St2 Passes on the video recording of their robots competing]

R: Very good idea ... (inaudible)

Day 2, Video 9, Discussion with the researcher

Extract 13

The extract above is taken during the second day of the competition where students have participated in one of the competitions and they have not been successful. Right after they return on their working table they had the short discussion presented above with the researcher. The video of the robot on the competition table is going to be used by the students as a basis to gain feedback on what went wrong with their robot. This is an interesting practice as the video captures behaviors and details that might be missed by the students during the competition. Additionally the video can be replayed over and over again so as to pay close attention to certain aspects of the robot performance, if necessary. We consider this as a very interesting use of the digital media in service of student constructionist activity during the competition.

9.1.9 Resilience

Resilience is examined here as recovery from failure and disappointment in the learning context of a competition. The FG we analyze here is a good case to study resilience because they are faced with a great challenge in a rather competitive context: i.e. they are first graders participating for the first time in a robotic competition. An overall estimate, only in terms of wining or not in the competition, is that the group did not do so well: They managed to win another group in a small task but they failed in a number of other tasks. Apart from this result, there are a lot of data that allow us to study resilience because students had a lot to say in their interview about how they perceived their experience in the competition, how they handled failure and how they managed in the end to have an overall positive and rich learning experience.

9.1.9.1 TESTING TABLES: A LOCUS FOR RESILIENCE

An analysis of the videos recorded during the competition showed that in the testing tables, students had the chance to observe others failing. This activity is supported by the structure of the competition with the practice- testing tables. In these tables, students, while waiting for their turn to test their robot, have to opportunity to observe the reactions of other –in this case more experienced (i.e. groups who participated in competitions in the past) - groups failing, going back, repairing their program or robot and trying again.

In the picture below we can see that the Focus Group has placed its robot on the testing table while the previous group hasn't left the table yet.

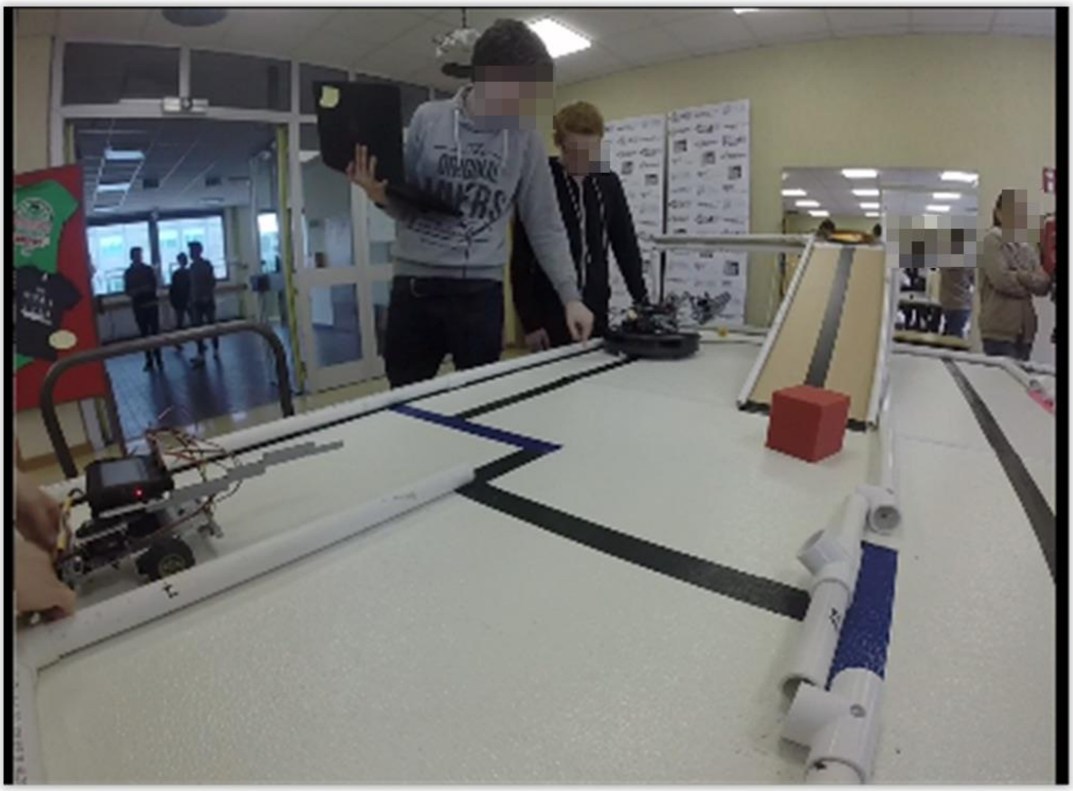

Fig.14. Overlapping groups on testing tables in ECER 2016

This is a structural element of the competition, which allows students to observe each other (see section on norms) not only in the final stage (i.e. when competing) but also during the development process. This is important because newcomers like the focus group, do not see only the final result i.e. a successful program and a robot that wins or fails the competition. Instead they can observe the competing groups during the process of working on their robot, which includes failures, analysis of the failure, repairs and numerous trials.

This does not mean that students do not get disappointed if something does not work out. In fact students have identified such moments of disappointment in their interviews after the competition and the camera captured such a moment (see next image):

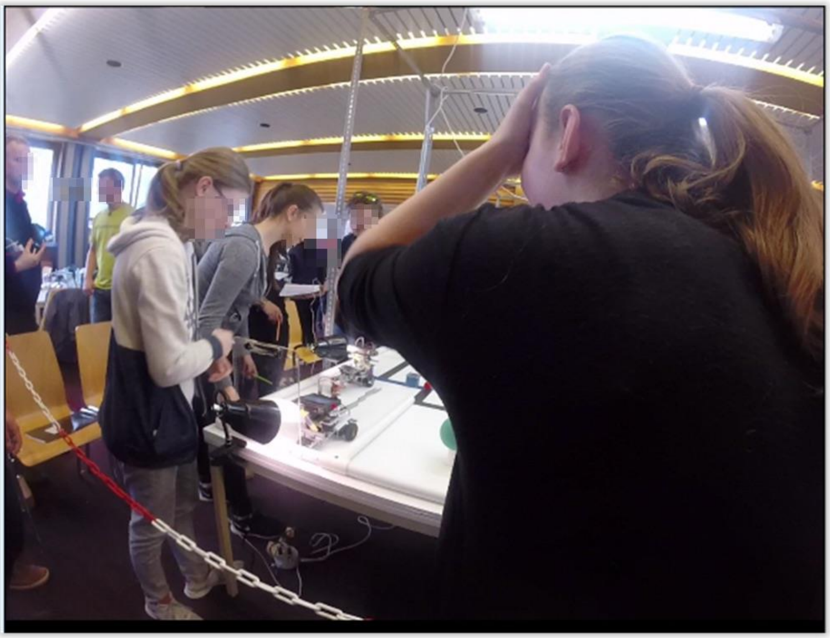

Fig. 15. Focus Group- St3 expressing her frustration with a gesture

However, as students point out in their interview, it is critical to have the skills that allow you to recover from frustration and keep trying (see section on patience). This attitude is interweaved with the belief that failure is part of the game and what is important is not to succeed on the first go but to be able to continue after you fail. Testing tables offered living examples of this belief when all competing groups failed and tried again and again.

In testing tables students had the opportunity to also observe how other groups think about their robot behavior and analyse it:

> *From the others we gained insight into how they are thinking and when we didn't understand something we tried to retrace it, how did he reach this conclusion, that the robot has to do this in order to do that and that, you are dependent on the others, how they are thinking, to be able to find out something by yourself….*

Post ECER 2016 Interview

Extract 14

Testing tables play a crucial role in this process because, when a robot deviates from the expected route or task, students tend to comment and offer explanations about what happened or what they should do. Furthermore, they review and change the program on the spot (See the student with the laptop in Fig. 11) so that they are able to test the robot again as access to the testing tables is scheduled and not unlimited.

9.1.9.2 ELEMENTS OF RESILIENCE

Student interviews after the competition, allowed us to unpack resilience to a set of constituent elements. We considered these elements as factors that can support students to develop resilience in the context of a competition.

9.1.9.2.1 ASSESSING YOURSELF AND LEARNING FROM OTHERS: PUTTING EPISTEMOLOGY IN PLAY

An important aspect of resilience is to be able to evaluate realistically your work. Resilience should not be based on false assumptions about the quality of the output i.e. claiming that it is good when it is not because such an attitude cannot lead to improvement. On the other hand when you realize your weaknesses then you can seek the resources and the means to improve:

> *Child 3: I was interested by the presentations, by the paper presentations, what the other people did, what they were interested in, and what they wrote about, and you can get tips for the next years from it, because our paper was actually not really.. [Laughter] well, not really so good I would say.*
>
> *[Laughter]*
>
> *Child 1: Yes, but we were chosen, that means that our paper [had something*
>
> *Child 4: [but anyway it was not so great*
>
> *Child 3: I mean we talked about how the situation being in the first grade felt for us*
>
> *Child 2:Maybe it was not as interesting for the others who went through the same but it might have been interesting for others, who didn't participate in the competition*

Post ECER 2016 Interview

Extract 15

In the extract above we can see that student 3 has assessed their paper as not really good. The conference included a presentation of student experience in the form of paper where all groups were expected to participate. The group participated for the first time in the competition so – as student 2 points out- the paper did not offer valuable information for those who had participated in the competition.

With respect to resilience this extract has two interesting aspects. The first aspect is that the evaluation of something as not really good does not mean that there is nothing valuable in it: *it might be interesting for others, who did not participate in the competition*. This attitude allows the students to not be overwhelmed by an overall not good result in the sense that: a bad result is acceptable; it can be improved; more experienced others can offer valuable information (i.e. tips for next year).

This last remark leads us to the second important aspect for resilience: others can be a valuable resource for learning and improvement. For this to be useful it is important to have a realistic assessment[2] of the work as we mentioned earlier. This allows the person to focus on specific things when interacting with others (even if this interaction involves only a presentation) which is exactly what student 3 does when she mentions that she

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[2] Students mentioned that their paper was chosen by the conference organizers – without explaining what this meant- however they were not carried away and they were able to be just in their assessment.

is interested what the other groups did (with their robots), what they wrote about and what they were interested in.

Students mentioned various instances where they learned from others in their interview. One thing they highlight is that while they all had the same task, they observed that other groups followed different approaches in resolving the problem in terms not only of robot behavior but also in terms of robotic construction:

> Child 4: *Well the different construct… I mean everybody had the same tasks, the different approaches, how they did it, the different constructions*

Post ECER 2016 Interview

Extract 16

An example of a different approach in the task in terms of robotic construction is highlighted in the extract below:

> Child 1: *I think we have gained many ideas from the other groups, for example like the one which stood under the ramp and had a big arm which cleared everything on the ramp, and I found that very interesting to get some ideas…*

Post ECER 2016 Interview

Extract 17

It appears that students did not simply acknowledge that there were different approaches. They moved one step further into analyzing the different approaches so us to understand the rationale behind each approach:

> Child 1: *from the others we gained insight into how they are thinking and when we didn't understand something we tried to retrace it, how did he reach this conclusion, that the robot has to do this in order to do that and that, you are dependent on the others, how they are thinking, to be able to find out something by yourself …..*

Post ECER 2016 Interview

Extract 18

The importance of learning from others for resilience is explained at the end of the above extract: "*you are dependent on others, how they are thinking, to be able to find out something by yourself*". Someone is difficult to recover from failure if he/she has a false belief about his expected performance in a specific setting. For example in the specific occasion if students believed they should know what is necessary to program a robot so as to be successful in the competition, then in case of failure it would have been very difficult to recover because such a belief would easily lead to a conclusion that students are not knowledgeable or clever enough to address the challenge. On the other hand students who have a more grounded belief about how learning in a new situation occurs, they are open and learn from all the resources available, they formulate a strategy around gaining new knowledge and they do not feel overwhelmed by their own lack of knowledge. Furthermore, the last line of Extract 19, shows that resilience, when it comes to learning situations, depends heavily on the person's epistemological beliefs about how learning occurs (social dimension of learning: you are dependent on others) and what is a successful learner.

9.1.9.2.2 ADJUSTING YOUR GOALS

An important part for resilience is to learn to set the right goals taking into account the situation. Resilience is difficult to evolve in situations where individuals or groups set unrealistic goals, which are not based on an assessment of the situation of the goals initially set, and of the prerequisites to achieve them. The FG in their interview after the competition describe a process of goal adjustment:

> Child 2: *We had many other things planned at the beginning, which didn't work out and then we did other things and it really is the trial and error and gaining experience, but when we were at the competition and saw the other teams, what they did, that was interesting as well and you can learn much as well.*

Post ECER2016 Interview

Extract 19

In the extract above it appears that students had set many goals, which were not achieved. This did not disappoint the students. Instead students re-adjusted their goals so as for them to be achievable. This is something that it was fostered not only by observing how other groups competed but also by the structure of the competition. Specifically each competition task was broken down into smaller tasks, which when they were achieved, they gave points to the group. This is something that allows the readjustment of goals. In the extract below students further explain how the structure of the competition influenced the process of readjusting these goals.

Interviewer:	*Good …. Was there somehow a special strategy or a plan you pursued? Where you said we want to solve this task or this?*
Child 3:	*Yes we wanted definitely to drive up the ramp ()*
Child 2:	*Yes, it was () task, I think we just started doing and then we tried and the task with the ramp was the thing we wanted to achieve by all means. But it wasn't our goal from the beginning*
Child 4:	*Yes*
Child 3:	*Yes, well we didn't have a certain plan what we want to do*
Child 4:	*And then we looked at the points, how much you gain from doing this and doing that, what is doable. And then we … first we wanted to go up the ramp, then we included some task before, to push the thing away and with the ball, and so it grew bit by bit*
Child 1:	*We didn't have such complex robots and therefore we couldn't do such complex tasks, but we tried to make the best of it and to get many points out of it although we hadn't so … we continued to add something, for example for pushing away we built something from the LEGO parts, and to reach for the points this way*

Post ECER2016 Interview

Extract 20

Students explain how their strategy was built bottom up (we did not have a certain plan of what we were going to do) but they had something challenging they wanted to achieve by all means (i.e. drive up the ramp). In the extract above students explain that re-adjustment of goals was based on assessing different parameters: i.e. assessing what is doable by trying out things, finding out something interesting, challenging and doable (like driving up the ramp), adding other small easier tasks around the big challenging task, considering the amount of points that could be gathered from the different tasks. This whole re-adjustment process seems to facilitate what students describe “as we tried to get the best out of it” given that they did not have complex robots that were able to do complex tasks.

However, one could ask here: Is this a way of teaching your students to thinking small? Instead it appears that students aim each time higher, step by step. Specifically for the next year this is something they aim for to set bigger goals:

Interviewer: *Good, now is there something you would change, for making it more interesting, more fascinating for you?*

Child 3: *Definitely to set bigger goals, not only doing the little tasks, which are gaining us some points, but not as much as the bigger tasks, and to build a more complex robot at some day and not only the small ones*

Post ECER2016 Interview

Extract 21

9.1.9.2.3 PATIENCE AND INSISTENCE

Patience and insistence are two skills highly related to resilience. If a person believes that success is not something that should happen at once and in the first try then it can develop resilience over failure and disappointment.

Child 1: *You should be very patient, because not everything is working right from the start like you imagined so he should be a bit patient and he should have nerves because sometimes I mean sometimes it has worked for two times and stops working at the third try and you should keep your nerves*

Post ECER 2016 Interview

Extract 22

In the extract above students describe that they feel frustrated especially when their robot seems to not behave consistently (functioning for two times in a row but not for a third time). However, and this is important for resilience, students highlight that the skills one needs to have in order to recover from frustration is patience “to have the nerves… to keep going” when everything seems to be going wrong.

Insisting on your goal and not giving up is something students highlighted in several occasions as an important aspect for improvement and success:

Child 4: *I think much has happened through trying, we tried something, and then it went wrong and then we tried again and simply until it has worked.*

Post ECER2016 Interview

Extract 23

Insistence is connected to patience. As we mentioned earlier students in several occasions they highlighted the importance of trying again and again and again until you succeed. This is something they could see happening in the testing tables with the other groups throughout the competition and this is something they practiced themselves in order to be able to stand in a robotic competition for the first time.

9.1.9.2.4 SUCCESS AS A NON BINARY CONCEPT

The internalized view of success seems to be an important part of resilience. Specifically if success is judged only by the final output and it is viewed as binary concept i.e. if someone succeeded or not, then it is more likely to feel frustrated by failures. In the extracts below students show that success is not only judged by the end product and that effort is a continuous process with various milestones where failures and successes co-exist.

Child 3: … Because of robotics, it is now much more logical for me (to understand) how to reach a goal. Even when I was not as successful in the implementation.

Post ECER2016 Interview

Extract 24

In Child's 3 point we can see that students acknowledge learning benefits in the process even if their robot wasn't always successful in the competition tasks. This can be considered a shift in Child's 3 who in the Pre ECER2016 interview expressed the view that you get something out of the competitions if you win or if you are good at it.

Interviewer: Alright, I see. Do you generally like tournaments?

Child 1: Yes, actually yes.

Child 2: Yes, yes.

Interviewer: Why?

Child 1: Because it's an incentive.

Child 2: Definitely.

Child 3: Yes. You get something out of it. At least when you win or are very good.

Pre ECER2016 Interview

Extract 25

The shift in perspective in the same student might be connected to the whole competition experience including not only how the specific competition is structured but also how the group worked together during the competition and the interaction with other groups. Interaction and observation of what the other teams did can also be a source of disappointment but for resilience the key is to be able to balance disappointment with the actual achievements of the group:

Child 1:So-so, it is a bit disappointing when you see how far the other teams got, but I am really proud about us, that we have achieved something [because,

Child 4: [It just was, sorry

Child 1:We worked with robots for the first time, okay maybe not for the first time, we hadn't had a clue at the beginning and then making points, I really think this is very …

Post ECER2016 Interview

Extract 26

The way the group balances its disappointment seems to be grounded on a contextualization of their effort, that is participating for the first time in the competition and being first graders (noted in previous extracts).

Another basis for entertaining their disappointment is that students acknowledge what they manage to do and give credit to themselves for that. These aspects are also related to the internalized view of success in the sense that success is not considered here as the final output (i.e. wining the competition) but as consisting of intermediate steps – small achievements. Moreover, taking into account the special conditions under which is the group was called to perform seemed, that it helped the group to not have expectations they could not meet (i.e. participating for the first time in the competition and expecting to outperform experienced groups). Thus the balancing of disappointment with achievements seems to be closely related with having grounded expectations.

The last dimension related to the internalized view of success and its relation to resilience has to do with the concept of improvement:

> *Child 2: …. the competition was rather exciting, and I don't know if I understood this right that next year there will be a similar task, but there you can improve*
>
> …
>
> *Child 1: you should keep your nerves and think "ok, I will improve this and then maybe it will work better" and several times and you shouldn't give up*

Post ECER2016 Interview

Extract 27

In the extracts above it appears that students see effort as a continuous process where one failure is not the end but there is space for improvement. This is conceptualization of success is the ground for patience and continuous effort as we showed earlier.

9.1.10 Skills

In the post- ECER interview the group discussed the skills that were important for the participation in the competition and the skills a scientist is necessary to have. As an overall comment is that students emphasized mainly meta-cognitive knowledge as opposed to pure cognitive knowledge e.g. knowing about sensors, or knowing more things about programming etc. Although one student mentioned that she gained in engineering and programming skills through the intensive character of the competition and the repeated practice other important skills came into the foreground such as: knowing how to set goals, patience, keep trying and pursuing you goal, organization skills, time management skills and more importantly social skills. Social skills were mentioned as something students brought with them and helped them in the competition in terms of interacting, getting support, asking for help and learning from others. English as the language of the conference – although most groups were German speaking- was a challenge for three out of the four members of the group and thus it was also highlighted as an important skill.

Social skills were emphasized very much by the students in the interview as a key feature for and of the participation in the competition. This is a very important characteristic for the structure and organization of the specific competition because it does not isolate groups in order for them to hide their strategies from others instead with its structure (testing tables and testing slots, waiting slots) encourages social interaction between the groups.

9.1.11 Gender

Gender was explicitly discussed in the pre and post interviews. This discussion is done in reference to the view that the domain and stem is boys dominated. In both interviews students pointed out that they do not feel that their participation is an issue of gender, rather it is an issue of experience.

Interviewer: *… Are you somehow afraid of competing against an all-boys team?*

Child 1: *No, not at all.*

Interviewer: *Or do you feel they might be better than you or something?*

Child 1: *Oh, probably most of them are anyway.*

[Child 2 and 3 laugh]

Child 2 and 3: Yes!

Child 2: That's what I was about to say.

Interviewer: *You never know that!*

Child 1: But generally: I think it doesn't matter if it's against boys or girls, because, at some point everyone has to start. And if the beginners are boys or girls, that doesn't really matter.

Child 3: What I find interesting is that there are almost no mixed teams. Either all-boys or all-girls.

Interviewer: *In the TGM that's the case, yes. There are some other teams who are mixed.*

Pre ECER2016 Interview

Extract 28

Student response at the beginning of the extract showed that students felt that the boys' groups were better than them. As the discussion evolved it was clarified that this view actually involved the more experienced vs the beginners which shows that students do not seem influenced by the widespread belief of boys domination in STEM and in robotics. Furthermore, the point Child 3 is making towards the end of the conference about non-mixed gender groups shows that the student might identified a discrepancy between robotics competitions and other collaborative situations. As we pointed out at the beginning of this section

Interviewer: *Maybe. You are a girls-only team was this important to you or do you think that it was actually not important?*

Child 3: That's just the way it developed, for me it was not important if it was a boys-only team or a girls-only team, it has developed that way

Child 2: We got along well with each other and I don't know if we would have gotten along better or worse when we were a mixed team

[yes in the background]

Child 2: It is ok the way it is, but it would have been ok the other way

Post ECER2016 Interview

Extract 29

In the interview after the conference student view doesn't seem to have changed. In the pre conference interview they added the dimension of experience. After the conference they add the dimension of the quality collaboration between the members (i.e. *getting along with each other*). So in the post conference students when it comes to gender they put forward the aspect of the "chemistry" between the members of the group.

This comment is grounded on the importance students have paid on the social dimension of the competition and the importance of group work.

In the extract below student 1, shows that one of the students has accepted the widespread belief that robots are for boys although the group did not think that boys are better than girls:

> *Child 1: I agree to being a girls-only team, I found it also interesting to see, that so many girls were interested in the robotic competition because I didn't expect that I found that I thought that robotic is rather something for boys when you see that we are a girls-only team, I think this was interesting for the others to see that we have managed as girls-only team that much and especially as first graders*

Post ECER2016 Interview

Extract 30

The experience of the competition seemed to have contributed, at least for student 1, to entertain the belief that STEM and robots are domains that interest only boys. Thus, according to student 1, participation in the competition showed a) that robotics can be of interest also to many girls b) that girls can do equally well with boys. The last comment "especially as first graders" corroborates the initial view expressed in the pre-conference interview where students emphasized not gender but experience in order to be able to manage with the competition.

9.1.12 Discussion

The overall experience from the competition appeared to be positive for the students. Despite the fact that students participated for the first time in a competition with a lot of experienced groups and they struggled a lot with the requirements and the tasks, the students managed some small wins and found this as a rich learning and social experience which the enjoyed and they would like to repeat.

From the analysis of the video data and of the two interviews (pre and post conference) we focus on the following aspects: a) The norms defining the competition as a learning space; b) the model of collaboration followed by the group; c) the focus and the character of the constructionist work; d) development and characteristics of resilience in the face of failure; e) the skills students emphasized as important for participation in the competition and d) student views on aspects related to Gender interest- performance in robotics.

Norms: our data showed that in the competition, it was formulated an informal setting where students behaved more like when at home or when with their friends. Additionally, the competition offered opportunities to the focus group to observe the work of others and of course being exposed in the observation of others. This characteristic of the competition seems to encourage the learning from others and the development of resilience.

Collaboration: Students by placing special emphasis on the social interaction not only with the other groups but also between them described an exceptional model of collaboration including participation throughout in their construction (co-construction model), strategic planning, time management and self but also group assessment as a basis for distribution of work (which was observed not that much during construction but mainly during the preparation of their paper and presentation). As we discussed in the respective section of our analysis, in the group we observed moments were students simply co-existed in their working table and were isolated however, this is something that mainly happened during waiting slots (before getting access to the testing tables or participating in the competition) and it does not diminish the quality of collaboration described earlier, instead it provides credibility to the collaboration model because collaboration is a messy situation which consists of many moments of different value.

Constructions: Our analysis showed that students worked mainly on programming as opposed in configuring their robot. The process of testing the robot appeared to be a rich learning experience which included programming, repeats of the same tests in order to control various factors influencing the designed robot behavior. Based on data from student interviews and on an analysis of the described robot behavior we distinguished in two approaches in student programming: robot centric and table referenced programming with the second being more credible in terms of robot performance. Finally, students used manual interventions on the robot behavior to gain focused feedback. Students following the informal norms of the competition used interesting resources (like their camera) to collect feedback for their robot during the competition and analyze the video in order to repair the robot behavior. Students asserted that the focused, intensive work during the competition was a context, which helped them very much into learning programming and connecting the robot behavior with the engineering of the robot.

Resilience: Resilience was a relevant aspect to investigate in this context as the FG was a group of girls, first graders, who did not participate in a competition before and did not have any special involvement with robots. We focused on how students handled failure in the context of the competition as they had only one small achievement. Our analysis showed that the testing tables were a locus with living examples of resilience as students had the opportunities to observe and interact with more experienced groups which were failing and trying again and again. Furthermore, during the analysis of student post conference interview we observe that the group's resilience was grounded in the following qualities: a) being open to learn from others after assessing yourself and the other members of the group b) understanding that failure is linked to unrealistic goals; it is important here to know how to adjust your goals into what is doable and what is important. Moreover, students showed that they adjust their goals into what is doable but the also aim high building their progress step by step.

Skills: When students discussed the skills they thought they were important after the experience of the competition they focused more on meta-cognitive skills like organization, time-management, and social skills.

Gender: the discussion with the students on issues of gender in the domain of STEM and ICT, students expressed the widespread belief about the boys dominance in STEM and robotics. However their participation in the competition showed them that this belief was not valid in the extend they thought as they saw many girls participating. During the pre and post interview, girls did not consider that boys because of their gender were going to be better than them, instead they put forward as definitive factors experience and "chemistry" in collaboration.

Overall one important remark is that the structure, the norms and the organization of the competition allowed for rich social interactions with learning value, provided an opportunity for intensive - focused learning of programming and supported the development of resilience. Students said that they were excited to participate in the competition, expressed their interest for the next year and the only remarks they had about the competition was the difference between testing and competition tables which resulted in their robot performing well during the test and failing in the competition.

9.2 APPENDIX B: ECER COMPETITION YEAR 2

ECER 2017 took place in Sofia, Bulgaria at Sofia Tech Park in April 24 -28 2017 (https://pria.at/en/ecer/ecer-2017/). It consisted of the same competition units as ECER 2016: i.e. Botball European Regional Tournament, PRIA Open, PRIA Aerial and PRIA underwater. Botball and PRIA Open consisted of the following types of competitions[3]:

- **Seeding Rounds**: Each group competes separately in three rounds. According to the tasks the robot completes successfully on the game table, the group wins points. The seeding score is the average of the best two rounds. Botball and PRIA Open
- **Double Elimination**: Two teams compete on the same table. The team with the highest score wins. Robot blocking of the other team is also an option. If a team loses two matches is out of the tournament. Botball and PRIA Open
- **Alliances**: Teams excluded from the Double Elimination can participate in Alliances. Alliances are formulated by the organizing committee and the competition has the same structure as the seeding rounds only that in this case two teams unite their strengths on the table.

The two focus groups, which are analyzed next, participated in the Botball competition.

9.2.1 Spatial Layout of the conference

9.2.1.1 MAIN ROOM

The room is long and thin with no windows. There is a big open space to the right with a projector about halfway down the room. This is used for presentations and students bring their chairs and fill up the space to the right as and when necessary.

9.2.1.1.1 COMPETITION AREA

To the left, about the same length, there is first of all the aerial competition area, then three game tables: two of them are used for the competition and one is used for practice. This area is roped-off.

Fig. 1. Areal competition area and a view of the competition tables on the back

[3] In the ECER 2016 report, the Competitions and the competition types are presented in more details.

9.2.1.1.2 WORKING AREA

Behind the projector screen is the technical support area where the ECER team is based. To the left and stretching back about the same distance as the first section are long tables for teams. Some teams share tables and others do not.

Fig 2. Overview of the working area of the groups

At the very back of the room and to the left, there is an empty space which at some point a group of students have used to create their own game 'table' on the floor, using electrical tape, for testing purposes.

9.2.1.2 SECOND SPACE

Before the 'main room' there is a second space. From the main doors to the whole room/hall, to the right is an open unused space, ahead there are some demos of VR kit for students to try out. To the left is the registration area and beyond this the main space.

9.2.1.3 OUTSIDE

Below the main space, and outside is the underwater competition area.

9.2.2 Data collection

The data reported here involve two Focus Groups (FGs). FG1 is a team from Austria "roboSpabs" and it consists of three girls and one boy. The name of the group is. The group participated in ECER the second time and they were also observed as FG during ECER2016. The group synthesis is almost the same with year 2016 with the exception of one girl who has been replaced by a boy. During a discussion between the Researcher and the group, students explained that the girl replaced did not like the competition and that is why they had to look for someone else. The boy chosen was from the same class with the other three girls and the criteria applied were two: a) the team asked someone who was good (probably in programming - engineering considering that students shared come from a school with a focus in technology) b) and was willing to participate in the competition (actually students said that "he was the only one who said yes")

The second Focus Group (FG2) is a team from Bulgaria "TUES Bulgaria" and consists of four boys and three girls. This is the first time for the team participating in the competition with the exception of one team member who had participated in a robotics competition before the "First LEGO league". Selection process was done by the school, it was conducted by the members of the school alumni association and it involved students writing a motivation letter. Students formed the opinion that the selection process was random and nobody actually read what they wrote. This opinion was based on the fact that some of the students participating in the team wrote an essay and others just wrote a sentence. However, students considered that the experience of participating in the conference was a happy coincidence for them. According to the pre-ECER2017 interview, the school participated in ECER also in 2016 but then there were no teams formulated.

The analysis presented next is based on the following types of data: Pre and Post ECER 2017 interviews with the focus groups, questionnaires completed by the competition participants, and video recordings of the two Focus Groups. The video data were collected with a go-pro camera, which was handed to the FGs by the researcher with the direction to use the rec and stop button according to their will. Thus, the data collected are not based on continuous video recordings of student activity instead it is based on student decisions when they want the camera to record their activity. FG1 used the camera less in comparison to FG2 which also captured long duration videos (i.e. 16- 20 minutes as opposed to the 10 minute videos of FG1)

Focus Group 1 (Austria- roboSpabs)				
	Testing Area	Working Area	Competition Area	Total Videos[4]
CAMERA Focus	6	15	2	23

Focus Group 2 (Bulgaria "TUES BG")					
	Testing Area	Working Area	Competition Area	Presentation Area	Total Videos[5]
CAMERA focus	3	25	13	1	53

Table 1. Camera focus in the two FGs

More than half of the videos where the camera focuses on the Competition Area were recorded by the Researcher and did not involve the Bulgarian Team.

Taking the above remarks into consideration, our analysis does not focus on a comparison between groups based the number of instances per code and per focus group – especially on the video data- because the groups treated differently the use of the camera. Instead the analysis identifies mainly critical episodes, which portray the way the two groups worked during the competition.

9.2.3 Analysis of the learning experience

In this section we report an analysis of the learning experience of the two Focus Groups (FG1 and FG2) during their participation in the competition. Our analysis has focused on the following dimensions. We refer to the competition Norms, to describe the context of the learning experience and the way the competition is differentiated from other learning environments like the school. An important part for Robotics education is Collaboration as in most cases students work on robotics not isolated but as groups. So in this report we describe the model of collaboration formed between the members of the two groups and we tried to identify the shaping forces. The other dimension of our analysis involves the focus of student constructions (programming and configuration of the robot), the process of testing their constructions and the formulations

[4] The number of videos is not the sum of the video focus instances because one video does not necessarily have one focus. Instead a case might be that the video has two foci: e.g. working Area and Testing Area.
[5] 11 out of the 53 videos had duration less than a minute (short videos) which in most cases did not focus on a specific episode but it was the result of accidental camera use or had to do with students changing their minds about camera use.

of strategies for “surviving” in the competition. In a separate section we discuss the lessons students felt they learned during their participation in the competition. This analysis explores again the development of resilience in both groups: FG1 who participates for second time in the competition, and FG2 who is a newcomer. We investigate students’ view on the role of gender in participation and performance in Robotics competitions.

9.2.3.1 COMPETITION NORMS

Competition Norms were also discussed in the report on ECER2016. Similarly we observed here again the established interactions and behaviors which are acceptable in an non formal learning environment such as the competition and which make it quite different from the formal educational setting. As we will show next the competition norms seem to play an important role in facilitating social interaction and learning from others (see next section)

9.2.3.1.1 INFORMAL SETTING

As it was mentioned in the ECER 2016 report in the competition we observed behaviors that are encountered more in settings where students interact with their friends as opposed to situations that are encountered in formal learning environments. Specifically students can eat, drink, discuss with others, listen to their own music or watch videos on their computer etc. This informal setting offers a context where students are expected to manage their leisure or pause time along with their work time. In several cases they might need to work in conditions that are not always agreeable:

Child 2: And also the empty room, it was loud, it echoed. And we were right next to the speakers again! That was quite annoying again.

Child 4: The gong.

Child 1: [This gong, it was so annoying!

Child 2: [Yes.

Child 1: Gong, gong, gong! Every 10 seconds!

Child 2: Yes, I liked the setup better when you knew when it was your turn and there was a gong only every 5 minutes then.

Interviewer: Uhuh.

*Child 2: I mean, in the end we even skived off to the end of the room - as far away from the speakers as possible! *grinning**

Extract 1

Post ECER Interview FG1

In the competition there was music playing and a gong, which sounded more often than students wished. Furthermore students complained about the management of sound in the room. Based on the extract above it becomes obvious that the characteristics of a non-formal learning environment, like the one described above can be destructing for the participants. In this sense students have an additional challenge as they had to find a way to work under conditions that were not facilitating concentration and focused work.

9.2.3.1.2 OBSERVING OTHERS

Observing others is a behavior that was also recorded during both competitions (ECER 2016 & 2017) however it was also an aspect that was further analyzed in the discussion between the Researcher and the Bulgarian team after the ECER2017 conference:

R: (...) What was it like seeing other teams

S7: It was refreshing.

R: Refreshing? What do you mean?

S7: You go to a place were there are two hundred other people your age. and you see robots, you compete against those teams. The robots are kind of the same like yours, but not exactly, you can see the designs, the different ideas. There is a lot of energy. Its like you see the robot and you start thinking what did they do? Why did they do this? And you kind of start thinking about other stuff

R: So you get ideas from other teams

Extract 2

Post ECER Interview FG2

In the extract above it appears that observing others is a rich resource for learning. Observing others might or might not involve direct interaction with the team. Even in cases that there is not interaction with the other team (i.e. discussion) it is observed a high intellectual activity as pointed out by S7 because observation is followed by an analysis of what is observed which starts with a number of interesting questions i.e. what did they do (which might be a different way of approaching a task), why did they do this. Apart from the interview a similar instance was captured by the researcher during her interaction with FG 2:

R: So where are the girls?

St: No idea (they all look towards the table)

(They laugh)

R: Have they abandoned you?

St: No

St: They are just watching the competition

R: Ah, and I was wondering why the boys are doing all the work and not the girls

St(girl): because the girls are watching, and so, yeah

R: Are you getting ideas? From the other teams?

St (girl):We are exploring the other teams work and we can take one or other idea

St(girl): and just like that, (to record), to invent something better

R: Have you seen any good ideas you want to use?

St (girl): Well I don't know because I am not actually the hardware girl

(R laughs)

St (girl): the one with the six members (i.e. the group) which won the five points, and I was like (wow)

R: I missed that, I missed it

St(girl) Well

R: That's "robot on fire" [i.e. the name of a team participating in the competition], yes?

St(girl): we are competing each other but that doesn't mean we can't be friends so we are, like, watch each others work

R: Yeah

St(girl): because we are (pupils/people)

R: Did you get any ideas, erm from watching the move and thinking about the program that's behind it?

St(girl) yeah, I can predict some of the things they are used in the program, like the sensors they use or how to get the () all these things like the (line following) it is something that I do

Extract 3

17_Video (file: GOPR0049) FG 2

From the extract above we can unpack the concept of observing others in the following elements a) it can be developed into a task for a team (some people working and some people exploring new ideas) b) it can be a valuable a valuable source for new ideas c) requires an understanding and an analysis of what is the mechanism underlying the behavior of the robot *(I can predict some of the sensors they used for their program*), however this analysis requires relevant knowledge (*it is something that I do)* d) identifying teams that are good so as to offer ideas and insights e) fostering a culture of shared knowledge which is expressed in a rather rough way by the student "*We are competing each other but that doesn't mean that we can't be friends and watch each other work*". What is interesting in this norm is that students cannot actually use ready made solutions applied by others because a) they do not have the complete piece of knowledge required and, as we showed earlier, students need to need analyze what they observe using relevant or previous knowledge b) each team follows a different approach in robot construction and in programming and thus a ready made solution from another team cannot easily fit in the team's approach. That seems to be the reason why – while in the context of a competition- observing others during work, or testing and on competing is not an issue that contradicts the concept of competition. However, our analysis involve only newcomers in the competition and it would be useful to see how high scoring teams handle this issue.

So, observing others is an instrument to learn from others and it appears that it is a demanding task. To this end students supported their observation activity with the use of digital media.

9.2.3.1.3 USING IMAGE CAPTURING MEDIA

This norm is tightly connected to the previous section of observing others. Specifically, in the case of FG2, students had a camera, which they used to capture not only their performance during competition or testing but also for capturing other team's performance during testing and competition (see Fig 3).

Fig 3. Camera use for the robot construction

In the picture above the boy from FG2 shows to the girl how to use the specific camera. The instance is taken before the group entered the testing table. This is not unusual for the competition as other groups had also cameras with them. Furthermore, in ECER 2016 we had captured FG1 to use their mobile phones as a medium to capture the robot performance and then to analyze it so as to get feedback for the refinement of their construction. In the instance captured in Fig3, one student of FG2 shows to the other how to use the camera, which was used during the team's testing but also was used to capture another team's robot on the testing table. In this occasion the boy from the team who was testing, showed an expression, which showed that the boy was annoyed in the presence of the camera. However, there was no verbal exchange between the two students and the testing was towards its end. Futhermore, the videos following the instance of camera use during testing, did not capture the group looking at the camera in order to refine their program or their robot, although students appeared to watch videos on their computer.

9.2.3.1.4 “BEING OBSERVED”

This is a norm also mentioned in our report for ECER 2016. During the competition, teams not only have the opportunity to observe others but they are also exposed to other teams observing them during the competition but also during their testing. During the competition there is always an audience, which participates by applauding or by expressing their disappointment with exclamations (such as ohhhs) when a robot appears to be doing well and something happens and looses points or fails at the task. However there are no reactions from the audience that make students feel uncomfortable if they do not manage to make it, instead it seems that there is some sort of empathy. Taking into account these observations it appears that our interpretation from year 2016 concerning student exposure to an audience is demystified in the context of ECER competition, gains a stronger ground. We noted in 2016 report that exposure to others requires from students to be confident enough to compete even if they know that their robot has flaws, and to set goals (see section on resilience) which can support this confidence (aiming for gaining points not for completing all tasks for example).

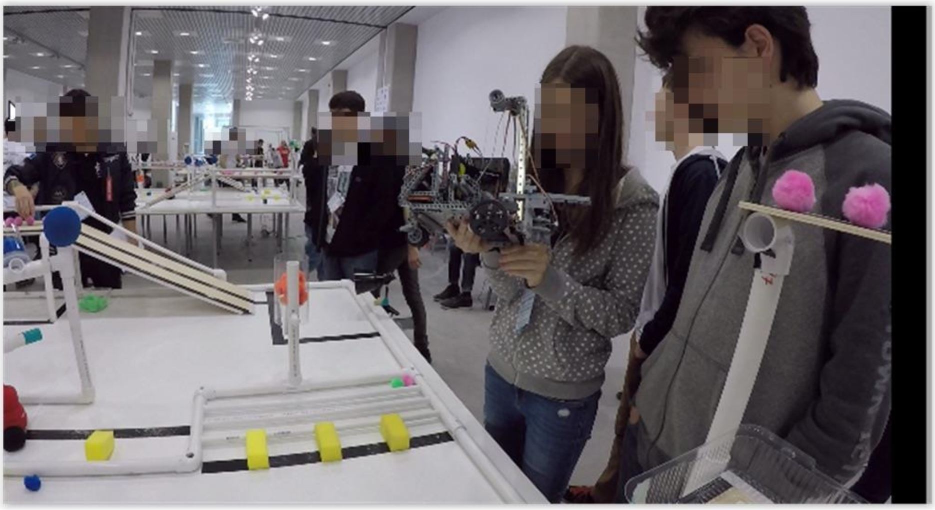


Fig. 4: FG 1 observed during testing

Apart from the context of competition students might also be observed during their testing as shown in the picture above (see Fig. 4). This might happen naturally while students for their turn on the testing table but a team might engage in observing another team if they were interested in the approach of a group. For the last point we have no actual data to support this conjecture, however this might be something worth of further investigation.

9.2.3.2 COLLABORATION

We mentioned earlier that the FG consisted of four girls and during the competition they had two robots they were working with. Their collaboration had a set of interesting characteristics some of which were identified during the analysis of the video data and some of which, were explicitly described by the students in the interviews with the Researchers.

9.2.3.2.1 DIVISION OF LABOR AND CO-CONSTRUCTION

In this section we discussed how collaboration was shaped around division of labor between the team members. Our analysis showed that the FG demonstrated different types of division of labor in their group but all three types were tuned to the model of co-construction which was also encountered in ECER2016: a shared participation of all group members in the work of the team.

9.2.3.2.2 SKILL BASED DIVISION OF LABOR

When students discuss about how they work during the competition they say that although there are different tasks they are all doing everything. A similar behavior was recorded also in ECER 2016 with FG1 and we defined it as a process of co-constructing :

R: what do you think would you differently as a team. Would you organise themselves in the same way or would you decide to have different responsibilities, or…

St7: the responsibilities were like everyone had to to everything

St1 (yeah)

R: Do you think that worked well?

St2,4 most of the times

St7: Sometimes people get exhausted. There have been times where a person might get exhausted from writing code and somebody has to switch with him. I think we should actually have more people working with it

R: ok so you can swap in people. Maybe if some one gets frustrated with something, they can leave it and some one else can come in and work with something.

Extract 4

Post conference Interview FG 2

In the extract above we observed that students from FG 2 explain that their mode of work involved all group members being involved with all tasks. St7 further elaborates on the necessity of such approach as the task is demanding (especially programming) and they need more people to be able to be involved with it. Students from FG2 described the same model of work also during their pre-conference interview:

Interviewer: How do you distribute your roles within the team? Because from the previous interview we had, I understood that everyone is involved with everything. How do you balance the work?

C2: We mainly work together on everything. Everyone is welcome to share their opinion and the team decides whether this is of importance to the project at the moment or not. The opinion, or like… yes, what has to be changed on the robot.

Extract 5

Focus Group 2: Preconference Interview

A similar answer is given by ST1 from FG1 in their interaction with the researcher during the competition.

St1 (inaudible)

R: Its more your thing, building.

St1: yes. I have something

R: Physical?

….

St1 (inaudible) he is better than me, so...

R: So who else is involved in coding? Are you coding (to St3)?

St3: yes

R: BOth of you. so is it just you that you are doing the building?

St1. No we all do building. I help them with the coding. Because I am very very (inaudible

St1: Because in theory

R: Yeah, theory

St1: In theory, it works and then they have to, to (inaudible) that it works

R: ok, so they have to make it to work, the program

Extract 6

Focus Group 1

In the extract above apart from the student statement that all group members are involved in the co-construction of the robot in terms of building and programming it appears that there are “specializations” within the group i.e. one person is better at programming and another is better in building so according to their skills they are assigned a task. However, the nature of the task seems to require involvement of those involved in building with the programming and vice versa. St1 offers an explanation, which leads us to think that due to the fact that the building of the robot is tightly connected to how it is programmed then the person who constructs it has to know the structure of the program and the algorithms used. The same seems to hold for the connections between programming and building.

A similar situation is observed in FG 2 where students admit that some students are more involved in the program and some others are involved with the building of the robot.

R: ok. And how did it work between boys and girls? Because I saw that the boys were mostly working on the mechanical stuff

St7: We were working on the code and (Name) and Peter were working on the robots because (name) knows the mechanical parts of the bigger robot best. And we were just changing the code to see what the robot could do

Extract 7

Post conference Interview Focus Group 2

In the extract above we can see that the group applied a similar strategy to the one mentioned by FG 1: the division of labor is based on the skills of the team members: i.e. the person who knows best the engineering of the big robot is engaged with that. ST7’s response seems to highlight the concept of the interconnection of the tasks which allows for division of labor but requires good understanding of the different tasks by all group members.

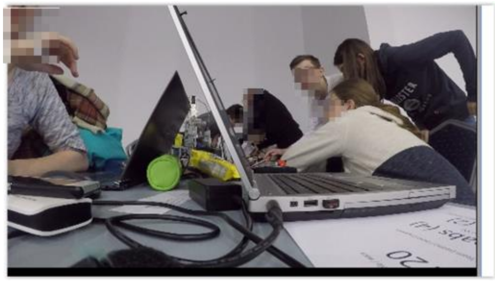


Fig. 5. Co-constructing FG 1 and FG 2

In the picture above, the camera captured an instance where three of the four members of FG1 (on the left) and two of the members of FG 2 are looking and tinkering with the robot.

Thus collaboration as co-construction is further elaborated with the data from ECER 2017 as a process, which includes division of labor but this division, defines domains of responsibility instead of isolated territories of work. The concept of roles as domains of responsibility was also observed in the ESI-CEE workshops. It appears that this model of work emerges in relation to the nature of the task as robotics consists of two separate but highly interconnected tasks: i.e. programming and robot building. This characteristic requires from students to delve into one of the tasks but at the same time they need to have good knowledge of the other task so as to be able to fine tune the two different aspects of the work (i.e. combine programming and working into one functioning robot). Furthermore, this knowledge is required for debugging in order for the students to realize what is wrong each time, the construction or the program.

9.2.3.2.3 HORIZONTAL DIVISION OF LABOR

Apart from the two main categories of tasks described earlier i.e. programming and building which we consider it a vertical division of labor, it appears that students needed to also divide the competition tasks (e.g. collection of the pomp – pomps, going up the ramp etc.) between them. We consider this division of labor horizontal because it cuts across and involves both main tasks i.e. programming and robot building.

Child 1:Well, we had from … regarding Documentation, I think we had a much better overview over when everything had to be done.

….

Child 1: Because we simply … We always got every E-mail from Julia and so on and that was not the case with [name of student no. 31001]. We only ever got chunks. Like, "Tomorrow, there's this." – "Oh, okay. Thanks."

…

Child 1: I also think regarding the division of work – who does what, that we … I think, in the beginning it was more like "Yeah … let's somehow divide this." But nobody actually said in which way. Anyway. In the end, it was like "You do this, you do this, you do this, you do (this)." That worked better than saying "Yes, let's divide this" and everyone sat there like "Okay. Let's divide it."

….

Child 2: I think it worked better because we actually had, more or less, not one boss but everyone had a say.

Extract 8

Post conference Interview Focus Group 1

In the extract above we present Child 1's opinion on the division of labor in the post conference Interview of FG1, which were captured at different instances of the discussion about collaboration. We selected them because they portray a picture of what we called horizontal division of labor and what it involves. Specifically, it seems that students during the competition and probably during their preparation for the competition they receive descriptions of the tasks their robots should perform. To this end and because of the complexity of the tasks, division of labor is a good model of work. However, as Child 1 acknowledges, division of labor is not a straightforward or easy task. Child 1 highlights this difficulty by saying that they only progressively managed to reach a stage where they were able to divide the work effectively. Child 1 connects this effectives with the timely distribution of all the information available which allowed students to understand what they were expected to do and when. The distribution of the relevant information lead –according to Child 2- to a decentralized model of decision making about the division of labor, as everyone had a say. So, it appears that in this case division of labor is not incompatible with the process of co-construction as all group members are involved in the process of construction.

9.2.3.2.4 DIVISION OF LABOR AROUND A ROBOT

In the Botball competition students participate with two robots. Each robot is different and they are designed to perform different tasks. In ECER 2016 we found that FG1 divided its work around the two robots: the initial plan[6] was for two students to work with one robot and the other two with the other. The same pattern is encountered in FG2 during ECER 2017.

> *So, out of the 450 people there 16 chosen. Some of the 16 people go at school in the morning and some of them go to school in the afternoon. So, we had to be divided in two sub-teams. So the team working in the morning worked the big robot and the team working in the afternoon worked with the small one. So we've always been exchanging ideas between the two subteams. There was a constant communication between us.*

Extract 9

Rehearsal preparation – Focus Group 2

The extract above is taken from the paper presentation rehearsal of FG2. The rehearsal is done in the working area by one of the girls of the team in front of another girl who at the end commented on it. The specific part of the presentation refers to the pre-conference preparation and it portrays that a form of division of labor is structured around the two different robots with which the team will compete. This division of labor seems here to be decided for spatiotemporal reasons as some of the students who were selected from the school to participate in the competition were going to school in the morning and some of them in the afternoon. In the picture below we can see the two different robots of FG 2. On the middle of the table is depicted the small robot and on the left corner it is depicted what students call “the big robot”

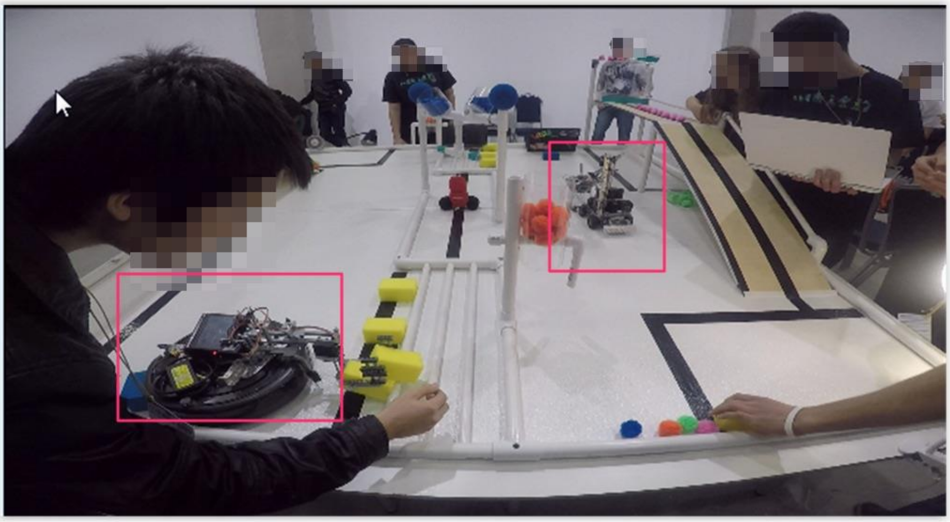


Fig. 6. The two robots of FG 2

The big robot was externally the same for most of the groups (also for FG1). However the smaller robot appeared in different variations

[6]During the competition the second robot did not work and all students focused their work on one robot.

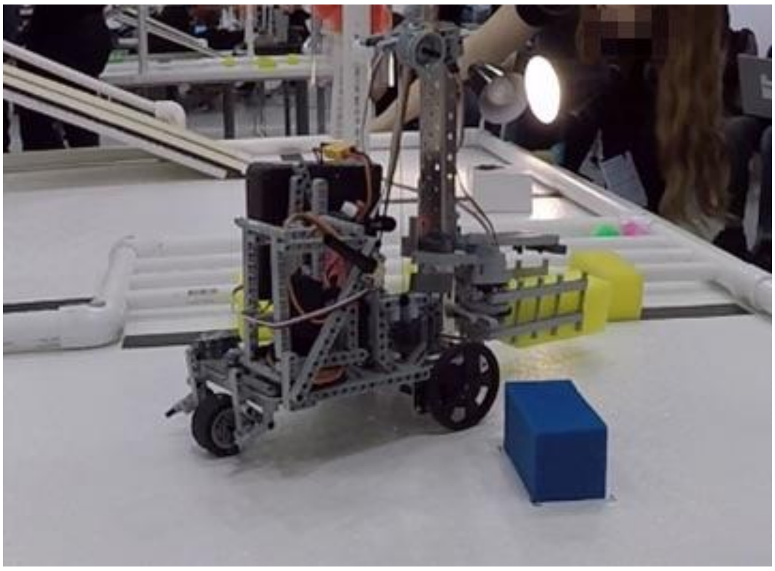


Fig. 7: Robot 2- FG 1

FG2 seemed that it followed the division of labor around the two robots not only during the preparation phase but also during the competition. The same seemed to be the case also for FG1 although students did not explicitly refer to that. However, the analysis of the video showed that the same students working around one robot and the same were working around the second robot. However, this does not mean that there were no interactions between the students around a robot different from the one which, was under their responsibility (see for example Fig. 5 for where three students from FG1 appear to be engaged with the big robot).

9.2.3.2.5 ORGANIZATION –OPINION SHARING AND DECENTRALIZATION OF WORK

During the pre and post conference interview with both FGs, students answered on questions regarding the character of their teamwork. In the case of FG1 who participated in ECER for the second time, a question that was brought up involved student progress in teamwork:

Interviewer: Uhuh. How would you say was the team better than last year? In which way?

Child 1:Well, we had from … regarding Documentation, I think we had a much better overview over when everything had to be done.

Interviewer: Uhuh.

Child 1: Because we simply … We always got every E-mail from Julia and so on and that was not the case with [name of student no. 31001]. We only ever got chunks. Like, "Tomorrow, there's this." – "Oh, okay. Thanks."

*Everyone: *laughing**

Child 1:So that was always like … yeah. That was … way better this year.

Interviewer: Uhuh.

Child 1: That we knew everything organisationally. And when we had to do something.

*Child 2: I also think that the division was better. Because the thing with "Tomorrow there's the deadline!", you *looks at Child 1* usually sat down and did it on your own and this year, we were actually able to divide the work*

….

Child 1: I also think regarding the division of work – who does what, that we … I think, in the beginning it was more like "Yeah … let's somehow divide this." But nobody actually said in which way. Anyway. In the end, it was like "You do this, you do this, you do this, you do (this)." That worked better than saying "Yes, let's divide this" and everyone sat there like "Okay. Let's divide

….

Child 2: I think it worked better because we actually had, more or less, not one boss but everyone had a say.

Extract 10

Post conference Interview Focus Group 1

Students raise two issues, which are relevant to the nature of their team-work. One of them is addressed as an organizational issue and the other is addressed as shared responsibility and equal participation. Organization here seems to have a rather practical character, which involves the time and the content of information shared. Specifically, students seem to appreciate the fact that one of the team members who appears to be the leader, shared all the available information involving the tasks and the competition in a timely manner. As opposed to the previous year where the rest of the group did not seem to have access to the whole package of information and wasn't aware about the timing. This lead to a centralized mode of work, where one student did all the work under the pressure of the deadline. Thus sharing all the information about the task on time, seems to be more than a practical issue in the sense that it gives the opportunity to the team members to process the information and use it to formulate a shared strategy for the team's next steps. This seems to be a critical aspect from the transition of a centralized to a decentralized mode of work where there is one leader in the group but all team members have a say. This decentralized model of work is at the heart of co-construction and it is also encountered in FG2:

Interviewer: How do you distribute your roles within the team? Because from the previous interview we had, I understood that everyone is involved with everything. How do you balance the work?

C2: We mainly work together on everything. Everyone is welcome to share their opinion and the team decides whether this is of importance to the project at the moment or not. The opinion, or like… yes, what has to be changed on the robot.

Pre-Conference Interview FG 2

C?: The coolest thing about our team is that everybody is free to speak their mind.

Paper Presentation Rehearsal FG 2

Extract 11

FG2, emphasizes here the concept of freedom of speech and that team-work evolved around shared ideas and opinions which were evaluated by the team members on the basis of their relevance to the task at hand. Students actually highlight this aspect in their paper presentation as the "coolest thing in their team". We observe two things in the above extract a) students consider free speech as an important part of teamwork and b) the team does not only offer the floor to any one who wants to have a say but it also has an evaluation system which is developed with reference to the project of the team and c) that the evaluation of the ideas is applied by the whole team.

Both instances from student interviews (extract 10 and 11) offer us an insight on how co-construction is put in function with timely sharing of resources (here information about the competition tasks), freedom to share ideas and a project based evaluation system of the ideas applied by all team members.

9.2.3.2.6 TEAM SPIRIT AND SHARED RESPONSIBILITY

The aspect of shared responsibility, the group and not the individual being responsible for the results, is an important quality that shows the unity of the team. In shared responsibility the individual cannot find itself on the final output and the team cannot find the individual in its success or failure. Thus, shared responsibility is an indicator of how compact is the team. The importance of unity is supported and demonstrated by "external sings" such as same t-Shirts. This was encountered in FG2 and also in the team "Robots on fire" who won the Botball competition:

Fig. 8: Unity in T-Shirts. FG2: TUES –BG on the left and "Robots on fire" on the right

Apart from the external forms of team unity, which were presented above, FG 2 further elaborated on the issue by referring to the importance of shared responsibility during the post conference interview.

> *R: Ok what have you learned about yourself. Not as a team. Individually. What have you learned about yourself this week?*
>
> *….*
>
> *R: What else did you learn?*
>
> *St1: And not to blame each other because everybody makes mistakes*
>
> *St7: The fault is on the team not on the particular person*
>
> *R: Ok. Team all the way through. In success and in failure.*

Post-Conference Interview- FG2

Extract 12

Shared responsibility was not the first thing mentioned when the researcher asked students what they learned about themselves. Specifically students mentioned something about their attitude towards failure, which will be further discussed in the section for resilience, and they also mentioned an incident of failure which was attributed to the stress. Specifically, students described how they connected the wrong way the wires of the wheels and their robot ended up going backwards during the competition. Exactly after this reference the two students St1 and ST7 referred to shared responsibility: i.e. to not blame each other and that the fault is on the team. This is an important realization, which can be connected to the characteristics of the task and the context of the competition. Specifically:

- shared responsibility might be more natural to emerge in the context of co-construction where all team members contribute in everything and every output is the result of different opinions, elaborated, tested, modified and combined. This process removes the individual from the scene and brings forward the team.
- Mistakes are not only human but they also depend on the context and team's previous decisions. Specifically, a wrong action due to stress might occur because of the organization of work, or because of the mistake someone else has made before. This is more likely to occur when students engage with complex and open-ended tasks like a robotic construction.
- The context of the competition is very demanding and in combination with the complexity of the task can contribute to a realization that the only chance to make it is to count on the strength of the team and to not loose team members by blaming each other.

9.2.3.3 CONSTRUCTION

In this section we analyze the process of construction with reference both to programming and robotics. Our data involve both FGs and are drawn from the analysis of the video data, student interactions with the lead researcher, student interviews before and after the competition. The construction process involves not only the time during the competition but also the preparation phase of the teams (as it is mentioned by the students in their interactions with the researchers). The analysis of the construction process covers the following aspects: a) the emphasis of constructionist activity during the competition b) the construction challenges students faced c) The nature and the elements of the testing process and d) the role of tactics in the process of construction.

9.2.3.3.1 EMPHASIS

In this section we explore the emphasis of constructionist activity of both groups during ECER 2017. FG1 devoted most of its work, during the competition, in programming. Students offer an explanation for this in the post conference interview and in the interaction they had with one of the researchers during the competition.

R: So how is it going so far? This year from last year?

ST3: Much better but we just had a problem

R: Yes

ST3: Because the program was ok and we just... emmm

ST2: We connected the two [inaudible] and we overwrote all our work from last week

St2: We had to do it again, and now we have to try it (and see if it is ok)

R: Ok, so when you went to the game table before, did it have the code from last week or it was then when you discovered you had a problem

St2: (We discovered it then)

FG1: Researcher – Group interaction (video file: 02_Video)

Child 1: Which meant that we had to fix all these little things again which led our program to actually … EXTREMELY fuck up.

*Child 3, 4: *laughing**

Child 2; We weren't able to make it work again until the end of the week.

….

Child 2: [We had a backup of the program which was a little more up-to-date but from the week before ECER and we had worked a lot on it the days before ECER.

FG1: Post conference Interview

Extract 13

FG1 had an "accident" with their program during the competition as they overwritten it with an older version of it. Even though the group had a back up, it wasn't updated enough and thus the group to have to repeat the work they had done during the preparation phase under the pressure of the competition. Due to this fact, the group was captured in the video working mainly on their program and they appeared to be only some fine-tuning of their robot.

FG1: Construction Focus	Frequency
Programming	6
Robot Construction	2
FG2: Construction Focus	
Programming	2
Robot Construction	16

Table 2. Team constructions - Emphasis

In the table above we present the focus of the work in each FG as it was captured in the videos we analyzed. As we mentioned earlier in this report the duration and the number of videos captured by the two groups is different, thus we do not direct our attention here to the actual numbers. Instead, we pay attention to the "tendencies" demonstrated by the numbers for each group, which is also backed up by the qualitative data collected during the interviews and the researcher – group interaction. Thus the table here confirms the focus of work for FG1, which was on programming due to the back up problem. Furthermore, analysis of the video data showed that the team engaged in rather light interventions in the robots more like a fine-tuning as opposed to the interventions of FG 2 and the focus of their work.

Looking at the numbers of table 2 we can see that FG2, worked more on their robots. The analysis of the video data showed that students engaged in more deep work with their robot in comparison to FG1:

R: Ahh ok, I saw the girls, they said one of your robots was too big.

St: Yes

R: Which one?

St: That one (he points to the other robot of the team)

St: And Georgi tried to make it smaller and also heavier at the same time because we need counter weight

R: Ah, ok.

R(talks to another two students who are engaged with the other robot). So you are having to re-design your robot?

St1: Yes

St2: Yes. We have to move this a little bit down (he points to the hand of the robot which has to be made shorter)

R:ok

St2: (Because it was too wide and made it heavier)

St1: Thanks very much

R:ok

Researcher – Group Interaction: Video file: 16_Video

R: So you worked on the basis that we know we have the mechanics right and we had the best mechanical robot

St2,4,5: NO, no. Good enough

R: A good enough robot and then we need the code to work with this robot.

St(all) yes

R: Not, to change the robot

ST5: At some point we noticed that the mechanics were not good enough. But they were good enough on the table we practiced on and we figured it out too late

FG2: Post conference Interview

Extract 14

From the discussion with the students it appears that FG2 faced more challenges regarding the construction of their robot. During testing they realized they had to make some significant changes in their robot – making it smaller and heavier because it needed counter weight in order to be able to climb up the ramp.

So it appears that each group placed a different emphasis on the construction during the competition and they were both faced with important challenges.

9.2.3.3.2 CONSTRUCTION CHALLENGES

Apart from the challenges that were designed for the competition, students in the competition are faced with several other issues, which need to address in order to be able to compete. Most of these challenges have to do with the robots being a physical construct. The solutions students need to find to these challenges range from practical to cognitive ones.

9.2.3.3.2.1 MALFUNCTIONING ROBOTIC PARTS: SEEKING PRACTICAL SOLUTIONS

One of the problems teams seem to encounter in competitions quite often is that some of the robotic parts might not work properly not due to wrong configurations but due to malfunctioning.

Child 2: We also had some problems with the wheels. We exchanged them quite a few times and [each time they started to get slower, the motors too and

Child 1: [(Each time it started again…)

Interviewer: Uhuh. Yes, that's difficult. What was the most difficult for you this year, generally speaking? So…

Child 3: Fixing the wheels because it didn't work. At all.

Interviewer: Okay.

Child 2: [They just fell off…

Child 3: [Because the motor was … we had replacement motors with us but …

Child 1: No, that was actually not the problem but…

Child 3: It was, among other things.

*Child 1: *laughs* The rubber tore off from the black wheel.*

Child 3: [Yes, that too!

Child 2: [Yes but the motors also broke.

Child 3: [The problem with the [motors was there, too.

Child 1: [Yes, the motors broke, too.

Child 4: ()

Child 1: But that wasn't the main problem, we had other motors. The main problem was that the tyre tore off of these new wheels that simply didn't work at all! I don't know what it is with these wheels. They just tear off!

Interviewer: I've heard of that!

Child 2: And then we weren't even allowed to glue them on.

FG1: Post-Conference Interview

Extract 15

FG1 in the discussion with the researcher explain one of their problems they had with the motors and the wheels of their robots. Both problems could have practical solutions i.e. having replacement motors and gluing the wheels. However students were able to solve only the first problem. The second problem appeared to be persistent until the end of the competition as the solution students found was against the competition's rules.

FG2 faced a similar situation during the competition as they realized that their servo-motor was dead and they had to buy a new one which was available in the competition:

R: What's happening

St(girl): the (servos) died

St(boy): the (servos) is broken

R: Ahh,

St(boy): (turns to R on his own initiative after the competition is over - and the robot did not work): there is only one piece almost (inaudible) (he shows the robot and the piece to the Researcher. The student in the competition table hands the robot on him. The specific student is among those engaged in constructing the specific robot (camera captured mostly him working on the robot with the help of others)

St: Our servo motor is dead (to the technical assistance of the competition)

TA: You can buy a new one from us

St yes

TA. But I would prefer to do it after the lunch break

FG2: Researcher – Group interaction (video File: 21 _Video)

Extract 16

9.2.3.3.2.2 THE IMPORTANCE OF ROBOTIC PARTS: COGNITIVE AND CREATIVE SOLUTIONS

In the post conference interview of FG2, students mentioned that they were using second hand parts during their preparation (and the competition) in comparison to another Bulgarian team, which seems to be due to the fact that the school of FG2 participated in the competition for a second time.

Ch2: Well, I think the difference is that we are using second-hand parts, while they (the other Bulgarian team) have received a new kit, which allows them maybe the opportunity for more experiments, as they have more parts, but as for our parts some of them are lost, some of them are broken or bended or burnt, we have fewer parts. We had a problem with our controller, we actually still have problems with it, but we solved the problem by using a regular motor instead of servo, as we burnt a few ports (laughs), but however, we don't need to get in details… in general they have better opportunities but don't use them, this is my opinion. But we use what we have from previous years and we managed to succeed, mainly because of our motivation.

FG2: Pre-Conference Interview

Extract 17

Student 2 brings forward another interesting challenge for the competing groups, that of second hand parts, which means that some of the parts can be missing, or malfunctioning. As a result students need to work with what they have and they also need to find alternative solutions in order to overcome problems related to the construction of the robot. Robotic parts, even when they are not second hand seem to be an additional challenge especially for students who engage with robots for the first time:

R: so how are you both finding this year? From last year? With building the robot and programming it? Is it easier? This year?

St2(?) Yes, much easier

R: Yeah?

St3? (we know which parts they are) because last year we had a big box, and, oh that part is new, that part .. and it was like "ah, ok"

R: So you' ve got a head start. Yeah?

St2:yeah

FG1: Researcher – Group Interaction (video file: FG2)

Extract 18

In the dialogue presented above, students connect the difficulty of the competition to the acquaintance of the robotic parts. This is an indicator of how important it is the role of robotic parts for participation in the competition. This discussion portrays the challenge, which is connected to the construction of the robot: students need to know the different robotic parts and their functionalities in order to be able to use them effectively.

Both these instances (extract 17 and 18) show that in order for the students to face these challenges they need to engage in tasks which are demanding from a cognitive point of view: a) they need to understand the functionalities of the different robotic parts not only in a declarative way (i.e. what each part does) but in a way that allows to combine them in a working construct (i.e. the robot) which involves synthetic thinking and b) they need to be able find alternatives when a robotic part is not available using their knowledge and creativity.

This is possible to happen due to the different combinations and solutions that can be pursued with the use of kits (consisting of small parts that can be used in different ways and combinations)

Another aspect regarding the challenges encountered with the robotic parts is highlighted in FG2 (extract 17). This aspect is related to the attitude towards the problems that might be encountered with the robotic parts. Instead of complaining for missing or broken parts students have the motivation to work with what they have and find solutions to their problem. This is an aspect related to resilience and will be further discussed in the respective section.

9.2.3.3.2.3 PRECISION AND HARD CODING

Another important challenge of robotic construction is precision. In the ECER 2016 we observed students using various instruments for measurements in the testing table in order for the students to be able to put their robot on the right start position. The placement of the robot in the exact position appeared to be very important for the robot not to end up off course and to complete the task. In ECER 2017 we did not observe similar behaviors (students using various instruments for measurement of the right position on the testing table), although teams spent a considerable time on setting the table and their robot on the right position before they started testing or competing. However, we have no image data capturing measurements but this might be due to the fact that there were no actual close ups of the camera on the testing and competition tables.

Discussion with the FG2 during the post competition interview brought up the aspect of precision as a challenge that has to be addressed during competitions and further elaborated on its importance.

St5: ... better organization. Next time, know things in advance for example " we can't buy in BG the specific material to build the table. Because we did not know this we had our game table a week and a half before the competition and everyone else got it for months, and this really set us back.

R: To practice on the actual table

St5: Also we did not build it very precisely

R: Ah, ok. Why is it important to be precise?

St6: Small change in the game table can affect very seriously the performance of the robot. Butterfly effect: one small mistake sets the entire machine off course.

R: Really nice way to explain it, the butterfly effect: one thing goes wrong, then everything else… ok

FG2: Post conference Interview

Extract 19

The students refer here in the organization of their work during the preparation phase before the competition. Specifically, they refer to the construction and use of a testing table, which appeared to be not exactly the same with the actual tables used in the competition. St6 used the metaphor of the butterfly effect to describe how vulnerable is the robot performance to small mistakes that can be attributed to lack of precision. Furthermore, when students referred to their robotic construction (see also extract 14) they pointed out the problems encountered with their robot due to the lack of precision of their testing table:

ST5: At some point we noticed that the mechanics were not good enough. But they were good enough on the table we practiced on and we figured it out too late.

R: What was the difference?

St5: The distance between the end of the table and one of the objects it had to catch

R: so, that is the issue about hard coding things like turns. Go this far and then turn.

FG2: Post conference Interview

Extract 19

The discussion above casts a new light on issues regarding precision, because, as the researcher points out precision is connected to hard coding or table related programming as mentioned in the ECER 2016 report. In this case students, use concrete values for turns and distances covered which are easily influenced by small changes in the initial position of the robot or in its turning. In ECER 2016 we observed that students, acknowledging the problems in this approach, re-tested their robots even if the first trial was successful. This was a behavior that was also observed in ECER 2017 in FG2. In ECER 2016 we observed that students seemed to have devised some correction mechanisms that seemed to check robot position after a turn and re-situate it in the right position on the table.

Even though precision seems to be connected to an immature approach to programming the robot (i.e. hard coding), it is by itself an important skill, which is practiced during the competition.

9.2.3.3.3 TESTING

Testing and refining is an important part of constructionist activity and the same holds for robotics in all settings (schools, workshops, competitions). We have mentioned in various occasions in this report and in the ECER2016 report that in the competition teams need to test their robots in tables which are identical to the competition tables (testing or practice tables). In ECER2016 we pointed out the importance of testing tables not only for the feedback students get for their robot but also for interactions between the teams, resilience and learning from others. During the 2016 competition there were two testing tables and three game tables. In 2017 competition, the testing tables were reduced to one, there was no time for free testing as students had access to the testing table only during the structured time for practice. In the post conference interview FG1 mentioned the existence of an additional testing table during the competition of 2016 but they did not discuss further the issue. However, we have some additional information on the issue because the researcher in her field notes recorded that there was limited interaction between the groups during testing in comparison to year 2016.

Even though the competition had set more restrictions with regard to testing this year, our data revealed different forms and testing modes, which are presented next in this section.

9.2.3.3.4 TRANSFERRING THE TESTING TABLE ON THE FLOOR

We mentioned earlier the importance of testing for progressing with the construction and given the limited time available for testing in the 2017 competition, students from FG2 came up with other solutions. Specifically, they tried to transfer part of the competition table on the floor using duck tape.

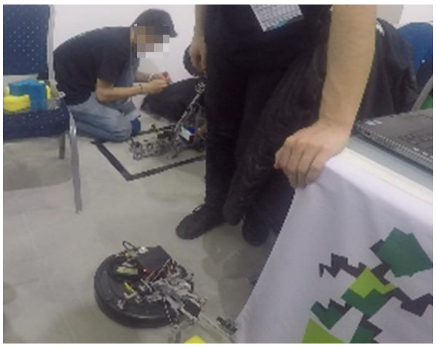


Fig.9 Floor testing with elements from the testing table

Fig. 10. Testing and competition table

On the picture on the right we can see the set up of the testing- competition table and on the picture on the left we can see that only the initial square of the testing table is transferred on the floor. The initial square seems to be very important for the performance of robot on the table as a small mistake on its placement can lead the robot completely off its route. Students tested their robots also on the floor outside the marked area as we can see in Fig 9. FG2 had also created a similar square on their working table for testing the robot.

Fig 11. Checking the surface of the working table

In fig 11 apart from the square drawn with the duck tape on the team's table, we can also see students checking the surface of the table. In order for the testing to be accurate the surface on which testing is performed has to be the same with the one on the game table because factors like the friction can influence very much robot behavior. The effort of the FG2 for more efficient outside the structured practice time entails the following elements a) understanding that they cannot rely only on the structured practice time in order to be able to compete b) finding a way out to be more effective in their testing c) making the necessary measurements (size of the square) and evaluating the surface (table vs floor) in order to support their testing more efficiently. A similar action was encountered also in ECER 2016 where in a space outside the competition area where a group shaped the outline of the testing table (without the ramps) and performed their testing there.

One might raise cheating concerns here, considering that the competition is very strict on some aspects (e.g. students not allowed to use glue for the problems with their wheels). However, this behavior seems acceptable because a) this set up is not hidden from the competition organizers and b) students can get a little bit more valuable feedback than free testing on the floor, which does not seem to make much difference. Another assumption is that this type of testing is required by teams who are not competing for the top places on the ranking because it seems to involve very basic robot movements (how to start) and probably well prepared teams do not need it.

9.2.3.3.5 CHECKING THE FUNCTIONING OF ROBOTIC PARTS

FG1 was captured to use only the testing table for their tests and they probably used their working table for short tests with their robot. In the discussion they had with the researcher they refer to the tests made during the process of building their robot:

R: When you were building it were you programming it and testing it as well?

St3: Yes, but mostly, just like with the function, you can put servos, you can put (inaudible), just test it without programming anything on the computer

R: So, you just check the functionality of it?

St3: Yes, and also you have to change some mechanical things, now to..

FG1: Researcher – group interaction (video file: 08_Video)

Extract 20

The discussion between FG1 and the researcher reveals a method for testing during robot building. Specifically students when they build their robot they just test the different sensors and motors to check that they are functioning properly. Based on this discussion it appears that programming follows this first check.

9.2.3.3.6 STATISTICAL ANALYSIS OF ROBOT "MISBEHAVIOR"

We have mentioned in several occasions that one of the construction challenges for the students during the competition was that the behavior of the robot could be influenced by several factors other than mistakes in the program. As a result students in ECER 2016 and in the 2017 competition engaged in re-testing their robot even if its performance was unproblematic the first time. There were several cases observed in competition 2016 where the robot did not behave in the same way during re-tests (i.e. going off-course when the first time followed the route without a problem). In the extract below we can see how, students from FG2, engaged in capturing these "misbehaviors":

St (girl): This graph shows the frequency our robot was repeating a mistake. So one day we were testing our robot and we programmed it to turn 90 degrees. We put a lego beam on the surface that was marked with degree angles. We watched what the robot would do when it would turn. Every time it would fall short in turning 90 degrees by a (inaudible) we represented it in the graph by a positive (inaudible). So the average instances, the average time that made this mistake, was 2.55. The minumum being 0 and the maximum being 4.

FG2: Presentation Rehearsal

Extract 21

This extract is from the presentation rehearsal of a student form FG2. In this extract the student shows the methodology the group followed in order to capture problems in the robot behavior. Specifically, students programmed a simple task for the robot (i.e. turn 90 degrees) and then they created a statistical analysis of the robot mistakes. Students found an average rate of mistakes, minimum and maximum values. This is an interesting approach, which shows that students understand that there are various factors interfering in the performance of the robot (although the program was the same: turn 90 degrees the robot did not always perform the same way) and they try to capture the influence of these factors on their robot. However, the students do not explain further how this analysis informed their design or programming and if they considered the average range of mistakes big or small for their robot.

9.2.3.3.7 MANUAL INTERVENTIONS

Manual interventions during testing, was also followed in the 2017 competition. Similar to the year 2016 competition when the robot did not perform a turn or a task accurately they used their hand to re-adjust it. This action proved to be useful as students were able to check the rest of the sequence of the activities and in some cases, like the one captured in the picture below, they could check what alterations in the behavior of the program would be effective.

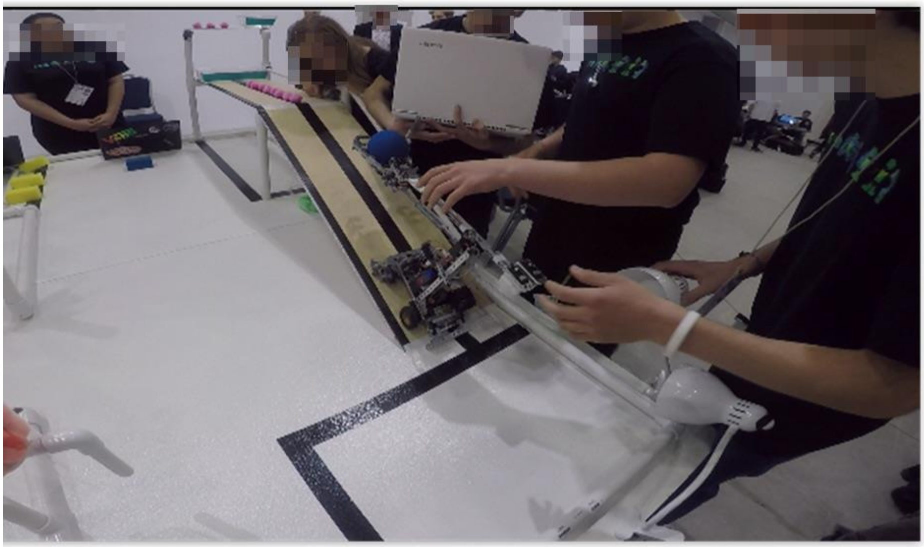


Fig. 12. Manual interventions

The picture captures an instance where FG2 robot picked up the blue ball and tried to climb the ramp. However, due to the fact that the robot started climbing with its hand raised it fell off on its back. So students lowered the hand of the robot manually to check if there was a position of the hand that was appropriate (i.e. not loosing the balance while going up the ramp and not touching the ramp). In the next trial students had programmed the robot to raise the hand, pick up the blue softball, lower the hand and then climb up the ramp.

To sum up manual interventions in the behavior of the robot is a method students use quite often while testing, it is connected to the physical character of the robot and facilitates not only the current process of testing but also provides insights to the next circle of refinements.

9.2.3.3.8 TACTICS, SELF EVALUATION AND PROBLEM SOLVING TECHNIQUES

Construction in the context of competition requires also the formulation of a strategy which involves an evaluation of the team's competences and a selection of tasks to be pursued in terms of robot construction and programming. In this competition both groups FG1 and FG2 considered themselves very ambitious in terms of the tasks they tried to pursue and they concluded that they should formulate a strategy that ensures easy points and then proceeds to more difficult ones.

St (girl) (inaudible), more simple things

R: So too ambitious

St(girl) Yeah

R: Ok. And you think you were too ambitious because you had another team, so you thought, you do better with

St(girl) Our home team, just this one boy, is from last year. The rest of us, are here first year and umm, our idea was like simple but not that simple. I mean, umm we were ambitious. I think we should have changed the tactics to the end.

St(girl): I think we could have one more point. But

R: So, tactics is as important, as programming and... building

St(girl) of course, of course. Definitely.

FG2: Group – Researcher Interaction (video file: 05_Video)

Extract 22

The student from FG2 in her interaction with the researcher, evaluates their strategy ambitious based mainly on the results of the team's performance. What is more interesting however, is the conclusion in this discussion. Specifically the student agrees with the researcher that tactics, i.e. what you choose to pursue – is as important as programming and building in the context of the competition. For the students participating for the first time in a competition, in order to formulate a strategy they need to consider the team's experience and capabilities against the tasks of the competition. So an essential part of the formulation of tactics is self-evaluation. A second step for the formulation of strategy is the method you work:

R: What will you take from this year? What have you learned from this year that you will take next year

St7: Play safe. Don't risk. Because we risked and failed

R: ok, so take the easy points

St(all): Yes

ST7: Organize our strategies better. Like, a smart strategy would be to take the green pomps (green soft balls), just put everything in it.

FG2: Post conference Interview

Extract 23

The competition is organized mainly around the collection of points. Thus tasks of varying difficulty offer different points. From the extract above it appears that students after the competition they realized the importance of valuing the "easy points". Thus after the experience of the competition students consider as a smart strategy to start small (i.e. collect all the green pomp-pomps) and then aim for more complex tasks.

R: Because last year you went "ok, we just want to not be last" (they all laugh). Ok, yeah? What's the plan this year?

St2: That the stuff works, that we programmed

R: yeah, the next thing is to try to score some points

ST2: All the things we decided to try would work

Group Researcher Interaction (video file: 02_Video)

Child 2: Regarding Botball: Yes, it's quite sad that last year, when we had participated for the first time and had had so much more simple robots, we had scored more points than this year.

Interviewer: Uhuh. So this year you had more complex robots than last year?

Child 2: Uhuh.

Interviewer: Okay. Well, I can also say from my experience that that happens a lot. That the more complex things are often more difficult and therefore won't work as good. Uhm, why do you think you had more complex robots this year and they didn't work as good? What do you think?

Child 1: Well, I think last year they were extremely primitive. I mean, they only had…

Child 2: … wheels. And that's it.

Child 1: Wheels and I think they drove up the ramp and pushed pomps off the panels. So they were really extremely … simple.

Interviewer: Uhuh.

Child 1: So this year we simply made it more complex because otherwise … without anything going up and down you don't get as much points. I mean, ultimately we also didn't get much points but … If it had worked, it would have been more.

FG1: Post conference Interview

Extract 24

In the extract above it appears that FG1 followed the strategy start simple during the 2016 Competition. In the discussion with the researcher, it is reminded to the students that their ambition was for the first time to collect enough points so as not to be last in the ranking. This is considered a rather moderate goal, which was based on what students described in the post conference interview as using really simple robots to perform tasks that could give them some points. Furthermore, the specific strategy worked because students managed to get more points in 2016 in comparison the 2017 competition where they participated with more complex robots. So, a conclusion from this discussion is that simple choices work better with robotics – at least for the new comers. This concept of the power of simplicity in robotics, is also elaborated by the researcher who belongs to PRIA stuff, she has an expertise on educational robotics and has participated in the past in robotics competitions.

The choice of more complex robots wasn't just an issue of confidence (i.e. we managed the year before so, we can try more difficult things this year) it was also a matter of the tasks of the competition. The students highlighted that the tasks on year 2016 focused more on having robots to explore and push softballs off the ramp, whereas in the current competition most tasks required robots that were able to lift and stack things. We have to consider here that the main problem for FG1 was not actually the strategy used but the problem they had at the begging with overwriting their program and not having an updated back up with them. So, as students point out if their program was not clobbered they would probably have scored higher.

Taking into consideration the opinions of FG1 and FG2, it appears that with robotics the best strategy is to begin with simple tasks and robots – which according to the experience of FG1 can be effective in terms of scoring- ensure that you win some easy points and then progressively move on to more complex tasks.

Apart from their own strategies students from FG1 discussed with the researcher strategies of other groups and specifically the top two groups on the final ranking.

R: Does it make any difference to you seeing an experienced team?

St5: Yes they used one of their robots to sabotage the other team's robot, but this way they could not use it to get points. So, perhaps it is not that good of a strategy.

St1: That's exactly the strategy we wouldn't want to use

R: yes, and robots on fire changed their strategy at the end

S(all) yes

R: They used the same strategy, to disrupt the other one

S1: That was kind of clever

R: Yes, but it didn't work

S7: Well, it happens. But it was a nice idea to change the strategy

R: So between different rounds, changing strategies. Do you think you would try that next year?

S(all) yeah (laughing)

FG2: Post conference Interview

Extract 25

The discussion about the strategies of the top two teams, involve the competition in the finals of the Double Elimination, which is a very challenging type of competition and the winner is highly respected by all participants. The teams competing in the finals was the world champion and robots on fire with the last being the winners. In the Double Elimination two teams compete with their robots against each other on the same table the same time. Teams have the option, according to the competition rules, to disrupt the other team's robot. The strategies mentioned in this extract have the following characteristics: a) they do not just focus on the points they will score (as FG1 and FG2 did) but they also focus on disrupting the other team's robot b) the teams can decide and change strategies from round to round –deciding if one of their robots will have a disruptive role or not. So here there are two new things added in the strategies formulated in the competitions: a) teams need to consider the opponent's strategies and b) they need to be flexible enough and re-adjust their strategy if necessary. Changing tactics from round to round after evaluation of the team's and the opponent's performance was considered a smart strategy to be pursued by FG2 in the next competitions.

9.2.3.4 LESSONS LEARNED – REFLECTION

In this section we refer to the lessons students said that they learned after their participation in the competition. The answers are drawn from the post-conference interviews. Before we continue with our analysis we will mention here the description of the competition experience coming from one of the students of FG2 who participated for the first time in the conference:

"We were constantly working, we were meeting people, observing, exploring. That was kind of exciting"

FG2: Post conference Interview

This statement resumes very eloquently the experience of the competition which included intensive work, social interaction, observations of other teams competing, testing, working and explorations of new things but also of the team's capabilities and limits.

9.2.3.4.1 THE VALUE OF THE TEAM

Students mentioned the importance of being part of a team when encountered with such demanding tasks:

R: What was the best thing this week?

St3: Being together: working together, failing together

FG2: Post conference Interview

Extract 26

We consider this an important contribution of the competition towards teamwork and collaboration because the competition offers to the students the context and the experience to value the importance of team-work not only in terms of better results but also in terms of supporting each other during work and during failure. When the researcher asked from the students to justify their response they further elaborated on the idea of failure.

9.2.3.4.2 LEARNING FROM MISTAKES

After ST3 from FG2 mentioned failure in the context of the team St 5 stressed the importance of learning from the mistakes.

St5: Learning from mistakes. This is a conference on educational robotics, where people learn most from their mistakes

FG2: Post conference Interview

Extract 27

One interpretation for this contribution is that St5 tries to justify the team's low scores or "failure". Even if this is the case, it seems that this experience helped students to demystify failure and understand the importance of learning from mistakes. Constructionism, as a learning process, is about learning from mistakes i.e. trying something out, understand what is it that does not work, refine it, test it again and so on. However, in the context of the competition mistakes happen at two levels: one is the level of the construction process where students build their final product through understanding their mistakes and in this context mistakes have more value and little social impact; the second is the level of the competition where the group is socially "Exposed" its final performance determines its ranking among the other groups. The second type of mistakes have a more strong social impact and the feedback collected is usually at the end of the process and involves choices the group made at a more higher level: i.e. construction strategy, robots selected, division of labor etc.

9.2.3.4.3 SIMPLE VS COMPLEX CHOICES

Starting with simple tasks and robots is, apart from an important element of the student strategies, one of the lessons students said that they learned about engagement with robotics.

St. Simple things are much better than complicated ones

…

St7: Play safe. Don't risk. Because we risked and failed

R: ok, so take the easy points

St(all): yes

FG2: Post conference Interview

Extract 28

There is one aspect we think important do discuss from the extract above. The student statement "Play safe. Don't risk. Because we risked and failed". This statement might be interpreted as a positive but also as a negative result of the student participation in the competition. The negative view is that failure scared the students and they decided to do only what it is within their limits. Even though this is a safe choice it does not allow students to push their limits and then progress. As we will show next, the risk students took might have led to failure but it was also a very valuable experience in regards to the focus and organization of their work in the next competition.

Another way to view this response has to take into account the fact that the team participates in the competition for the first time. So, setting low goals at the beginning especially because they have to first understand how the whole concept of the competition works, is not necessarily a mode of work all the way through. On the contrary, as we saw with FG1 (see section on Tactics) in the first year they also aimed low (not to be the last team) and the second year they were more confident to try out more complex tasks and robots which in a sense is a calculated risk and pushes the team's limits. Furthermore, the nature of the competition is such that teams are expected to push their limits from year to year if they expect to climb up in the ranking. But this is a process which requires that teams start from understanding first what they can do and then progress with their skills and work.

9.2.3.4.4 PRACTICAL – ORGANIZATIONAL ISSUES: THE IMPORTANCE OF THE "UNIMPORTANT"

FG2 stressed in their discussion with the researcher the importance of practical – organizational things which if neglected they can impact the final result very seriously. One such thing, although it is not mentioned by FG1 in their interview was the use of back up. The fact that FG1 did not have an updated back up of their work with them cost a great deal in the final performance and the scoring of the group. Similarly FG2 identified a set of other issues that are of practical nature and they played an important role in the team's performance:

St Girl: just before you start check that the wheel is ok or not (all laugh)

R: What happened with the wheel?

St3: Fell off

St6 check the list with the things that we are allowed to use

R: Ah, the parts. Make sure you know the rules of the game and how something has to happen

St: Yeah

St5: Also better organization. Next time, know things in advance for example " we can't buy in BG the specific material to build the table. Because we did not know this we had our game table a week and a half before the competition and everyone else got it for months, and this really set us back.

FG2: Post conference Interview

Extract 29

Acknowledging the importance of “unimportant” things – in comparison to the effort and focus on programming and building- the like those mentioned above is a significant realization because as students realized in the competition success in many cases depends from little easy things that for various reasons were not taken into account.

9.2.3.4.5 LEARNING FROM OTHERS

Learning from others and socializing was one of the things that students from both FGs stressed.

R: What was the best thing this week

StGirl: Making friends, getting close with another team. It has been a hell of an experience

FG2: Post conference Interview

Extract 30

Learning from others was an important dimension of the learning experience in ECER 2016. Our analysis there revealed the important role of testing tables and the structure of the competition, i.e. that students had free time to socialize and interact with other groups. In ECER 2017 it appears that the Alliances competition offered a structured opportunity for the teams to interact with each other and learn from each other:

R: Did you talk to the other teams? Not the other Bulgarian teams. The other teams. Did you talk to the other teams?

S(all) Yes

St1:The Ukranian team. WE were in the alliances with them. They are really nice, we made friends, we talked a lot with them

FG2: Post conference Interview

Interviewer: Uhuh. Okay. You were in Alliances.

Child 1: Yes.

Interviewer: How was that for you? How did it go?

Child 1: [But then the team Spengergasse, the team … they were not present in the beginning, that’s why we had … were three teams at first.

Interviewer: Uhuh.

*Child 1: But then they actually did show up and I … I had already known one of them. Because I’m in dance school with him. *grinning* Anyway, I had known him. And yes, that worked out a lot better. But yes. In the end, their robot drove … I think … over the … over the white pipes on the sides, which had never happened before.*

Child 2: But yes…

Child 1: Which then … yes. But I … that worked out very well then. Regarding communication.

Child 2: They also showed us some things and we helped each other. I mean, in the end none of the two programs worked but we still learned something from each other.

FG1: Post conference Interview

Extract 31

Both FGs refer to Alliances as a context where they met new people, they discussed and worked with them. FG2 mention that they learned from each other although their programs did not work at the end. Alliances seem to offer a good context for the teams to communicate, socialize and learn from each other. The reason is that groups come together when they have already done some work, so this work can be a starting point for discussion, exchange of ideas and socializing. This was the case with the Ukranian team and FG2. In the case of

FG1 this process had another entry-point, which was the acquaintance of one of the FG students with a student from the other Alliance team. However, the context of Alliances competition wasn't always enough for the students to communicate and learn of each other

Child 1: Well, at first we were paired with two Arabic … or [Arabic-speaking teams.

Child 4: [Kuwaitis.

Child 4: Kuwait and Egypt.

Child 1: Yes, well, anyway. They always communicated with each other [… which we didn't understand at all!

Child 2: [And we didn't really catch on to that.

Child 1: Because they didn't … How should I answer? "Okay, okay. Thanks."

Child 2: And they … I mean, they didn't talk to us a lot. The one team, the all-girls-team, they didn't [… .....

Interviewer: So the only thing that was really difficult was communication with the Kuwaitis?

*Child 3: *nods**

FG1: Post conference Interview

R: What you did not like this week?

S1: Not everybody was friendly and communicative. We went to some people but they sat alone and they did not want to communicate

R: Was there any reason you can think of?

S7: Maybe they don't like the Bulgarian team, or they just wanted to work by themselves.

FG2: Post conference Interview

Extract 32

The extract above includes the experience of both FGs with other teams that they are not open to communication and interaction with others. In the case of the FG1 the communication with the other team was in the context of Alliances, whereas in the case of FG2 it seems that communication with other teams was an initiative taken by FG2. FG1 does not offer a reason for the reaction of the other team, although there might be there cultural issues, which cannot be explored here. FG2 on the other hand seems to take some sort of blame on them in the sense that they seem to consider themselves inferior – they wouldn't want to talk to a Bulgarian team. However, they balance this idea by acknowledging that the other group might want to work alone. Given that there is no information available on the characteristics of the other group, the type and the context in which some members of the FG2 tried to approach another team we cannot draw any conclusions. On the other hand these extracts offer us the valuable information that the culture of the competition and structured contexts such as the Alliances are not enough for communication to work. Instead an important factor is the culture of the team and its openness to interaction with others.

9.2.3.4.6 LEARNING "LIFE SKILLS"

When students discussed the lessons learned they referred to some other kinds of knowledge they acquired during the competition for FG1 it was learning how to travel and be autonomous in a foreign country and for FG2, which did not have to travel as the competition was taking place in Bulgaria, was offering help with their participation in managing huge orders (i.e. 200 pizzas).

Child 2: And what I also learned … not really because of Botball but more or less alone in Bulgaria or …

yeah, we fought our way completely differently. For example, each day, having to find something where you could eat.

*Everyone: *laughing**

Child 2: You really learn a lot by that!

Interviewer: Uhuh. A bit autonomy, right?

Child 2: Uhuh.

*Interviewer: Yes. *looking at Child 4* How was it for you?*

Child 4: Yeah, you could learn a bit of Cyrillic.

*Everyone: *laughing**

Child 4: And Google Maps was very important, too.

Interviewer: Yes!

Child 4: The taxi drivers sometimes didn't know where to drive at all.

Interviewer: Uhuh.

Child 4: At our hotel, they told us to tell them "Sofia Tech Park" and you will arrive there. But the taxi driver actually called someone because he didn't know where it was.

Child 1: Trenner [one of the teachers] said: "Yeah, they know where to go, they know where to go." When we tell them Sofia Tech Park, that's enough. And he was like "Yeah, ALL of this is Sofia Tech Park. How am I supposed to know where to go?"

FG1: Post conference Interview

Extract 33

In the extract above students explain the challenges they faced during the competition in terms of every day needs. It is interesting that students mentioned that they "fought our way in Sofia completely different" in comparison to the 2016 competition which was held in their city of origin (i.e. Vienna). Thus participation in the competition offered to the students the opportunity to face as a team a set of real life challenges which are connected to travelling and to "surviving" in a foreign country.

R: Anything else? In general?

S1: We learned the domino's pizza menu. WE were helping with ordering the pizzas like 200 pizzas. Labelling the pizzas (this extract is not transcribed in full detail as students were laughing and talking together. However, it appeared that it was a challenging task to order such a large number of pizzas and distribute them correctly to the right people)

FG2: Post conference Interview

Extract 34

The situation for the FG2 was a bit different regarding the other fields of knowledge they gained through their participation in the competition. Their offer of help to the competition to order pizzas for the participants showed that a) the team realized that it had some skills that could help with the process: students they could communicate with the participants through English and through Bulgarian with the local pizza restaurants b)they showed initiative to help and c) they practiced organizational skills as they had to manage to deliver the right pizza to the right people. This task gave the opportunity to the team to socialize a bit more with the participants and become useful.

9.2.3.4.7 DOMAIN LEARNING

An overview of this section will show that students when they were asked what they learned from the competition they referred mainly to soft skills. However in FG1 one of the students emphasized that she gained more experience and knowledge in mechanics:

Child 1: That was … yes. But I think we learnt a lot about mechanics. Because you already knew the *parts and knew what was available. I mean, there were some different parts … the wheels, it wasn't really a good decision to take them in the beginning. Because then you had the robot and then you had to, when you wanted to … because we wanted to go up the ramp, we had to rebuild half of the robot because with the centre of gravity, it would have worked but if we had used the other, … the smaller wheels, we would have had to rebuild it. So we thought: "No, it will work this way, too." Ultimately, we should have already rebuilt it at that time but we didn't know that it would be THIS much of a problem.*

FG2: Post conference Interview

Extract 35

In the extract above the student highlights a piece of knowledge regarding the mechanical parts of the robot. Specifically the student demonstrates the piece of knowledge acquired through the competition, which involves the size of the wheels and the center of gravity. It appears that underestimating the role of the wheels in the construction proved to be a major obstacle for the successful performance of the robot. The fact that students explicitly refer to specific domain knowledge obtained during the competition is an indication of the contribution of Robotics Competitions not only on soft skills but also on domain knowledge.

9.2.3.5 RESILIENCE

In this section we revisit resilience and we investigate it as recovery from failure and disappointment in the learning context of a competition. During the 2016 competition we investigated the elements of resilience demonstrated in the FG1 which was participating in the competition for the first time and they found themselves meeting their goals but at the same time having a rather low position in the ranking. Even though the ranking was low, the team in the 2016 competition appeared satisfied as they believed that for newcomers they did quite well and they had a number of effective strategies and attitudes that helped them recovering from failure: these included student perceptions of success and failure, patience and persistence, realistic self-evaluation and setting the right goals and adjusting them when necessary.

In this year FG1 did not discuss their problems and failure in terms of resilience. Their major problem was due to an accident i.e. overwriting their program with an older version of it and not being able to recover it. So, students said that they were sad that this happened but they did not seem to consider it as an important failure because it did not have to do with the focus of their work i.e. programming and building. Furthermore, students claimed that the structure of their program did not have any problems and if it wasn't this "accident" then they expected that their program would have worked. They also mentioned that the only parts of the program, which were hard-coded were related to the curves of the robot's route. Hard coding is the main reason for robot "misbehaviors" i.e. performing well one time and being off course the next.

Child 2: Well… I think that basically it would have worked but with the program … with the clobbering we messed up quite a lot. So concerning logic we didn't have any mistakes in the program.

Interviewer: Uhuh.

Child 2: It was only the curves that we had to hard code.

…

Interviewer: And generally, did you like it this year? Are you satisfied with your performance or unsatisfied?

Child 1: Well, that it wor- … Well, you couldn't really be satisfied because it didn't work!

Interviewer: Uhuh.

Child 1: It would have been nice if it had worked in the end but yes. It was the clobbering that was really annoying because all of these … We've had, we tried to not make the program static but there were, I think, 3 or 4 curves that were … and one short distance that were static. And these were… all of these were gone. They were not usable they were … 90 degree curves were like, I don't know, 45 or something like that. That was not really usable.

Interviewer: Yes.

Child 1: That was annoying.

Child 2: Yes. So generally speaking, I actually liked it this year. In spite of the clobbering and all of the other problems we had … I liked it and I would like to do it again next year.

FG1: Post conference interview

Extract 36

So with respect to FG1, based on what students said in the extract above, it appears that failure did not discourage the students and although they were not satisfied with their performance they recognized the good parts of their work and they were willing to participate again in the competition.

Elements of resilience were more evident in the discussion with FG2, which participated for the first time in the competition, and they are presented next.

9.2.3.5.1 ATTITUDES TOWARDS FAILURE: BEING POSITIVE

One of the main parameters that contribute in the development resilience is how students relate to failure and how they feel about it.

R: Ok what have you learned about yourself. Not as a team. Individually. What have you learned about yourself this week?

St2: Be positive

R: Why positive? Like have you learned you should be positive?

St2: Yes

St1: Because it helps you to keep going

R: Is that what you were thinking?

St2: yes

St1: When you constantly fail you have to be positive because that is what keeps you going. And we can have fun even if we fail. I mean we did have fun between us even though we failed.

R: So you had a fun week, even though you didn't succeed

Stall: Yeah,(They laugh)

FG2: Post Conference Interview

Extract 37

Being positive in failure is the first response students offered to the researcher's question "what did you learn about yourselves". Although the specific student did not further elaborated his thinking, another student explained that positive thinking is important in order to not be discouraged and keep going. Being positive is not presented here just as wishful thinking, instead it has the role of helping students not to be discouraged when they are faced with disappointments. Another aspect of being positive is that it allows students to enjoy the process (of working, participating in the competition) instead of being overwhelmed with disappointment. This is an important element of resilience because it allows the individual to acknowledge that one failure in one domain does not influence its whole world. The context of the competition seems to support the development of such feelings mainly because: a) the task of robotics is very demanding and complex and many teams face failure b) in the context of the competition students have the opportunity to socialize and do also other things than constantly working on their robot c) failure takes place in the context of a team.

9.2.3.5.2 PERSISTENCE

Another aspect of resilience, which was also present in the elements of resilience appearing with FG1 during ECER 2016, is persistence. Persistence has to do with not giving up because you are discouraged by disappointments and failure. Students from FG2 connected persistence with being positive as an attitude that keeps you going when you "constantly fail". The context of the competition seems to be an environment that can support the development of persistence mainly because: a) each group has more than one opportunities (three rounds) in competing with their robot; b) if a team fails in one competition (Double elimination) then they can continue with the support of another team who is in a similar situation (i.e. has failed the Double Elimination), in the Alliances competition; c) in the context of Alliances, one team joins strengths with another team that also faced failure, there, teams can support each other not only in psychological terms but also in practical terms as they probably have done different mistakes and they can continue working based on a more solid ground (i.e. the work of both teams).

9.2.3.5.3 TEAM SPIRIT AND SHARED RESPONSIBILITY – LEARNING FROM MISTAKES

In the section describing collaboration we analyzed how important it is for a team to understand the value of team spirit and shared responsibility. These two elements are also important for the development of resilience because failure does not become a burden for only one person; instead, it is an issue that involves the whole team. When responsibility for failure is shared then it is easier to recover from it and the context of the team should offer mechanisms for recovery not only in psychological terms (see extract 12) but also in terms of taking action based on what you learned from your mistakes (see extract 27).

9.2.3.5.4 SETTING APPROPRIATE GOALS AND ADAPTING

Setting the right goals by evaluating your experience and the difficulty of the task is another element of resilience, which was also present in the 2016 competition. Students stress the importance of starting simple and making sure that they can pay enough attention so as to win first some easy tasks. Their first experience with the competition showed them that engaging straight away with complex tasks wasn't a successful strategy. However as one of the students pointed out it was an experience that helped students to learn from it:

> *R: Ok. Anything else you didn't like*
> *St5: Obviously the fact that we weren't prepared enough*
> *St7: Actually i kind of liked it a bit, because we learned from it.*

FG2: Post Conference Interview

Extract 38

Here comes the role of adaptation of your goals based on the evaluation of your performance and experience. Due to the fact that students participated for the first time in the competition, they did not have adequate information to evaluate the situation against their capabilities as a team. So, the goals they set were not achievable. As it is apparent from student comments in their discussion about lessons learned and strategies for next year, students based on their experience they adjust their goals so as to ensure better performance as a team. This experience does not force students to aim low, instead as it became apparent with FG1, aiming high is important to be grounded on a solid background which includes self evaluation and good knowledge of the situation and as we will show next hard work

9.2.3.5.5 PRACTICE AND EARLY PREPARATION

All the above elements of resilience are important only if they are grounded on hard work, timely preparation and practice:

St1: Start earlier, have more time to practice on the real table

…

R: You talked also about the precision

ST5: yes and also early preparation

FG2: Post Conference Interview

Extract 39

The role of practice and early preparation in success is tightly interconnected with resilience. If success is perceived as a result of personal intelligence only (i.e. the clever ones succeed) then it is more difficult to recover from failure because it becomes a problem of "who I am" which is difficult to change. On the other hand if students understand that success is tightly connected to activities such as practice and early preparation then it is something that can bring change in the way people act. The role of the competition in supporting the development of such beliefs might be connected with the structuring of the preparation and the interaction with other teams (either through observation or through discussion).

9.2.3.6 GENDER

Gender did not seem to be an important issue during the competition. Specifically, the situation with FG1 was that its composition changed from an all girls team to a mixed team with the participation of a boy. The lead researcher's observation notes indicated that the new member was not that well integrated in the team. Specifically, during her interaction with FG1 one of the team members, the student who was more involved with robot building, admitted that initially she had a leading role and she was telling to the new member what to do. However there is no evidence if this was a gender issue or an issue related to the fact that this student was a newcomer. Furthermore, the analysis of the video data showed that the student was interacting with the other members of the team, was mainly responsible for programming the big robot but he appeared to be also tinkering with it. He was also active when the team was on the testing tables.

Gender issues were mentioned also with FG2. There, students responded for the team gender is not what it counts; it counts what you can do. This response was similar to the response FG1 provided during the 2016 competition when they discussed gender issues and especially the male dominance in the competition:

Interviewer: *... Let me ask you another question. How do you feel about participating in a mixed-gender team in which there are predominantly males. Do you have some thoughts on that?*

C3: *Well, boys don't really make the difference, according to me. I mean, they care what you can do and not who you are.*

C2: It is true.

FG2: Pre conference Interview

Extract 40

So, it appears that even if males dominate the competitions, girls do not feel that there is a discrimination against them because of their gender. What students highlight here is the competences of each person are not gender defined or determined by stereotypes (e.g. girls are not good at STEM). This belief is a good ground for girls participating in the competitions and also for boys in accepting them in their teams or as their opponents.

However, a discussion between the lead researcher and one of the members of the ESI-CEE team showed that in the specific team there might be a bias towards the girls:

R: So the girls were felt protected in the team? Because their teacher was really keen to get them in the team

T: Yes

R: So why did they feel protected?

T: Because they had support from the elders, like the headmaster and some of the teachers and one of them, she is not a teacher. The school has an alumni association and one of the ladies there, she did the preliminary selection. I think she chose initially more girls. And the girls felt, like, they were closer friends, they team up together better.

R: So they probably have to, more in school anyway because there is less of them

T:I just have the feeling that they felt more like a (loop) and they didn't be excluded, more like the opposite, they were a little bit more pushy with their ideas.

R: And you think that's because they have the support of a senior female teacher

T: They have the support, also they are more combined as a group. This is more like a reflection.

Researcher discussion with a researcher- member of ESI-CEE team

Extract 41

This extract portrays a situation where the effort to engage more girls with STEM and robotics might lead to another type of bias: That of girls being bossier over the boys. The reflection of the ESI-CEE researcher shows that the initial selection balanced more towards girls and the support they felt allowed them to try to impose their ideas. Furthermore, this sense of protection might have led to a heavier engagement of the boys with the construction of the robots and with the programming as the interaction of the researcher with the group showed. Specifically, the analysis of the video data showed more boys being engaged with the building and the programming and girls being engaged with lighter tasks such as using the camera to record the testing or the competition, watching competitions, presenting the group work etc. (see extract 3) Furthermore, when the researcher asked one of the girls what did she observe from the other groups she stated that she could not say much about the other robots because she wasn't the hardware girl (see extract 3). However, another girl in the same discussion (extract 3) mentioned that she was engaged with the sensors and thus she could infer the use of sensors in the robots of the other teams.

To sum up, competitions might be dominated by boys and in some cases like the finals of the Double elimination, this domination and even the bias towards boys is present in non verbal behaviors: only the boys of the two competing teams were present in the game table. However, the beliefs of the FGs regarding gender did not show any kind of bias against or towards girls. Furthermore, some background information on the selection process of the members of FG2 and a close observation of the video data showed that there might be some sort of protection towards the girls. This protection from the one side allowed girls to pursue more strongly their ideas but on the other hand they seemed more engaged with lighter and not that responsible tasks. We have to note here that this was not the case with FG1, which is a girl-dominated team and girls appeared to have equally or more active roles in comparison to the boy of the team.

9.2.3.7 COMPETITION EVALUATION – RECOMMENDATIONS

Both FGs considered that the competition was an exciting (FG2) and a very good experience (FG1). Both groups stated that they would like to participate next year without hesitation

St2: It has been a hell of an experience

…

R: Do you think you will compete again next year?

St(all):yes

FG2: Post conference interview

Child 2: Yes. So generally speaking, I actually liked it this year. In spite of the clobbering and all of the other problems we had … I liked it and I would like to do it again next year.

FG1: Post conference interview

Extract 42

Apart from the specific evaluation of the teams, the analysis of the data showed that the competition was a rich experience for both groups in terms of collaboration skills, domain knowledge (constructions), social interaction, resilience and life skills (like travelling and being autonomous in a foreign country).

9.2.3.7.1 ISSUES RELATED TO SPACE AND SOUND

Students from FG1 when they were asked what they did not like in the competition they referred to some of the characteristics of the space – it did not have windows, they were seated next to the speakers and the room echoed. They also mentioned the frequency of the gong:

Interviewer: Alright. Uhm, how did you like the organizational setup of ECER? That was a little bit different from last year because last year it was at the TGM and this year in Sofia. Uhm, what did you like, what did you not like? Also regarding the spatial setup.

Child 3: The room didn't have any windows.

*Everyone: *laughing**

Child 3: That was [horrible after some time!

Child 2: [Yes, I also found that annoying!

Child 4: Okay…

Child 2: And also the empty room, it was loud, it echoed. And we were right next to the speakers again! That was quite annoying again.

Child 4: The gong.

Child 1: [This gong, it was so annoying!

Child 2: [Yes.

Child 1: Gong, gong, gong! Every 10 seconds!

Child 2: Yes, I liked the setup better when you knew when it was your turn and there was a gong only every 5 minutes then.

Interviewer: Uhuh.

*Child 2: I mean, in the end we even skived off to the end of the room - as far away from the speakers as possible! *grinning**

FG1: Post conference interview

Extract 43

Another issue raised by FG1 who travelled into a foreign country in order to participate in the competition was the duration of lunch breaks and easy access to places for lunch:

Interviewer: Uhuh. What would you recommend us that we should do differently next year?

Child 2: What I would say is that […

Child 1: [A different gong.

Child 2: Yes.

*Everyone: *laughing**

Interviewer: A different gong. Okay?

Child 2: During lunch breaks, we didn't like that first of all, there was nothing nearby and secondly, you barely had the time to manage to eat in one hour.

Interviewer: Because there was nothing nearby, right?

Child 1, 2, 3: Yes.

Interviewer: Yes.

FG1: Post conference interview

Extract 44

9.2.3.7.2 TESTING AND TESTING TABLES

In the ECER 2016 report we revealed the importance of testing tables as a locus for rich social interaction, learning from others, helping each other. This year there were three game tables out of which only one was used for testing.

Interviewer: ... What about the game tables? We've had 3 game tables now [was that better?

Child 3: [Last year, … last year, we also had a practice game table. Outside, by the team of Hollabrunn. [That was very comfortable actually.

Child 1: [That was comfortable but that one was also already (set up) so that wasn't really… [But for the …

Child 2: [But it was better than doing nothing!

Child 1: Yes.

Interviewer: Yes. So you would have liked to have another game table for practicing?

Child 3: Yes.

Child 2: I mean, in the back, we've noticed that quite late actually, there was another game table set up, more or less. It was on the floor with some white sheets of paper and hayballs.

Interviewer: Ah, okay!

Child 2: So we practiced a bit at this one but it didn't really work.

FG1: Post conference interview

Extract 44

In the discussion above, students point out the need for an additional table for practice like in ECER 2016. The importance of practice tables involve also the structuring of student time during the competition: if there is not enough time for testing then students end up doing nothing. So students prefer to test in tables that are not that accurate (a testing table on the floor which wasn't set up properly) than to be inactive and wait for hours. This remark does not have to do only with the progress of student work but also with the social activity developed around testing tables analyzed in details in the ECER 2016 report.

The need for improving testing was also mentioned in two of the questionnaire responses:

The times for practicing have not been well planned. Often you had test time although there was nothing to test and as you had stuff to test, then there were no test slots. It would be best if all teams could simply test as they wish. Everyone who wishes to test simply does it and no one complains.

Response 1 - Post conference questionnaire

Everything was nice, but testing was not well organized. / I would suggest that each team gets a certain amount of time or a number of time slots at the game table that can choose oneself, similar to a timeout system.

Response 2 - Post conference questionnaire

Extract 45

From the above two responses the first is useful because it echoes the testing problem. The points that follow have more to do with the challenges of the competition – i.e. working in specific time intervals and be prepared for it – and with a need for order when a large number of teams compete. The second response is more structured on its recommendation acknowledging the importance of keeping an order and defining specific time slots. However, as we mentioned earlier the value of these two questionnaire responses is that they highlight that there was a problem with the organization of practice. The fact that criticism on testing is mentioned by two different sources (FG1 and in the questionnaire) plus the learning and social value of testing tables show that careful consideration is important for the organization of the next ECER competition.

9.2.3.7.3 AWARDS

At the end of all the competitions there is a big ceremony for the awards to the winners. The ECER competition has lots of different awards, one of which is about being strategic. This award was given to FG 1 because they decided to focus all of their efforts on one robot. We have mentioned earlier that both FGs participated in the competition with two robots and in the case of FG1 the team had two robots, which did not work properly. Their reaction to the award is based on the lead-researcher observation notes: *The girls said that "the other robot was broken – that's why we did not use it but we were not strategic ". They did not look very happy with their award and they did not want a picture. They said "this is a rubbish award" and that they felt defeated - the award was like the final hit in the teeth"*. It is interesting how such an incident, which in general is considered as a positive event, can have such a strong negative influence to the students. In the post conference interview FG1 did not seem defeated neither by the technical problem they encounter nor by the final low scoring. However, the effect of the award on them might have a number of explanations: a) One explanation is that they felt defeated because they did not get an award for what actually they worked for but for something that wasn't actually their decision or intention b) another interpretation might connect the award with actions of pity (i.e. give something to those who did not do well even if they do not deserve it).

With respect to the competition, the idea behind the large number of awards is to encourage all participants and make them feel that they accomplished something. However, there are two problems with this approach: a) the large number of awards reduces their importance and b) it is difficult to define clear and measurable criteria for a large number of awards. Thus a recommendation for the next competition might be to further investigate the role of awards and reconsider not only their criteria but also the number of awards.

9.2.3.7.4 QUESTIONNAIRES

To provide a complete picture of how participants evaluated the workshop we present here student responses from the Austrian group to the question how many stars they would give to the competition along with the justification they provided.

No	Student-No.	Sex	Age	Stars	Because
1	31069	boy	17	4	I liked it a lot overall, although sometimes it got quite long due to the conferences from 8 a.m. to 7 or 8 p.m.
2	31104	boy	17	4	
3	3115	boy	17	5	
4	31013	boy	15	5	It was a lot of fun
5	32258	boy	15	5	I liked it
6	32257	boy	16	5	Interesting, funny, successful
7	31003	girl	17	5	The European cup was awesome, mostly if it takes place in your country./ and robots are cool. / Furthermore i am totally satisfied with our result. / The PRIA-team was always helpful. ;-) / Nice alternative to a normal school week
8	31020	boy	16	5	

9	32251* FG1	boy	16	4	Nice time with a team, met a lot of teams and interesting lectures
10	32205	boy	18	5	I made a lot of nice experiences
11	32206	boy	16	4	It was ok, could be better
12	31008	boy	15	5	It is a lot of fun each year, one learns a lot, you met interesting people and even if the organization did not work perfectly, i would recommend it without hesitating
13	31009	boy	16	4	Great Location, could start earlier and leave later
14	31042	boy	19	4	Nice talks and good music
15	31014	boy	16	4	The times for practicing have not been well planned. Often you had test time although there was nothing to test and as you had stuff to test, then there were no test slots. It would be best if all teams could simply test as they wish. Everyone who wishes to test simply does it and no one complains.
16	31019	girl	17	5	Simply genius
17	32233	boy	17	4	Nice experience, a lot of fun and much informative things, although sometimes there was a luck in organization (mostly when working with the hedgehog controllers due to connection issues)
18	31099	boy	17	5	Because the competitive aspect and the exchange of information and the communication between teams through presentations and alliances were always in the foreground and the conference was well organized overall
19	31154	girl	17	4	
20	32271	boy	17	4	Everything was nice, but testing was not well organized. / i would suggest that each team gets a certain amount of time or a number of time slots at the game table that can choose oneself, similar to a timeout system
21	32247	boy	17	4	i have never been to Sofia and we had a nice time there
22	31027	boy	17	3	
23	31007*FG1	girl	15	5	it was fun
24	31002* FG1	girl	15	4	
25	32230	boy	17	5	was cool
26	32259	boy	16	4	
27	32270	boy	15	5	competition was very fair, good lectures, good organization

Table 3. Austrian teams' responses to the post conference questionnaire

The first remark we can do looking at the table is that participants evaluated the competition with high scores: Only one 3 with no justification and 27 rated the workshop as good and very good (13 out of the 27 participants gave five stars and 13 gave four stars). Apart from the quantitative result, which indicates that students experienced a very good competition, the justifications they provided offer useful insights on the things participants found valuable or on the things they expected to be improved next year.

Things appreciated by the participants:

- Fair competition
- Learning:
    - Interesting lectures
    - Interaction with other teams – socializing
    - Exchange of information
    - Visiting new places
- Good music
- Interesting
- Fun

Things to be improved:

- Time and space for practice
- Problems with network when working with hedgehog controllers
- Start and finish time – duration: For some the start time was too early and the duration was too long (only two students pointed out this issue).

Only four students had recommendations for next year although three mentioned that the competition was not perfect and that it could be improved. From the good points highlighted it is interesting to see that we find repeatedly answers, which highlight the importance of interaction with other teams the exchange of information and the interest they found in the talks.

Overall the quantitative data confirm the insights gained through the analysis of the qualitative data about the value of the competition in terms of learning and social experience.

9.2.3.7.5 RECOMMENDATIONS

In this section we resume the recommendations collected above, for the organization of the competition next year:

- Characteristics of the space: it is important to have windows, less echo etc.
- Easy access to places for lunch and duration of lunch breaks (one hour was not enough).
- The volume of the background music and the position of the speakers is an issue to be considered as students complained about it
- The frequency of the gong, which according to FG1 changed from year 2016, appeared to be a problem (in terms of distraction).
- The number of testing tables and free testing time: Reconsider the number of testing tables according to the number of students and the existence of free testing time (especially for new comers). The 2 plus one testing tables of ECER 2016 seemed to work well.
- The use of notebooks during testing: FG1 mentioned that they were not allowed to have notebooks with them during testing, however this was a practice they all followed at the end because there were instances where they wanted to small changes and try again. Thus since this is an established and silently accepted practice between the groups, the organizers might need to reconsider this rule.

9.3 APPENDIX C: GREECE CASE STUDY 1

This section presents the first of two case studies from workshops in Greece. These are selected because a) they include full data sets and b) they have important changes implemented on their activities plans regarding last years' recommendations. For each case study firstly the context of workshop id described, then the findings are presented by data set and finally there is a discussion of the findings based on further triangulation and tracking of interesting cases of participants across the data sets.

9.3.1 Context and activity plan

In this case study we analyse the robotics workshop that took place in a Model Junior High School of Athens as an activity aligned to the curriculum. The workshop was implemented as part of the school subject "Technology" and were performed by the school teacher with its main focus being on Technology and Engineering fields. The activity plan had duration 6 hours and it lasted for 2 weeks. The activities were designed for children aged 14-15 years old with little knowledge of Arduino and electronic parts and good knowledge of the basic programming concepts in Scratch or similar environment. The type of school is a model, public, junior high school in Athens and it differs from the type of school that the same activity plan was implemented last year, which was a vocational school. This decision is based on our purpose to study the impact of this activity plan on students with quite different background. The main difference is that the two schools have quite different curricula: In vocational schools students choose a field of expertise very early and they take classes of specialized subjects such as engineering, electronics or programming. In general public schools, on the other hand, all students follow a number of common and more general subjects and only one year before graduation they select to focus on two or three selected subjects depending on the university they want to apply to. As a result, in those two school types, students at the age of 15 have acquired quite different knowledge with respect to STEM subjects and robotics. Thus, the implementation and evaluation of the same activity plan in such different context may be proved helpful for the development of a robotics curriculum with multiple entry points.

According to the activity plan this workshop had several goals related to the subject, to technology and to the social and communication skills of the students. More precisely, with respect to the subject (technology) students are expected to study the way all the electronic materials should be placed on the robot (angle and position) as well as to engage with the construction of operating legs so that the robot could move correctly. As far as technological goals are concerned, this workshops aims to introduce students to the design with Arduino Uno board, to the way the electronics part are connected and function together and to some basic programming concepts through the open-source Arduino Software. Finally students will exchange ideas, argument and improve their collaborative skills through their collaboration for the robotic insect. More precisely it is expected that the above goal will be achieved by identifying an authentic problem, making assumptions, testing solutions and deciding on which is the best solution to follow.

Students are working in mixed-gendered teams of 3-4 persons. Each team was asked to design, construct and program their own robotic insect, using an Arduino platform, electronic components and every day affordable material of their choice. More precisely they should use a given servo motor to generate the movement of the legs, allowing their robot to move autonomously and then attach a sonar sensor on their robot in order to detect obstacles. In addition they have to modify a given code to make their robot move forward in a specific speed and when it detects an obstacle with its sonar to move backwards with a higher speed. Students were free to decide the appearance and the construction structure of their robotic insects and there were building instructions given to them. One difference from last year, was that last year students were given a robotic insect prototype to base their own build on, while this year they weren't given anything. This decision was made in order to foster student's creative thinking and collaboration on the construction.

The workshop was held by the school IT teacher in two different classes of the third grade (age 14-15). In class 1 there were four teams of three students each, three of which were mixed-gendered and one had only girls. In class 2 there were five teams of three students each, four of which were mixed-gendered and one had only male members. For the case study analysis we focused on the workshop data from class 2 (code: UoA 424_b).

9.3.1.1 CHANGES FROM LAST YEAR'S ACTIVITY PLAN

The objectives of the workshop have remained almost the same with last year's activity plan. The only change is a more detailed description of the technology related goals.

One change was made regarding the material. Last year the everyday material that students had available were limited to those that have been used for the robot porotype. This year students were provided with a big variety of materials to choose from in order to foster their creativity and imagination during the robot construction.

One element that was added to this activity plan in relation to the 1st version is that students were asked to assign their teams a name. This may seems a small change but it gave the students the feeling of ownership and identification of their work. It is remarkable the excitement they had when they discussed the team's name and the effort they did to create a nice logo. This process seemed to help them creating a stronger connection as a team throughout the workshop. This small but very useful detail may be included to next year's activity template extended with other related actions like "give your robot a name".

With respect to the phases this year's workshop seems more structured regarding students engagement to its three main fields: programming, electronics and engineering. There is at least one phase focused to each one of them and it is made clear how students will transition from one to the other. It is described in more detail what they will do in each phase. However there is no clear description of how students reflection will take place during the activities neither how they should distribute roles as it is mentioned in the objectives. Finally the assessment procedures are still not very clear nor detailed.

9.3.2 Observations

During the workshop there were two cameras placed on opposite sides that took video of the whole classroom and one camera over the focus group. The video data provides a clear view of the whole process for all teams. The workshop took place in the computer laboratory of the school where students were sitting in a round formation around the room. Each group had a large desk to work on and a computer. On the desk of each team there was a box with all the necessary equipment: An Arduino, a servo motor, a sonar and a few electronic parts (wires, piezo). In the middle of the room there was a big table with all the available material that students could use for their robot construction such as different kind of ropes, wooden sticks, clippers, tapes, glue, 2 glue guns etc. The videos revealed that the table of materials in the middle of the room, acted as a common space were students from different teams met, discussed about their artefacts and exchanged ideas about their future plans. This was a quite interesting outcome regarding the space formation in robotics workshops and will be considered in the formation of next year's activity plans.

At the beginning of the first session the teacher presents the overall aim and the objectives of the workshop. In addition that there is a brief demonstration of the electronic parts, sensors and available materials that students will use. After that students watch a short video presenting an already-made robotic insect by the teacher that uses the same material. Before students start working, groups are asked to choose a name for their team, write it on a piece of paper and hang in on the wall. Most of the students decided to think and draw a logo for their team instead of just writing the name, resulting in spending more time on that task than expected by the teacher. However we can see that this process bonded most of the teams from the beginning of the workshop and had a positive effect later on.

During the rest of the 1st session students implement the activities on the worksheet. Firstly they create of a circuit, then they integrate and program the sonar and finally they start the design and construction of the robot skeleton.

From the beginning of the activities we can see students of different teams communicating with each other and asking for ideas or help. For example a girl from group 5 gets up and goes to another team to ask about something probably related to the circuit. This was happening mostly between teams that were sitting next to each other and especially between group 5 and group 2. However we can see that as the activity progressed the teams were becoming less willing to help and to share their work with others. For instance at the end of session 1 a boy from group 4 goes to group 2 and says "that's nice! Can I see how you did it" and they answer "No! It's a secret". Finally after a lot of negotiation the boy sees their robot and examines how it is constructed. At the end of the whole workshop this group (group 2) blamed other groups for "stealing their work and ideas".

An interesting observation from the first session was the collaboration within group 2. This group consisted of three boys and almost from the beginning of the session one of the three boys seems to be isolated by the two others (for the purpose of the analysis we will call him student1). We can see the two other boys working together, sometimes even with their backs towards boy1, and occasionally boy1 trying to participate or to see what the other two are doing. At a certain point during the creation of the circuit, boy1 takes a piece of paper and starts drawing something. Then he interrupts the other two showing his suggestion to them and they seem to approve it. After that he starts to participate more but still there are moments where he is isolated by the other two. After the middle of the session there is a moment were they face a problem with the construction of the skeleton. We can see the two boys fighting about whose idea is better and boy1 sitting back and not participating. Suddenly one of two boys who was the most outgoing character goes back and says that he quits from that task. Then boy1 suggests a solution which is correct and that was the critical event which made the other two boys trust him and include him in the team. For the rest of the workshop they keep asking his opinion and include him in the teamwork. This example is quite similar with one described on a last years' case study, and shows that sometimes students have to prove their abilities in order to be accepted by a team especially when the other members consider themselves smarter or experts. This fact is something that needs to be considered in group formation […]

The focus group for the first session was group4 which was consisted of 2 boys and a girl. During the first task of the session one of the boys (boy1) moves all the material and the instructions in front of him and he is working alone. He only askes the two others to bring him any extra material he needs or to hold the light for him. At some point the teacher intervenes and says "Kids I want you to know that this is a group activity. This means that it shouldn't only one person to do all the work but you have to collaborate". After that the girl and the second boy start to make some suggestions to boy1 and to read the instructions. However he continues to work alone until there is a second intervention from the teacher. They finish the task with the sonar all together. Until the end of the session we can see the three students equally participating, exchanging suggestions and explaining their ideas to each other.

During the second session students finish the construction of the insect basis and then use and programed the servo motor to make the robot move. Once they understand the programming part, they are challenged to find a proper position for the servo motor, as well for the legs, in order to make a functional autonomous robotic insect. This was the part that all teams spent most of their time on since they had to consider many different things like the shape of the legs, the position of the legs and the position of the servo motor on the already-made robotic skeleton, whether the program of the motor results in a satisfactory movement of the robot, etc. During this part students expressed different ideas, argued a lot and many of the teams tried to get ideas from other teams, not every time successfully. In the end each team's solution was little or very much different from the others but every one of them was unique. When they finally managed to complete the construction, students focused on debugging the code in order to achieve their final goal and make their robotic insect move according to the instruction; moving forward and when it detects an obstacle make a sound and move backwards for some seconds, then start moving forward again.

At the middle and at the end of the second session, the teacher made mini video-interviews with each team in which they presented their robot and explained what they had done so far. By the end of the workshops all the teams had created an insect robot that was able to move, but apart from the robots of 2 teams, all the other robots had some movement issues. However all the kids were proud for their creation and presented on camera with particular excitement. Some of them also explained to the teacher what they believed was wrong and what they could modify to make it better.

During the second session the focus group changed to group 5, a decision made by the teacher. This group consisted of 2 girls and one boy. As it emerges from the video data they demonstrate great collaboration throughout the activities. The robotic mechanism remains in the middle and every action is firstly discussed by everyone. Some team roles seem to have been occurred during the workshop as we can she one girl is responsible for the construction (girl1) the other girl for the electronic parts (girl2) and the boy for programming. Most of the times each one asks the opinion of the others before proceeds to any changes. We have no specific evidence of how these roles where distributed however as it arises through students' dialogues, girl1 likes arts and crafts and the boy was good at programming so probably the roles were assigned according to their personal interests. What we can see as the process progresses is the girls becoming even more actively engaged with the construction and proposing very creative ideas like the one on the following critical episode:

> *Girl2: "Ok. Do we like it?"*
>
> *Girl1: "Yes I think its fine. And also it looks like it has wings" (she takes the wires and makes them like wings) " We will split the cables like this and they will be like wings"*
>
> *Girl2 takes a wires combination and raises it above the insect*
>
> *Girl2: "And we can put it like this..like an antenna"*
>
> *Girl1 "Like an antenna hahaha"*

They also seem to apply concepts from physics and maths in their construction driven from their experience such as friction, symmetry and motor engineering:

> *G1: "Hey guys! What do you say to put at the edge of the legs glue in order to avoid to be slippery? One very small dot of glue"*
>
> *G2: "yeees!! Bravo G1 great idea" (with excitement)*
>
> *Boy: "But when it will walk it will stick down"*
>
> *G2: "No! What she means is to put it and let it dry. Then it will move more smoothly because of…of friction"*
>
> *G1: "we had done in arts class something similar"*

In the above episode girl1 makes a suggestion based on a construction she had done in arts class and girl2 interprets it in the physics context and explains it to the boy by using the term of friction. This is a very good example of how STEM concepts can be combined with the field of arts and applied to making activities. Then she improves her idea by applying the concept of symmetry as she realizes that *"all the legs must be symmetrical and have the same length"* but the small added some extra length to each leg. Thus she constructs new legs and explains it to her teammates *"I did a smaller drop of silicon to the back ones in order to much exactly the height of those in the front".*

Finally during the final programming of the robot there was a critical episode where the boy starts to explain to girl2 what he was doing in programming and they are trying to find the solution together. As we mentioned before, programming was mostly assigned to the boy as the more expert one, but after that incident girl2 started making suggestions and participating actively as we can see below.

Girl2 "Maybe you should change the prefixes here?

Boy " yes probably to make them minus"

Girl2 grabs the mouse (she never used it until now) and starts making changes.

9.3.3 Student Reflections

At the end for the first session the teacher did a small video interview with each team and the students presented their work so far and discussed their ideas for the next session. One of the groups expressed quite unique idea for their robotic insect. They decided to search in google, find an image of a spider they liked and make their robot to look like it.

Moreover all the teams filled in the "student's reflection" sheet with questions related to the way they worked, any difficulties they may had and their future plans. From the data analysis emerges that most of the teams found the activities hard but also very interesting and fun. Most of them mention that especially the construction and integration of the legs was the most challenging and difficult part. An interesting outcome is that after the 1st session students most of the teams mention collaboration as the thing that needs improvement. For example group4 answered *"To have less disagreement between our team members"* and group 3 *"to distribute the work better and to have more team spirit"*.

After the end of the workshops the same reflection process was repeated but with different questions on the reflection document. It is worth mentioning that most teams highlighted the important role of collaboration for their achievement. For instance group 4, who had said before they need to improve their collaboration, they answer *"with team spirit and patience we successfully built our robot*". Finally all of the teams explain in detail both in the final reflection sheets and in mini video interviews what changes they made to their robot, demonstrating in that way their engagement with different STEM concepts. For example group 2 says *"We changed the degrees and the speed in programming and our robot moves much better now*". Group 5 also stated that *"Robot was moving backwards thus we reversed the values of the motor in the code so now it goes forward*".

9.3.4 Tutor Reflections

The school teacher who conducted the workshop answered a reflection questionnaire after every session. At the end of the first session she mentions that "*all teams asked for further explanation on assembling the sonar sensor because the instructions on the worksheet were not very clear"* and she said that for a next workshop she would *"add more detailed instructions on the worksheet about the assembling of the electronic parts*". Apart from that she argues that students they didn't struggled with something specific as they already had some experience in simpler electronic circuits.

After the end of the workshop she points out the difficulty some students faced during the robot construction as she says : "*Some teams have been struggling to implement the legs of the insect and support the motor, but through experimentation they have managed to find solutions and to successfully address any problems*."

Moreover she writes about two specific teams where she noticed reduced participation of some members. More precisely she mentions that "*In two groups there was a member who acted as a leader, considering his exclusivity to carry out the activities. The rest of the team managed to assert their roles with difficulty, but in the end they worked together*" .

Apart from these collaboration issues, she refers with great satisfaction to the constructions of children by saying that "*Their constructions are unique, fanciful and functional, considering that they only had one motor. When they successfully completed the construction and set the robotic insect in motion, their satisfaction was evident*!"

Finally she makes a suggestion to have each session lasts 2 hours instead of 3 because it was quite tiring for everyone.

9.3.5 Interviews

After the workshop, the teacher interviewed 2 students from group 4 (focus group 1st day) and 2 students from group 5 (focus group 2nd day). The interview questions were related to the context of the workshop, to the activities, to students' engagement with STEM concepts and to their opinion in general about STEM and about scientists.

One girl from group 5 confirms what we have observed in the video data about the group collaboration. She says that "*We tried all of us to be involved both in the programming and in the construction of the robot. Each one did what he/she believed that he could do better. Some of us maybe was involved more with construction and less with programming and others the opposite, depending on our interests*."

From her answer we can see that they distributed roles according to their interests and this seems to have worked quite well for their case.

The same girl later suggests some creative improvements for the workshop.

> *I:. Supposing that next year we repeat this project, do you have any suggestion for improvements so that the process is more easy or more pleasant for the students?*
>
> *Child1: In general the process was nice and interesting. One small detail that is not very important. Since we call it an "insect" we could give it an appearance like an insect. For example we could use colours or other material at the construction. Of course in this way it wouldn't be reusable…Only if with some way we could decompose the basic components and used them for other constructions*
>
> *I: Would you like it if we had for example colourful cartons and papers that you could cut them in shapes like wings, paint them and attach them to the robot? Something like this?*
>
> *Child1: Yes! And also a shell could be made by…silver foil...Something like this*
>
> *I: Oh! Very nice! Very nice ideas*
>
> *Child1: (interrupts) Yes. To have more the appearance of an insect*
>
> *I:So Very good idea! And it is quite easy*
>
> *Child1: (interrupts) This is what I didn't like in the whole process. That it didn't seem to me like an insect. It was only a common robot. I wanted to extend it but I didn't have enough time and also the material to do it.*

From the above dialogue we can see the girl's excitement about robotics because she connected it to her personal interests. It is also evident a combination of STEM with Art, which can probably be a way to attract more female students to STEM and to robotics.

Later on there is also another example of girls attraction to STEM through robotics by an answer given from girl 2 of the same group. The teacher asks if they have learned anything for themselves and she says that "*Personally, I had been engaged with robotics before and I didn't consider it as something amazing, but I* *realized that when you begin from zero and you get to a result, it gives you the joy and the satisfaction with yourself*."

On a following question about the characteristics of what makes a good scientist, students mention:

Child2 : Patience for sure

Child1: To know how to do tests and tries. To be able to accept any failure

Child4: To accept comments and help from others

I: To be open minded?
Child4: Yes. Not to consider himself as always right

Child3: He should consider and think carefully whatever occurs during his research

I: To try always to find a solution?
Child3: yes

Child1: And also to have imagination!

We can see that they are focusing more on skills and on the methodology of work than on specific knowledge.

9.3.6 Questionnaire

The analysis of the pre and post questionnaires helped in understanding students' background and attitudes to STEM. They were also helpful for identifying any changed or sustained attitudes towards STEM by comparing their answer to pre and post questionnaires.

Most of the students argued that during the workshops they used knowledge related to technology and to how things work and only 4 students said they used maths or science. However as we can see from the videos they are using maths and physics concepts especially during the construction of the insect skeleton. The same distribution of answers also happened in the question "Work with robots has helped me learn about…".

Furthermore, the open questions of the post questionnaires acted as additional evidence on students' reflection, collaboration and evidence of learning. The majority of students seem to have a positive opinion for collaboration according to their answers. Some characteristics examples are the following

"That it is more fun to work in a team and that everyone can contribute with their own way"

"Whatever you do it becomes easier when you collaborate. I wouldn't have managed to build the robot if I didn't collaborate with my team"

"That you have to listen to the other's opinion even if you believe that it will fail or that it is inefficient. You can off course suggest something else, but you should never deny someone to express his thoughts"

"Undoubtedly collaboration is one of the most difficult parts of the work but with understanding and mutual retreats it is possible to solve any problems"

With respect to their engagement with robots, most of the students mention "patience" and "hard work" as characteristics of robotics on the question "what have you learned about robotics" but they also say it was interesting and fun. Finally some of their open answers can be considered as evidence of changing attitudes such as the following:

“I learned that this part of technology is very interesting”, “Probably in the future I will do something with programming”, “It was very interesting to engage with that type of programming”

9.4 APPENDIX D: GREECE CASE STUDY 2

UoA243a

As a second case study from Greece we have chosen a workshop that was implemented in a public Junior High School in Athens. ER4STEM workshops had been organized in this school last year in the context of IT classes. However this year’s activity plan was designed as an extra curricula activity. Students participated voluntarily and in the end there were 15 participants in total. The majority of students who took part were boys (11 out of 15) which, considering that the participation was optional, confirms that boys show more interest in robotics than girls. The age of the students was 13-14 years old and they were all at the 2nd grade of middle school. The activity plan was implemented as two different workshops (UoA423a and UoA423b) due to time limitations that some student had. In the 1st workshop participated 10 students and in the second 5. The duration of each workshop was 7 ½ hours divided in 3 sessions of 2 ½ hours each. For the case study analysis we selected the first workshop UoA423a due to the bigger number of participants and also because at the second one there were no girls participated.

9.4.1 Context

In the beginning of the workshop students formed groups of their choice with the size of 2-3 members. The four girls were put in two groups together because they hadn’t agreed with the video recording. Thus, they were also not recorded on the video data. According to the activity plan students will make an autonomous system (vehicle) that disposes garbage at a dump. No prior knowledge of programming or technology concepts is necessary. The activities are emphasizing mostly in Technology (10/10), Engineering (7/10) and in a smaller percentage in Mathematics (3/10). Considering subject related objectives are related to introduction to the basic robotic characteristics and to the construction of an autonomous robotic vehicle. More precisely the learning process focuses on a) how different programming structures and different sensors affect the robot’s behavior and b) how a robot acts in real world situation in contrast to what it is expected to do. The activity plan is divided in 3 phases all of which contain both programming and construction. Students will program their robot in LEGO programing environment where they will be engaged with basic programming concepts such as loop, variable and sequential programming. Moreover during the construction they will use LEGO sensors (light, distance) and motors. Regarding social objectives, it is expected that students will collaborate in groups where they will distribute and exchange roles. Moreover communication with other groups to find solutions is mentioned in the activity plan. Finally with respect to argumentation and maker culture, the workshop aims to promote students to identify an authentic problem, make assumptions, test possible solution and choose the best one as well as communicate with other “makers”.

The workshop took place in the school's computer laboratory. Every team was sitting in front of a desktop computer and was provided with one Lego Mindstorm NXT kit. They also had available an electronic manual with step-by-step instructions for the construction. The desks with the pcs were in a round formation around

the room and the empty space in the middle was used as testing area for the robots (Image 1).

9.4.2 Data collected

In this workshop a full data set was collected. This included video recordings of the focus group and of the whole class with the exception of three girls who didn't agree to get recorded. Moreover, 15 students answered the pre-questionnaire and 13 the post-questionnaire and 4 of them were interviewed by the teacher at the end of the workshop. In addition the teacher completed a reflection questionnaire at the end of each session were he mentioned important incidents and future plans. All students answered a number of reflection questions at the middle and at the end of the workshop and drew a scientist at the "draw a scientist" activity. Finally they participated in an online conversation during the workshops using the online tool "Edmodo". The collected data were analyzed firstly by type with the software Atlas.ti and important incidents were marked with representative codes (see the codes analysis section). After that the results from different types of data were compared and evaluated again following a triangulation method. The final results try to answer the main research questions of the project and are divided on the categories created by the codes that occurred during the analysis. Below are presented and discussed the results for each category which contain a combination of evidence from different data types.

9.4.3 Collaboration and Teamwork

As mentioned above students worked in small groups of 2-3 members. More precisely there were 4 groups all of which had same gender students. This happened because the four female participants didn't agree to the video recording, thus they had to be in groups together and not be recorded by the video cameras. The teacher asked the 4 girls to form 2 groups the way they preferred (group 1 and group 2). Similarly, the other 2 groups (group 3 and 4) were formed by the students' choice. Below we firstly present the outcomes from the collaboration in all teams of the workshop and then we focus on the collaboration within the focus group.

9.4.3.1 COLLABORATION IN THE TEAMS

In general, there was not any significant problem in collaboration within the teams and even in the cases that students disagreed on something, it had a positive effect on their total collaboration. In the video data we can see from the first activity all students participating, discussing and trying things together. The way they worked depended on their choices as long as they all were involved. For instance in group 4 (3 boys) students didn't had roles but they worked all together on one task at a time. In contrast group 3 (focus group) distributed roles of who will do the programming, the construction etc. At the next session there is a detailed analysis of the collaboration within the focus group.

Evidence that students were satisfied with their collaboration are present also in their replies on post-questionnaires and in their reflections. On the post-questionnaire all of the students (9/9) (strongly) agreed that working in a team was "Interesting" and "Fun" and that "worked as part of a team". Moreover 8 out of 9 (strongly) agreed on the statements "I was able to choose what I wanted to do" and "I was encouraged by my team".

In addition, below are presented the open answers and the reflections of two selected cases of students that confirm the above result.

42303 is a girl from group 2 who mentions in the reflection document "We achieved this with the good collaboration between all the team members and with many tests". Also on the question "What have you learned about yourself?" she answers that "It really helps me to collaborate with other people". 42305 the second girl of the group also answers that "Collaboration is very important. Moreover through collaboration you can make new friends"

42306, a girl from group 1, agreed on the pre-questionnaire statement "I like working on my own". During the workshop we can see her having a very good collaboration with her teammate and this is also evident in her reflection where she discribes the way they worked as a team. She argues that they achieved their goal by "helping each other to reach a decision". Moreover at her questionnaire she mentions that "It makes things easier" on the question "what have you learned about working with other people?"

It is important to mention again that in this workshop students chose their teams and as a result most of the team members were friends or had already worked together in other projects. This is a significant factor that is possible to contribute to a harmonic teamwork and should be studied further as suitable method of forming groups in robotics workshops. However a strong disadvantage of this method was that there were no mixed gender groups formed. Thus we were not able to study the interaction and collaboration between boys and girls.

9.4.3.2 COLLABORATION OF THE FOCUS GROUP

The focus group consisted of three boys aged 13 years old. By looking at the videos we see a quite effective collaboration within their team and all of them being actively engaged in the activities. As the workshop proceeds we observe them discussing and exchanging ideas but also disagree in many points which seemed to be a positive factor for their team. Moreover their answers to the post-questionnaire depict the development of a very good collaboration in the team.

> <u>Student 42308</u>
>
> *Q "What have you learned about yourself?" A" That is more pleasant to work in a team than working alone" Q "What have you learned about working with other people?" A: "That other people help you and they probably have some useful ideas for the solution of problems"*
>
> *Reflection question "How did you achieve the above?" A: "With hard work team spirit and good collaboration".*
>
> <u>Student 42307</u>
>
> *Q "What have you learned about working with other people?" A: "That it is fun to collaborate with others in order to achieve something!"*

Student 42314

Q "What have you learned about working with other people?" A: "It is fun and all together we achieved our goals very quickly!"

Overall I would give this workshop "5 Stars. Because I learned how to collaborate better with other kids"

By analyzing all the data of the focus group we identified two critical factors which seem to have contributed in having such a good collaboration. The first one is a continuous switching of the roles in the team. As it emerged both by the video data and the interview, students distributed roles which were changing between the activities. Their roles included programming of the robot, construction and testing. As a result by the end of the workshop everyone had been involved in all parts of the activities and they felt they had contributed equally to their team's success. Below is a part of the interview were students are talking about their way of work.

42307: No it wasn't something specific. Every time each one did something different. Although we took roles, who will program, who will be on the computer, who will make the robot, construct it etc, we didn't take them in a specific way.

I: So your roles were stable or were changing?

42308: For the first session he did the programming and me with the other kid we did the construction, but at the second and the third lesson I was mostly at programming and the kids were constructing.

[…]

I: How did you decide the roles? Was there someone who distributed roles or did you decide it all together?

42314: Well we didn't distributed them exactly. If we had a problem and someone wanted to contribute he tried to help and to find a solution.

[after a while at the same interview]

42308: I believe that your advice helped us do it so well, but also something very helpful was our collaboration and that we could all express our opinions in order to find a solution to the problems we faced.

This way of teamwork was not very common in the other workshops. What students usually did was distributing roles regarding programming, construction etc which remained stable until the end of the activities. However in this case, the switching of roles generated a feeling that they should contribute wherever the team needed and not focusing only on one assigned task.

The second important aspect of the way this group worked was that one of the boys (42314), after the first session, started to act as the "leader" of the team. In the videos we can see him sitting always in the middle, controlling the computer and holding the robot most of the time. However, he didn't actually put aside the two other boys, but in contrast he encouraged them to express their opinion and he was testing the ideas they proposed. For example at the following dialogue 42314 is in front of the computer programming the robot and asks the opinion of his team mates.

42314: Ok guys now we should make it turn…

42307: Make it to do a whole turn and then move forward

42314: What do you mean by a "whole turn"? Like this (he shows with his hands)

42307: Yes like that. And then make it move

42314: Ok lets try it. How much did you say? 5 seconds?

42307: No 2.5

We can see that he wants to be sure he understands the suggestion of 42307 by asking for more explanation and then he applies it. Most of the time organized and encouraged the team like that which seemed to work very well for the 2nd and the 3rd session.

9.4.4 Attitudes to STEM

In order to identify changed or sustained attitudes to STEM, apart from analyzing the interview and the reflection documents, we also compared the answers of students on the pre and post questionnaires. From the analysis emerged that the 3 students of the focus changed their opinion for STEM subjects. More precisely during the interview the students of the focus group mention:

42307: I didn't like technology as a subject…but through this project I understood ***that it is useful in life*** *so* ***I will pay more attention in the class from now on***

*42314****: Yes me too. When I was in the class I didn't give much attention to technology but now I understood that it is quite useful***

42307: This with technology, I also believe that ***I would like it more from now on****.*

I: And you?

42308: I had a negative opinion about mathematics, I didn't like them. However through this workshop I realized that ***they are necessary in life for every problem may occur to us.***

[…]42307: I would like this to be a school subject!

In the above dialogue we can see some important statements related to students' attitude to STEM subjects. Firstly the statements of C2 and C3 are quite interesting since they both combine a connection of STEM to real world and a changing attitude to a STEM field. Both students make a connection of the subject "technology" to every day life and this connection seems to motivate them to pay more attention in the classroom. This is an outcome that we want to strengthen through ER4STEM workshops. Furthermore C1 seems to change his negative opinion about maths because he realized their implementation and importance to everyday problems. This is also a positive influence that was fostered by the connection of STEM to real situations.   This outcome is also confirmed by the answers they gave in the post questionnaires.

42307 answers.

Q: "What have you learned about yourself?" A: " I learned that I am better than I thought with technology!!!"

Q:"What have you learned about working with robots?" A:"It is easier to program than I thought as a kid".

Q: "How many stars would you give to this workshop?" A: "5. Because I liked programming and working with robots more than I expected, because it makes you think and helps you extend your knowledge"

42308 answers

Q: "What have you learned about robotics?" A: "That there are many things I have to learn about robots because they will be useful in the future".

Another outcome is that the 2 of the 4 girls who participated had a negative attitude to maths and science before the workshop which didn't seem to have changed after it. One of the girls on the pre-questionnaire disagrees that she likes maths and says that Maths is the subject she likes least because "I don't understand them very good". Moreover she disagrees with the statement "In general I find maths easy". The other girl answers "I strongly disagree" on the questions "I like science" and "I like maths" and she also says maths the subject she likes least because "I don't understand many things and I don't like them". Moreover she claims that maths lessons are boring (agree) and that she doesn't find easy neither maths nor science. These girls were in different teams and during the workshop didn't seem to have any significant difficulties. They were both actively engaged and contributed in their teams. However at the post-questionnaire, even though they mentioned would like to solve more challenges like this one" and "they would like to learn more about programming", they don't mention anything about becoming more interested in maths or science. This outcome confirms that students can become interest in programming and technology through robotics workshops but we cannot claim it with the same certainty about maths and science. This issue, of changing student's attitude to those two fields, is something we should focus at next year's workshops.

9.4.5 Evidence of Learning

In order to study if and how student gained any new knowledge, we focused on evidence that demonstrate students' engagement and meaning generation related to STEM concepts. We studied both the implementation of concepts that the students had already been taught and also the expression of ideas about concept that were new for them. The analysis of the video and the interviews revealed students used and expressed concepts related to programming, technology (light sensor, distance sensor), engineering (robot construction and stability) and mathematics (Pythagorean Theorem, mathematical reduction, rotation and circle perimeter). This is also confirmed by the answers on the post-questionnaire question "Working with robots has helped me learn about…" in which 5 out of 10 students answered "Maths", 5 out of 10 "Technology", 5 out of 10 "How things work" and only 2 out of 10 "Science".

9.4.5.1 ENGAGEMENT IN PROGRAMMING

There is multiple evidence in all the data sets of students' engagement with programming and engineering concepts. More precisely all the teams studied and applied the concept of loop for the repetitive movement of their robot. They also experimented with the commands' sequence in a program by changing the sequence of commands and observe the result on robot's movement. Finally they seemed to make a connection between programming and engineering by realizing how an algorithm controls and affects the behavior and the different sensors of the robot. Below are some answers of the students on the post-questionnaires which demonstrate their engagement with programming concepts.

42314 (boy) I realized that the more commands you use the better your robot will become.

42303 (girl) I learned many things, like how to program them (the robots)

42306 (girl) We learned new things about programming and about robots

9.4.5.2 IMPLEMENTATION OF MATHEMATICAL CONCEPTS

It is quite interesting that in this workshop students engaged with mathematical concepts more than all the other Greek workshops. The revision of the activity plan played an important role to this, since there was more focus given to include multiple STEM subjects and especially mathematics. This outcome demonstrates the importance of designing an activity plan before the workshop, in order to achieve a multidisciplinary robotics workshop. Evidence of this outcome are present throughout the data sets.

For example in the following interview conversation we can see the students claiming how they engaged with maths in the activities.

> *C1: We became better at mathematics, because this (robotics) needs mathematics and programming. We also improved at programming*
>
> *C2: I agree and I also want to add that we need maths in everyday life and in many jobs.*
>
> *C3: […] We also improved a science we do in school, technology (it is the name of the subject) because we used it at the robot's construction. Moreover* ***we had to use all the knowledge we had from mathematics*** *in order to program the robot.*
>
> *[…]*
>
> *C1: We learned that we are good at maths…in a way..and that we are good in constructions.*

Moreover it is worth mentioning a critical episode in the video data regarding students engagement with mathematics. After students have programmed their robot to move for a specific distance, the tutor asks them to generalize their code so that it works for any given distance (number of tiles). After a little discussion in their teams, students start to suggest mathematical solutions.

> *Group 3: We thought to see in one rotation how many cm the robot moves and then to calculate the distance by having this number as a basis*
>
> *Group 2: We thought that for 5 tiles we needed 3 rotations and we did 5/3 to find how many rotations are needed for 1 tile. Then we could multiply this number with the number of tiles we have.*
>
> *Group 1: We did something similar. Since for 3 tiles we used 4,5 rotations, for 10 tiles x so this x= (4,5*10)/3*
>
> *T: They are correct but they are also experimental because you first have to put your robot on the ground and count the distance. Imagine you must do it with a space rocket! There you don't have the allowance to make real time experimentations.*
>
> *42314: We could use the radius of the wheel and calculate the rotations based on that.*

By looking at the above example from the video data we can see that the first solutions of the students are based on an experimental approach. However after a small intervention of the teacher they started thinking more abstract, and express mathematical relations and meaning about specific concepts i.e. the radius of a circle in relation to the rotation.

Moreover during a later activity one team decided to use the Pythagorean Theorem in order to calculate the length of the ramp. However they couldn't do the maths and the programming language they used didn't have the possibility for using mathematical functions like root. This process delayed them so they decided to abandon the idea and make it experimental as the other teams, so they would not be slower than the others.

9.5 APPENDIX E: MALTA CASE STUDY 1

AL-2-4-VER

This case study was implemented in a private middle school in Malta and run with students whose age was between 11 - 13 years. The workshop lasted 2 days, 4 hours per day and participated students of both genders, 7 girls and 8 boys. With a difference to church schools in Malta where the workshop was also held and where the population is more of a diverse social status, Verdala International as a private school suggests that the majority of students come from a high social background and there are more foreigners attending. Few of the attendants had prior knowledge of Scratch language that helped with the programming of the robot and few others had attended Lego Mindstorm classes, while the rest had no previous knowledge in programming or robots.

The materials students used for the workshop were a tablet with drag and drop visuals and the Dash and Dot robots. Other materials used by the students were worksheets containing graded activities whose difficulty increased from one task to another, a powerpoint presentation used by the teacher in a manner of reflection and introduction to the next activity and a hard copy of programme for time management. Each team had at its disposal one tablet and one Dash robot. The STEM concepts workshop covered was Technology (8/10) and Mathematics (6/10) as graded in the activity plan. The specific tasks that were related to the subjects were programming through conditional commands and loop statements and mathematical concepts including probability and random numbers. Specifically students would control Dash's motion and behaviour in order to avoid obstacles, turn its head and speak, relating its moves with probabilities and random numbers. Additionally the workshop intended to emphasize the learning processes of multiple programming solutions to the activities, communicate and discuss tasks set and decide on the way forward and write up about your experience, learn about collaborative issues.

9.5.1 Context

The workshop took place in the indoor basketball gym of the school and was recorded with one camera placed on the floor. Due to the nature of the open space of the gymnasium instead of a classroom, the video data provides a clear view of the whole process for the focus group and some idea for the general process for the rest of the groups. Students were working in groups of 2 with an exception of one group of 3 students which were formed by the teachers before the beginning of the workshop. All groups were sitting on the floor arranged in a shape that resembled a semicircle. This formation allowed groups to have both the space that they needed in order to experiment with the motion of the robot while they could easily compare their results without copying the solution of other groups by simply looking around the motion of other robots. Additionally, for the most part of the workshop they were free to move around the court and exchange hints and ideas while the teacher was moving between them offering them counseling and observing their progress. In the court there was also a projector and possible a board where the teacher was presenting the solution and the reflection of difficulties at the end of each problem and the aim and the objections for the next. Throughout the videos the process seemed more like an experimenting game with the students having a loose posture, moving around, comparing and encouraging or competing one another than a traditional teaching classroom even within a lab where the space is limited. For example, in the first session a student gains interest when he has to pretend a robot and obey the commands of his friend making intense pace imitating this way the kind of behaviour a robot has in his mind, an introduction activity posed by the tutor to . On the rest period of first session he seems disoriented, but on session two is seen to move around the gymnasium and discuss ideas with focus group on how they would make robot sing and makes suggestions on the code. A student like that that likes to express physically would be bounded or restricted in the sitting environment of a classroom.

Generally the video data revealed that the students seem to lose interest when they have to pay attention on the projector or fill their worksheet and gain interest back when they have to solve something challenging that involves direct experimentation on the robot.

9.5.2 Data collected

In this workshop an adequate data set was collected. This included video recordings of the focus group where the discussion between the members is sufficiently distinct. In the same recordings it can be extracted a general picture of the whole process for the great part of the other groups. Moreover, 15 students answered the pre-questionnaire and 13 the post-questionnaire which included both quantity and quality questions. The collected data were analyzed and important incidents marked with representative codes (see the codes analysis section). After that the results from different types of data were compared and evaluated again following a triangulation method. The final results try to answer the main research questions of the project and are divided on the categories created by the codes that occurred during the analysis. Below are presented and discussed the results for each category which contain a combination of evidence from different data types.

9.5.3 Collaboration and Teamwork

In the data analysis there was quite a lot evidence of collaboration in most of the groups. More precisely in the videos we can see the students exchanging ideas, discussing their problems and try the different solution that members suggest to one another. In some cases the members within the teams exchange roles (tablet operator, worksheet marking) or make collectively changes on the tablet. Moreover it is noticed expression of ideas and discussion out of the boundaries of each team as the students for the most part of the workshop were free to move and approach the other groups. Thus, there were many cases that students got up walked around and talk to other teams or looked at their tablets.

9.5.3.1 COLLABORATION IN THE TEAMS

In general the level of collaboration within the teams were sufficient with the exception of two groups for which we can see problematic collaboration in the video data and in their answers to the post-questionnaire. These two groups were both mixed gender which seem to have collaboration problems during the first session of the workshop. As a result, in the second session we observe that both groups have different members with whom they seem to have better collaboration. The first one had extreme difficulty on collaboration as the boy was continually excluding the girl from using the tablet. The girl is seen to be enthusiastic and eager to make suggestions and changes on the code but the boy wouldn't let her. He adopted a posture that made it difficult for the girl even to see the code as he placed the tablet on his lap, instead of the floor where the most groups did, and controlled it all by himself. After a while the girl was limited in only marking the answers on the worksheet. Even when the tutor noticed it and gave the tablet to the girl after a short period of time the boy took it back and when the girl retook it and used it for a while the boy regained it and never gave her back despite of her requests. On the second group the inadequate collaboration is identified on the lack of discussion or exchange of ideas between the members. The girl doesn't seem interested in making changes to the tablet and sometimes she seems disoriented not even noticing what her co-student does. Most of the time she sits back and seems bored, but also her teammate doesn't make any effort to include her. Her only participation on the activities is sometimes to look at the code and mark the answers on the worksheet.

At the post questionnaire the girl (520115) agrees with the statement "working in a team was difficult" and "I worked on my own" and strongly agrees to the statements "I did most of the work", "I feel that other people did not listen to me" and "I was able to choose what I wanted to do". Unfortunately she hasn't answered the rest of open questions so there is no more evidence on her opinion about the collaboration. On her pre questionnaire she marked "strongly disagree" on statements "I learn best with other people ", "I like working in teams", and "strongly agree" on the statement "I like working on my own" so we can assume the existence of difficulties in collaboration before the workshop. Probably this could be the reason why she didn't participate and avoided to contribute in her team. By her answers on the post questionnaire, it appears that the workshop didn't change her opinion that she prefers learning alone and not working with others.

There were also two other students both of them boys that noted problems in collaboration on the post questionnaire. Student 520114 answered that "strongly agrees" on the question whether the collaboration was difficult,"disagree" on the likert question "I was able to choose what I wanted to do" and "neither agree nor disagree" on the question "I feel that other people did not listen to me". Additionally on the question "What have you learned about working with other people?" he answered that "They try to be a leader".

Student 520109 had even more negative experience with collaboration as in his pre questionnaire he seems to be very positive in teamwork marking "I agree" on statement "I learn best with other people ", "strongly disagree" on "I like working on my own" and "strongly agree" on "I like working in teams". However, at the post questionnaire he disagrees that "working in team was interesting" and strongly disagrees that it was fun while he strongly agrees that it was difficult. Additionally, on the question "What have you learned about working with other people?" he answered that "I don't like working with teams so much" revealing a total conversion of his original belief that he is learning best with other people. On the end of the post questionnaire where it is requested to rate and comment on the workshop he also answers "4.5: because I enjoy programming but I don't like working in teams so much". At this point it is important to mention that for both of the students the problems in collaboration did not prevent the growth of interest in STEM learning aspects of the workshop. On the question "What did you learn about yourself today?" student 520114 answered that "I can program" and student 520109 answered that "I learn that robotics is a subject I find interesting".

The rest of the groups seemed to work quite well together and with rather interest and enthusiasm on the activities, especially during the first session. Some of the students argued on the post questionnaire that working in teams is interesting and fun given the fact that there is mutual respect and members listen each other. On the question "What have you learned about working with other people?" the boy 520101 tates "That it's fun and you have to listen to one another", the girl 520102 that "*It can have pros and cons*" and another girl 520106 that "*We can work good if we listen to each other*". For the rest of the students working in groups had a more distinctive positive impact on their learning process. The girl 520103 whose pre questionnaire was rather negative about working in teams (agree on "I like working on my own", disagree on "I like working in teams", disagree on "I learn best with other people") stated that "It's good to have many ideas" on the question "What have you learned about working with other people?", showing a change on her opinion about collaboration. Other answers to the same question that reveal the role of collaboration in expressing ideas and making learning a more interesting procedure are also "*its more fun than working on your own*" (520110, boy) and "*I learned that it's fun to share ideas with other people*"(520111, girl).

It is important to mention that in this workshop teams were already predefined by the tutor before the beginning of the workshop. While this resulted in mixed groups whose behaviour was an interesting fact to study, we do not know whether the problems in collaboration would have occurred if students chose their team members by themselves.

9.5.3.2 COLLABORATION OF THE FOCUS GROUP

The focus group was consisted by one boy and one girl. By looking at the videos we see a really effective collaboration within their team and the two of them being actively engaged in the activities, especially in the first session. They did not distribute distinctive roles for any of the activities. On the contrary, they were taking turns in order to both program on the tablet and write on the working sheet while there were periods where they were both making changes on the tablet collectively. On each activity they were discussing, planning, making decisions and testing these decisions by changing the code on the tablet.

On the second session they continue to have a pretty good collaboration but with less turns on the tablet-worksheet. They prefer to make changes on the code collectively but the boy is slightly more active on this session. Additionally, when the focus group found some difficulties in activities they prefered to try to resolve them by discussion rather than call for teacher's help. At the end of the workshop they both have contributed equally to the success of the activities following the circle of expressing ideas, discussing on them and testing. An interesting example of how the focus group's collaboration combined with the use of robot resulted in problem solving and helping each other in understanding is when on puzzle 2 they had to make Dash look left and right of 5 times. As it was observed in the videos the boy couldn't understand the outcome of the code they had written in order to extend the solution of the activity so the girl ran the code and explained the number of the repeats of the loop by showing the number of the turns robot's head was making while she was synchronising the moves with her own head. While she could easily take over and extend the activity more by herself as she was fully aware of the solution and let the boy mark the answers on the worksheet, she prefered not to proceed until the boy has clarified his understanding. On the top of that, the projection of the explaining on Dash made the procedure easier helping the team to easily overcome the obstacle of misunderstanding and move over to the next task of the activity.

9.5.4 Attitudes to STEM

With respect to students' attitudes to STEM, the analysis revealed a few cases of students who changed their opinion about the STEM related school subjects of IT, technology and maths. By comparing the pre and post questionnaire we observed that even if the activity plan attempted to embody some basic concepts of mathematics, like random numbers and probability, students don't appear to consider that math affected their actions. Specifically, on the pre questionnaire no student considered IT to be his/her favourite subject in school while 3 of them considered it to be their least favourite subject. After the workshop, on the question "I would like to learn more about programming" 7 out of the 13 students answered yes. Considering math on the pre questionnaire only 4 out of 13 students answered yes on the question "Working with robots has helped me learn about math" while 8 out of 13 answered "Working with robots has helped me learn about technology" and 9 out of 13 answered "Working with robots has helped me learn about how thing work".

Student 520109, which was also one of the boys that had difficulty in collaboration as described above, was one of the three students that disliked IT as a subject in school. After the workshop 520109 gives the following answers that reveal his changing of attitude into considering IT more interesting and his intention for future involvement.

Q: "What have you learned about yourself?" A: "I learnt that robotics is a subject I find interesting"

Q:"What have you learned about working with robots?" A: "They are challenging to program but fun"

Q: "How many stars would you give to this workshop?" A: "4.5: because I enjoy programming but I don't like working in teams so much".

Additionally, on the questions "I would like to try to solve more challenges like this one" and "I would like to learn more about programming" he answered positively.

Another student with considerable changing of attitude towards both mathematics and technology is 520105 (boy). While on the pre questionnaire finds maths a relatively easy subject (3 marked) he doesn't consider it important for the job he wants to do in the future nor the most interesting subject in school (both questions marked with 2), but considers it important in general (marked 4). The student wants to follow professional rugby career in the future. Considering technology, he likes to use computers, learn how things work and believes he is good at solving problems but doesn't consider Science or IT one of his favourite subjects in school. After the workshop student 520105 seems to have strengthened his attitude towards IT finding that technology is something that he is good at and gaining interest for future involvement with programming. He also recognizes the importance of math and believes that he is good at it. The following answers reveal the changing of student's attitude after the workshop.

Q: "What have you learned about yourself?" A: "That I'm quite good at technology"

Q: "How many stars would you give to this workshop?" A: "It was a lot of fun and I learned a lot more about programing"

Q: "I would like to learn more about programming" A: "Yes"

Q: "I understand how important science is" A: "Yes"

Q: "I understand how important maths is" A: "Yes"

At this point it's interesting to mention the effect workshop had on the girl that was member of the focus group with student number 520100. On her pre questionnaire she states that IT is her least favorite subject in school and explains the reason she considers that is because "I am not interested in IT". The effect the workshop had on her attitude towards technology is not obvious as her answers on the post questionnaire and data from video recordings do not agree. The answers that she gives are the most negative compared to other students and her co-member boy 520101. Particularly she states the following:

Q: "What have you learned about yourself?" A: "Nothing in particular"

Q: "What have you learned about working with other people?" A: "Nothing in particular"

Q: "What have you learned about robots?" A: "That they need a lot of programming"

Additionally she doesn't mark any of the statements regarding future involvement like "I would like to try to solve more challenges like this one" or "I would like to learn more about programming". While her answers appear to reveal real indifference on the subjects of STEM, on the videos, especially in the first session she seems fully engaged and enthusiastic with Dash, expressing ideas, making changes on the code and overcoming obstacles on the problems posed by the activities. Her attitude seems to change on the second session. During one activity teacher is talking about the importance of data and asks them to fill the activity sheet with some charts. The girl and most of the class is disappointed and loses interest while stating on the camera "*oh my gosh, it's so boring*". During this time some students are trying to play with robots. On the contrary when focus group students finish their activity start to play with the robot and recommend one another ideas. Her following statement on the post questionnaire appears to derive of these moments where she lost her interest.

Q: "How many stars would you give to this workshop?" A: "1.5: I found it to be extremly boring and I don't like how it was presented"

The girl of the focus group was not the only that her interest on the second session of the workshop reduced. While teacher was trying to use examples related with their life like linking the meaning of variable with their name on facebook or an inadequate solution with the waiting on the traffic like, random numbers with lottery etc. students were losing interest when they had to pay attention on the projector and were gaining interest back when they had to solve something challenging. For example when deriving random numbers to simulate the lottery wasn't enough but when they had to use those numbers in order to compete with their robots in a class race they were excited. The following comments of the post questionnaire seem to agree with the negative changing of attitude on the parts of the workshop that were more static or not challenging enough

Q: "How many stars would you give to this workshop?"

520103 (girl) A: "3:It was fun but the challengers were to basic and easy"

520102 (girl) A: "4.5: It was interesting but sometimes not that fun"

520114 (boy) A: "3: It was pretty fun but not amazing"

520106 (girl) A: "3: because it was fun and boring in some parts"

520112 (boy) A: "4: It was pretty easy - more difficult problems would be funner, but it was still awesome"

520113 (boy) A: "4: It's very fun and interesting but sometimes it gets boring"

9.5.5 Evidence of Learning

In order to study the evidence that demonstrate students' engagement and meaning generation related to STEM concepts we primarily focused on the concepts of multiple solutions and the generalisation of the simpler solution in form of structured program both of which consisted objectives of the workshop. We studied the way students expressed ideas in order to reach in multiple solutions and the steps they took in problem solving in order to produce a general solution. In this context the analysis revealed students used and expressed concepts related to programming, technology (distance sensor, loops, conditionals, variable). Secondarily, we looked for evidence of learning on the mathematical concepts of random numbers and probabilities which were also included in the objectives of the workshop but the results were rather ambiguous and not important findings were discovered so we will not proceed on further analysis.

9.5.5.1 ENGAGEMENT IN PROGRAMMING

Extensive analysis in both video recordings and questionnaires revealed students' engagement with programming concepts including loop for controlling robot's movement (repeat..until), conditionals (if statements) combined with sensor input in order to avoid obstacles and the use of variables both in form of numbers on the distance Dash was moving and in form of strings on Dash's speech. Among the findings is interesting the way students project directly their solutions on the robot, repeatedly testing and reflecting the steps that drive the outcome they want to achieve. Additionally the existence of robot and the idea that they can control it is a concept that they find intriguing as they are constantly trying to communicate with it, even extending its behaviour out of the boundaries of the activity. For example some students attempted to make Dash sing in between the activity. On the post questionnaire we can see some comments that reveal students aligning programming with robots and evidence that they understood programming through them.

Q: "What have you learned about robots?"

520106 (girl) A: "how to programme them"

520109 (boy) A: "They are challenging to program but fun"

520111 (girl) "That they are very intelligent and listen to what you tell them to do".

Furthermore in the videos we observed that all of the groups had found at least two different solutions to their problems verified by the tutor and the end of each phase.

9.5.6 Creativity

By analysing the video recordings we discovered focus group showed evidence of obstacle overcome and unexpected solution both of them characteristics which we consider parts of creativity.

Solve a problem creatively

During the workshop the focus group confronted great difficulty on a specific activity where they have to make robot avoid automatically obstacles. They discussed, made changes, tested, failed and did so for several times while most of the other groups had come along with a solution. They were challenged by others' group success and did not give up. At some point they asked for help to the teacher. They continued following the hint she gave them and finally they succeeded. When teacher asked them to show their solution they did so but with a little extension. They moved the obstacles closer and closer while the robot was moving in order to make sure that their solution is 100% right and can be generalised. They way students of focus group had internalised that further proof is needed in order for their solution to be correct in different aspects of their problem is also evidence of knowledge that a program needs to be generalised in order to be efficient.

9.5.6.1 UNEXPECTED SOLUTION

During an activity students had to treat robot like it was their student and freely decide what they would like to teach it. Then, they should implement a solution compatible with their idea. Focus group combined all the commands that they had learned up to this point and came along with a creative idea which very proud showed also to the camera. “make dash greet, say “hello”, then dance, then say “ta-da”, walk a square distance, then greet again by saying “bye”. They also implemented correctly all the steps of their idea. The concept of focus group revealed **creativity** while they came along with an **unexpected solution** and **extension** of the activity while some other groups prefered easier ideas like make the robot walk some distance. Nevertheless, the majority of groups came along with rather composite ideas (make robot avoid obstacles or make robot talk and turn) which each one presented in front of the whole class. It was interesting how depending on the complexity and how impressive the implementation looked the students were applauding with more or less enthusiasm their co-students.

9.6 APPENDIX F: MALTA CASE STUDY 2

AL-1-8-AugustineA

9.6.1 Context and activity plan

In this case study we analyze the workshop that took place in an Elementary church school in Malta. The activities of the workshop emphasized on concepts of Science and Technology and they were not aligned to the curriculum. The activity plan had duration 8 hours, split across 2 sessions of 4 hours each. The activities were designed for children aged 10 years old with no prior knowledge on Dash, a readymade robotic artifact that used in the session. The main focus of the activities is on discovering the functionalities of Dash, using its sensors, and programming Dash to get out of a maze, to do a race race and to move between two fixed posts.

According to the activity plan, there are subject, technology use, social and action, argumentation and making culture related objectives. With respect to the subject and the use of technology, students will be involved with basic programming concepts like loops, and will develop skills of using remote control and drag and drop visuals. Regarding the social and action related objectives students are expected to *develop collaborative skills, learn how to take turns and listen to each other in order to reach a compromise and decision*. Finally, with respect to argumentation and fostering of maker culture objectives, students *were encouraged to make the robot intelligent, to work at any point in time and not only once and to test before they tell the tutors that their work was ready.*

The materials and artifacts used in the sessions include a drag and drop visual environment, the Dash robot, worksheets and powerpoint presentations. The workshop took place in the school gym where students sit on paper mats on the floor, facing projector during talk time by tutors. Teams were asked to accomplish 10 puzzles by programming Dash robot to move in a maze, race and move between two fixed posts. For completing these puzzles students are expected to program the robot using the drag and drop visual, observe the robot's behavior once programmed, discover its functionalities and use its sensors. It is expected that students will exchange ideas and roles in the group and get involved in collaborative and competitive relationships, while tutors intervene, monitor and facilitate.

In this particular workshop, 25 male students participated, split in teams of 2-3, all boys. The focus group consisted of two 10 year old boys, who, according to their answers in the pre questionnaire, had never done any programming before. Both had already positive attitudes concerning the use of computers, science and collaboration.

9.6.2 Data collection

A full data set was collected at this workshop. More precisely, 24 students answered the pre questionnaire, in the beginning of the workshop and 23 students answered the post questionnaire. Video data were provided by a camera which was placed in front of the focus group and their working place. The two students of the focus group were also interviewed by the tutor at the end of the workshop. Reflection postcards were given to the students to paint or sketch whatever they wanted in order to describe their experience of during the workshop. Finally tutors discussed with the students some reflection questions on which they kept notes as data.

9.6.3 Collaboration and teamwork

9.6.3.1 COLLABORATION IN TEAMS

One of the main interest of the workshop was to study students' collaboration during their work on the puzzles. Generally, most of the students' answers in the pre and post questionnaires, referring to working with other people, were positive. According to the pre questionnaire 20 of the 23 students (strongly) agreed that they like working with their friends and 3 of them that they prefer working on their own.

After the end of the workshop, 18 of the 23 students claimed that working with friends was interesting and fun. Moreover some selected answers of students' answers on the question "What have you learned about working with other people" include

51173: "problems are solved quicker"

51183: "you can achieve more"

51185: "It is more fun and easy"

Positive attitudes and outcomes concerning collaborative skills of the students were also evident by their answers on the open questions of the post-questionnaire. On the question "What have you learnt about working with other people" student 51177 says "*I have learned that everyone has different ideas and me and my friend work well together*". 51182 mentions that "*You have to share*" and student 51184 argues that working with other people "*takes a lot of patience*".

However there were students who noticed difficult parts on their team collaboration. For example student 51194 agrees that "working in a team was difficult" and on question "What have you learned about working with other people" argues that "collaboration slows you down". Moreover he gives to the workshop only 3 stars and he explains "80% fun, 20% teachers, 0% partner". Looking at the other two students from his group (group 11) we also see difficulties in their collaboration. They both agree that "working in a team was difficult" and they disagree that it is "fun". Student 51172 also says on the open question that "collaboration isn't that easy". 51178 notes "I hate working in team" and despite the 5 stars he gives at the workshop he mentions that "I liked programming but not my team they were not nice to me".

9.6.3.2 COLLABORATION OF THE FOCUS GROUP

The students of the focus group (51176 and 51177) start collaborating from the moment their tutor gives instructions about putting the Dash into operation, as 51176 repeats to 51177 the tutor's instructions and 51177 opens the robot. At the beginning of their work with the robot, it seems they distribute roles but while the activity progress they don't follow them.

Referring to the way they collaborated, during the interview 51177 says“that was a good teamwork” :

J. Ok pity, who did what? You go now

51177: 51176 wrote and we just I write and he do the tablet and then we swapped again at the task at puzzle 1 and puzzle 2 we swapped and that was a good teamwork we did.

J. And who decided what you would do?

51176: We decided together I did the at first I started checking out everything to see what we can do and not so we know and one was looking with me and then so we didn’t find them that hard so…

During their work with Dash they experiment actively with the robot. It seems that even when they disagree, they test their ideas, they discuss and make decisions which they test, by observing the robot’s behavior. The robot is placed in front of the students and most of the time both of them discuss and each one shows his ideas to the other on the drag and drop visual environment of the tablet. Working on the puzzle 9 for example, we can see that them having a long discussion. Students are asked to make the robot *“go crazy and turn in a circle when he hears you!”*. Student 51176 explains his idea to his team mate. Then the second one makes another suggestion and finally adds something to the program that 51176 had written. Both of them are working together on the tablet and discussing at the same time and finally after some time they implement the final program which is correct.

An interesting observation is that we can often see communication and collaboration between members of different teams, as we observe in the video students from other teams approaching the focus group. At a point in the middle of the second session and while students of the focus group are trying their program boy1 from another group approaches the group and starts talking with one of the students. Later he gets closer to the boy of the focus group and shows him something on his tablet. The other boy of the focus group comes closer too and looks at the tablet of boy1. After boy1 returns to his group, students of the focus group start discussing about what he had done on his program.

Later, when focus group has completed the puzzle and starts dealing with the next one another boy (boy2) approaches and sits with the group. It seems they are looking at the tablet. Boy1 who firstly approached the team comes again, shows to the focus group the worksheet with the puzzles and leaves. Finally the three of them are sitting together discussing and looking on the tablet. Student 51176 of the focus group takes the robot and puts it in a position where everybody can see it.

After a while the boy1 who firstly approached the team comes again and asks student 51177 of the focus group to go with him, probably in order to show him something. When both students of the focus group have returned to their seats, boy1 comes again and shows to 51177 what he has done on his tablet so far. 51177 left a few other times from this team and went to other teams probably to help them or to explain something to them.

9.6.4 Students’ attitudes towards STEM education

Generally, students’ prior attitudes to STEM education and STEM careers seem to be positive. Most of the students, according their answers in the pre questionnaire seem to like using computers and prefer Mathematics, Science and IT. More specifically 21 of the students who answered the pre questionnaire claim that they like using computers, 18 of them like Science and 19 of them like Maths. As far as it concerns IT 10 students choose it as their favorite subject.

13 students choose Maths as their favorite subject and 16 students claim they would like to study Maths when they are older.20 of the students find Maths easy and 21 of them find it important but 19 of the students find

Maths lessons boring. 20 students think they are good at Maths. However 2 students choose Maths as the subject they like least. Student 51175 explains he doesn't like Maths because "Sometimes it's hard".

Concerning Science 5 students choose the subject as their favorite, 13 students find the subject easy and 16 of the students think science is important. 7 students claim they would like to study Science when they are older.

Looking at the post-questionnaire we can claim sustaining attitudes from most of the students. According to their answers all of them found the problems they solved during the workshop interesting and fun. Moreover most of them gave positive comments regarding the activities with an average of 4,65 stars rating. Indicatively student 51180 says: "It was amazing, very fun and were helping us a lot" and 51189 comments: "It was a really good and challenging thing to do".

In addition, there was evidence that the workshop contributed not only in strengthening the positive attitude of students towards STEM, but also in changing negative opinions about STEM subjects. In particular, students of the focus group admit during the interview to have changed their attitude towards STEM subjects, as when tutor asked them what they had learnt about themselves after this workshop, they argue:

*S2: "That I can do things, because **before robotics I wouldn't believe that I could do programming.** I said that I'm not good at robotics and technology and now **I'm sure of myself that I can do programming**".*

*S1: "I discovered that I like robotics a lot and **I've started like Science** and also that Maths is included in almost everything"*

This positive turn in their altitude is also clear when they are asked whether this workshop has changed their view about science and about their future job:

Tutor: These 2 days workshops have they changed your view about Science, about your career about your interest for STEM?

S2. Yes I became more interested. Because I hated Science before and now after we did these I loved it so much especially the robotics...that's all I think

J. Do you think you would look into taking up a job lets say which has to do with Science or programming ?

S1. Yes!

From the above interview parts, it seems that these students have changed their attitude towards technology, robotics and programming and they have become more confident about being capable of achieving in these fields.

9.6.5 Evidence of learning

The evidence of learning emerged by the data analysis includes learning outcomes related to technology and programming. There was no evidence of knowledge related to mathematics, science or engineering and this is probably because of the lack of construction this workshop had.

With respect to technology during the activities of the workshop students express their ideas about what is and what isn't a robot, how a robot may look like, its functionalities and the way it works. In addition they confirm their knowledge about robotics in their answers of post-questionnaire. For instance, on the question "what have you learned about robots" student 51194 answers "*They are not just a talking bunch of metal/plastic*" and student 51176 "*That to be a robot it doesn't need a plug*".

When asked during the interview what they have learned about robots about programming perhaps about Science, Technology, Maths, the students of the focus group answer:

> *51176: Robots need to walk in order to be robots...* ***if they're plugged to something they are not robots...*** *they need to move they, also need to not be with a remote control, they need programs to go in.*

> *51177: The same that* ***the robot doesn't need a plug*** *if it's with a plug is not a robot, a robot needs to move by itself*

The above answers to the questionnaires and to the interview show that these students changed what they thought abouts robots and have developed a more accurate idea.

Moreover there were answers in the post questionnaire referring to the functionalities of robots. It seems that through their engagement with robots, students realised the variety of these functionalities and the way they can make them useful in order to accomplish something. Student 51173 mentions that he learned that robots "... can do many things like a human being" and student 51184 learned "That I can make a robot move".

Students also implemented basic programming concepts during the activities. In the interview student 51176 explains what they did in the workshop and refers to his engagement with programming.

> *J. About what you did in these 2 workshops?*

> *51176: [...] then today the last part we did, we did a clap race with the robots* ***we programmed them so when they hear someone talking they move at random*** *but our robots was without charge so we didn't complete*

> *J. And what did you find most interesting in all that you've done across these 2 days?*

> *51177: [...]most of all them I found the bodyguard very interesting when* ***we programmed it*** *to go forward and ...go forward again until it reaches the wall and when it's something...he turns* ***even if the passage is shorter or longer doesn't make any difference is still turns***

It is evident that their engagement with robotics helped them realise the relation between programming and how robots work. For instance 51194 argues that he learned through the workshop that robots "... are programmed" while student 51178 noted that robots "...are fun to program"

9.6.6 Interaction with robots

A quite interesting outcome is related to the interaction between students and robots and the relationship they developed with them. On the post-questionnaires there were some students who referred to a human-like relationship with robots like a 10 years old boy who says"... robots are nice buddies" and another boy of the same age who mentions that "... robots can be your companion". Moreover at the question what have you learned about robots 15773 answers that "He can do many things like a human being".

In addition, the video recordings, there are many times when students interact with Dash as it is their friend. For example the younger of the boys of the focus group, during the first session looks at the robot, smiles and he shakes his hand saying "hi". Later, tutor as he experiments with Dash's functionalities, when robot turns to him he shakes again his hand and says "hi".

The development of a "personal" relationship between young students and Dash robot was also evident in other workshops of Malta. This kind of interaction and perception about robots may be due to the small age of the students (9-10 years old) and to the fact that they didn't have previous experience with robots. However for this specific student it seemed that as the workshop progressed he changed his idea about what a robot is and how it interacts with the environment. This is evident from his following answer on the interview.

J. Ok , what have you learned about robots about programming perhaps about Science, Technology, Maths

1.. About robots I learned that for example that robots don't have feelings. They don't feel anything and … if we punch them they don't feel it for example

We can see that in the end of the workshop makes clear that robots don't have feelings or emotions. We can assume that this change in his attitude may be due to the fact that, through the workshop, the student realised how a robot works by being programmed. However it is quite interesting to study the idea of younger students about robots and how they interact with them in contrast to older students.

9.7 APPENDIX G: BULGARIA CASE STUDY 1

9.7.1 WORKSHOP 1: Description of the activity

In this workshop the ESI-CEE team implemented the activity plan under the title "Educational Robotics for creativity with the ESI tank". This activity was implemented in two sessions. During the first session, the camera captured assembling a vehicle robot in the form of a tank (see fig 1) following a visual guide.

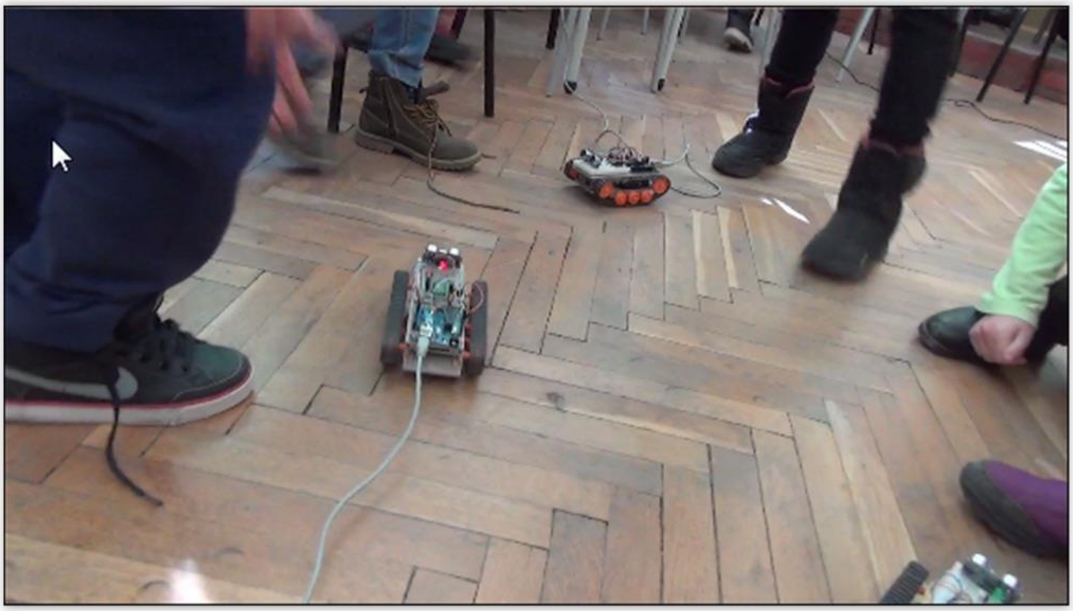


Fig. 1. The robots assembled by the students

The second session involved a mind mapping session on practical applications of robots in every day life. During the second session students also programmed their robot to make simple movements on the table and then on the floor.

The Robotic kit used was Arduino and the programming language was Scratch

A full description of the workshop is provided in Deliverable D.4.2. Operational release of activity plans. Next we provide a summary of this activity, which was included in the information package given to the school.

"During the educational robotics workshops the students will be able to learn the basic concepts of robotics through demonstrations and games with NAO – a humanoid robot. Together, with the support of the instructors and through visual instructions, the students will assemble an Arduino robot that they will program to perform simple tasks with visual programming software. In order to build the robot the children will be divided in groups. The workshop also includes a creativity seminar based on the mind-mapping concept of Tony Buzan, which aims to encourage the children to discover additional practical applications of robotics in various fields of science and in everyday life."

The stated objectives of the workshop involved:

- **Subject related:** learn the robotics key elements; construct a robot, develop visual program to control a robot; creative thinking how to use robotics for other fields;
- **Technology use related**: Arduino controllers; motor drivers; ultrasonic sensors;
- **Social and action related**: team work; creative thinking; presenting results;
- Argumentation and fostering of maker culture: formulate and express ideas; listening to peers; make decisions with in consensus with peers in the team, etc;

9.7.2 Contextual information

9.7.2.1 STUDENT PROFILES

The analysis of videos recorded involve two groups of students:

- One focus group of 4 girls (3 nine year olds and 1 eight year old)
- A group of three boys between 8 and 9 years of age

The selected focus group for workshop 1 consisted of four girls. Three of them were nine year olds and one was eight years old. One of the tutors in her observation notes mentioned that the group consisted of students who were friends before school and knew each other very well within an-out-of-school context also. They were in the same kindergarten and were playing together since 2-3 years old. They had a strong bond with each other and were used to working together as they used to play together in teams when younger. The tutor also mentioned that students were not fighting between them and they shared on multiple occasions that they were happy to work together. However, in their interview, students mentioned that there was a dispute between two of the four girls (Child 1 and Child 2).

Fig. 2 Focus Group with the final synthesis (22113 in place of 22108)

Group composition was altered between the first and the second session as the two sessions had were situated away in time due to technical reasons. During the first session another girl (22108) was part of the group instead of girl 22113. In the second session, girl 22108 was sick so, she was replaced by girl 22113 who participated also in the interview after the workshop.

In the first session of the first workshop some valuable data on collaboration were also gathered from another group consisting of three boys. This was not intended to be focus group (see data analyzed) thus there is no available information about the criteria according to which this group of students was formulated.

Fig.3. The second group of students observed during the first session

9.7.2.2 SCHOOL INFORMATION

The workshop was carried in a public school and was integrated in the school context. According to student responses in the interview the activity seemed to be highly linked with the lesson of mathematics. The teacher was present in the first session of the workshop and she also used her mobile phone to take pictures of the robots students made. In the second session there were present only the tutors – researchers

9.7.2.3 ROLE OF RESEARCHERS – TUTORS

In the first session of the workshop two tutors were present (plus the teacher). In the second session there were present three tutors but not the teacher. The role of the tutors was to introduce the activity to the students, to orchestrate classroom discussions and to intervene in group work when they judged that students needed, when students asked for tutor help. In tutor reflections they mentioned that they intervened mainly to support students with technical problems they encountered.

9.7.2.4 DATA ANALYZED

The analysis we report here is based on the recorded video sessions, the pre and post questionnaires, the interviews with the focus group, the observation notes of one of the tutors, the reflection notes of the tutors and the “draw a scientist” information.

With respect to the video data collected for this workshop, the camera was supposed to focus on the group. However this group was far away from the camera and thus it was not easy to observe their interactions and what they are doing with the robot. We only observed instances where the researcher approached to help or when a student from another group visited. The impression from the observation is that in the focus group only three of the four members participated. The fourth girl had a more peripheral role and in several cases she was observed to be off task.

In front of the camera there was a group consisting of four members two boys and two girls. The camera focused only on their heads and thus it was also not easy to understand how they were engaged with the robotic construction. An estimation based on how all students were leaning their heads on the table, is that in this group all four students were enaged with assembling the robot. This group was the first to finish assemblying the robot.

When the group in front of the camera finished their work we had the opportunity to observe closely for about fifteen minutes, the collaboration of a group of three boys who were behind the group of the two boys and two girls. So, a large part of our video data analysis during the first session of the workshop involves not the focus group but the group with the three boys.

9.7.3 Data Analysis

9.7.3.1 LEARNING ENGAGEMENT

During the workshop students engage in three types of activities: assembling the robot with the help of a visual guide (see section on description of the activity), creating a mind map about uses of robots in everyday life and in the future and finally programming a robot to move according to specific rules. Programming also involved use of sensors, which mainly identified obstacles. Apart from programming students tested their robots on their desk and on the floor. Testing in several cases provided the context to students to alter their programs in order to introduce new behaviors to their robots. Next in this section we describe how students perceived their learning based mainly on the posttest questionnaire and we view these results in the light of the analysis of video data.

9.7.3.1.1 STUDENT VIEWS ON THEIR LEARNING

In this section we analyze student responses in the questions that involved metacognitive thinking, and domain learning i.e. reference to robots.

STUDENT CODE	SEX	What have you learned about yourself?	What have you learned about robots?
22127	boy		
22128	boy		
22126	boy	With hard work everything is achieveable.	That they are very interesting.

22122	girl	That I can construct a robot.	They are very fun.
22114	girl	?	?
22113	girl	That I have a great imagination.	That they are intelligent, good and fun.
22111	boy	That I am a programmer.	A lot of things.
22109	girl	That sometimes I have to retreat to others but not always.	That they don't have a heart, a brain or feelings.
22120	girl	?	?
22132	girl	?	?
22110	boy	I don't know.	I don't know.
22124	girl	?	?
22117	boy	That I'm hard-working.	
22107	boy	That I'm hard-working.	
22106	girl		
22123	girl	That I'm very creative.	That they are very intelligent.
22131	girl	That I can achieve everything.	That they are very intelligent.
22125	boy	Nothing.	Nothing.
22119	boy	That I can robotize.	That they could be any kind.
22130	girl		
22116	boy	That I have to work in a team.	That they are very interesting.
22112	boy	That we are smarter than robots.	That they are very cool.

Table 1. Posttest: Student responses on their learning after the workshop.

The student responses about what they learned about robots can be organized in two main categories. One category involves the characteristics and attributes of robots (intelligent, robots could be any kind, they don't have a brain or feelings) and the other involves student attitudes towards the robot: interesting fun and cool. Although students do not refer to specific domain knowledge e.g. we learned loops or we learned using the sensors, their responses have learning value because they consist a generalization of the specific activities they did on the workshop in the sense that they are conclusions about the robots (intelligent, they don't have a heart) and that they are connected to their personal interests and tastes (interesting, cool, fun). Especially the latter category of responses indicates that the workshop had an impact on students' attitude towards robotics (finding them interesting, fun and cool).

The other question in the table above involves student knowledge about themselves. In this set of responses only the grey ones refer to the specific task students did in the workshop (i.e. robots and their ability to construct a robot). The other responses have a meta-cognitive character and refer to what it takes to achieve a goal (i.e hard work), to student skills (being imaginative and creative) and to the social dimension of learning (I have to work as a team and I have to retreat to others but not always). These responses indicate that the workshop appeared to have a more deep impact to the students than the focus on robots. Furthermore, it appears that students during the engagement with the workshop tend to realize a set of aspects that are important in learning in general especially when you are facing a challenging task what are your abilities and skills, what it takes to achieve a complex task, the importance of collaborative work. From this perspective it appears that the robotics workshops can have an important impact on students building on their attitude towards learning in general.

9.7.3.1.2 EXPLAINING

During the programming of the robot students discussed between them and it appears that in several cases group members took the opportunity to explain to the others what they had done.

Fig. 4. Explaining to the others

In the picture above we can see C2 showing a line of their program in the computer screen to the rest of the group. We interpret this as an instance of one group member showing something specific in the other students about the program. From a learning perspective these opportunities are valuable because articulation of an idea can lead to further elaboration, reflection and understanding not only for the members of the group but also for the person who articulates this idea. From a style of work perspective this phase of construction simulates the role of the teacher (who is the one who knows and explains to the others) here we might need to consider the body language and especially the fact that the student is standing (usually teachers are the ones who stand while explaining whereas students when they are listening they are supposed to be seated. Furthermore, this construction phase is in line with the turn taking mode of collaboration where one person is in charge of the task and they others observe or have a supportive role (analyzed in the Collaboration section).

9.7.3.1.3 EXPLORING THE CONSTRUCTION

Based on the analysis of our video data, we identified an instance where one of the students started examining closely the robot after the construction was complete (See Fig. 5)

Fig. 5. Analyzing the final construction to decode the integrated knowledge

This instance is also analyzed in the section where we discuss collaboration because it is the result of a control taking collaboration model in the sense that one student was in charge of the robot construction and excluded the others from participation. The student depicted in the image above, after the construction was completed found an opportunity to return to their desk when the others were absent, and have a close look at their construction. The specific student had an active role in assembling the robot at the beginning and then another member of the group set him aside completed the construction. The other student took over when the construction appeared to have reached an impasse. So the student depicted here, due to his limited participation in the final phase of assembling the robot, probably missed a part of what was supposed to be group – shared knowledge due to the fact that the other student excluded the rest of the group. When the student found the opportunity he tried to complete this missing part of knowledge about the group construction by "opening up" and analyzing the robot. We interpret this instance as evidence of student interest on the group construction and as an expression of strong incentive for learning and covering the missing part of knowledge. This is not a usual attitude in group work, as the main trend is, when one member has done the work, the others do not bother to understand how they ended up to the specific result as what is important is that the work is done. Here the student not only he is interested but because the other student would not leave him to touch the robot while he was in charge and he wouldn't provide any explanations, he took the initiative to decode the knowledge implemented in the robot by analyzing its construction.

9.7.3.1.4 UNDER THE BRIDGE: ROBOTS AS TOYS

Students after finishing their constructions they had the chance to try out their robots on the floor. Each group would place their robot on the floor and let it move, put obstacles in its way so that its sensors will activate a turn or a backwards movement etc. This part of the workshop was very successful according to the observation notes of the researcher, as students forgot the competition between boys and girls and were playful and excited.

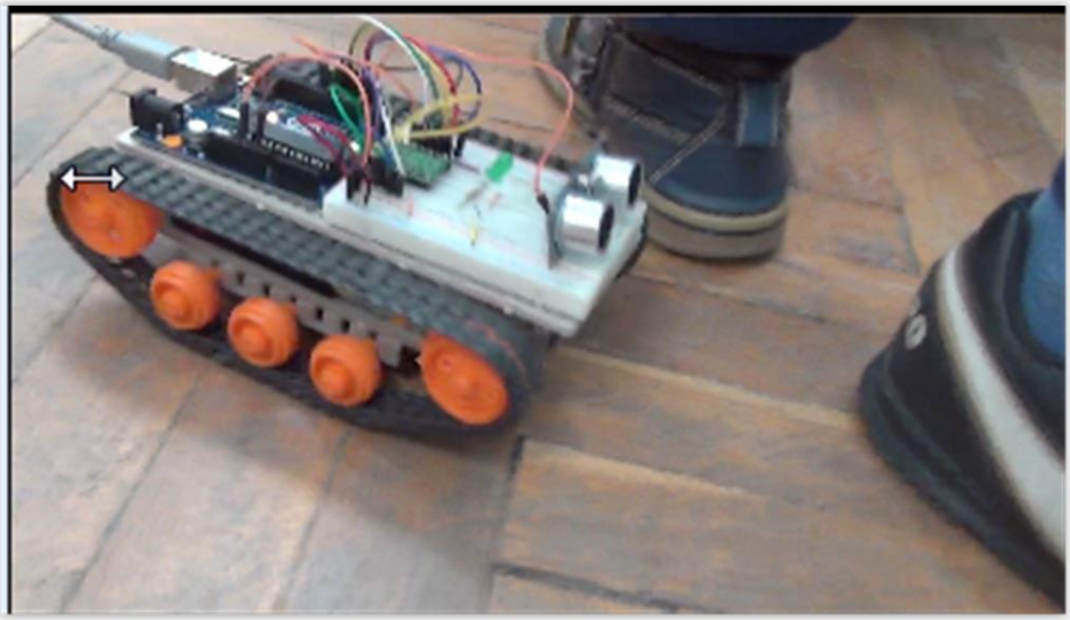


Fig. 6. Playing with the robots

In the picture above we can see a boy forming a bridge with his feet so that the robot will pass under it. This was one expression of the playful activity that was developed during the workshop, which shows that students had the opportunity to treat their constructions as toys and give personal meaning to their activity, in the sense that what they construct is not something irrelevant to them, their interests or their lives. Furthermore, this activity could probably have encouraged students to address working with robots as fun (see student evaluation of the workshop section) and to consider the workshop as interesting and fun activity.

9.7.3.1.5 EXPRESSIONS OF AMAZEMENT WITH CONSTRUCTIONS

Apart from the playful character of the workshop where students had the opportunity to play with their robots and use them also as toys we found in the video data student expressions of amazement with their constructions.

Fig.7. Expression of amazement with the robot behavior

The picture above is taken from an instance where students have managed to make their robot move forward, then they have added a sensor and they were trying to make their robot turn and continue moving towards a different direction when it reached the edge of the table. There was a tutor intervention during this phase of programming and probably students struggled a bit. When they tested their robot on the table and they realized that the robot actually demonstrated this behavior C2 made an Ahhh of amazement and brought her hands in her face (see Fig.7). But why is this expression important? It is important because it shows that students in the context of the workshop they were surprised with what they were able to do and with the characteristics of their constructions. This is an important contribution of the workshop towards the development of ownership over student constructions as students are proud for what they construct and it is also an important contribution towards the development of resilience (see relevant section in this report) as they realize that they can actually do something complex and exciting which probably did not seem possible before the workshop.

9.7.4 Collaboration

Collaboration in this workshop appeared to be a challenge according to the observation notes of the researcher mainly due to the competitive spirit between boys and girls cultivated by the school-teacher. In this section we outline a general picture of student views about collaboration based on the post-questionnaire responses and then we proceed into further analyzing the characteristics of collaborative work, which developed during the workshop in the specific school, based on video analysis and interviews. We devote a small section on the competitive culture of the specific class because it provides a necessary background for interpreting the gathered data.

9.7.4.1 STUDENT EVALUATION OF WORKING WITH OTHER PEOPLE

The posttest questionnaire included a number of questions that involved collaboration i.e. stating how interesting, fun, difficult was working with others, what students learned about working with others, if students worked as a team, worked alone, if they were bored while working as a team if they felt that they were good at listening and if they helped someone:

		WORKING AS A TEAM WAS:							
STUDENT CODE	SEX	Interesting	Difficult	Fun	What have you learned about working with other people?	I worked as part of a team	I worked on my own	I was good at listening	I helped someone
		5	1	5	I learnt that it's fun.	5	1	4	5
22128	boy	5	2	5	I learnt that it's fun.	4	1	4	4
22126	boy	5	1	5	That you have to work in a team.	5	3	5	5
22122	girl	3	2	4	That it is very nice.	4	3	4	3
22114	girl	3	2	5	?	3	3	4	3
22113 Focus Group C4	girl	3			That it is fun, as long as we don't fight each other.	3	3	3	4
22111	boy	5	1	5	That it sucks.	1	5	1	5
22109 C3	girl	5		5	I have to help others.	3	3	3	3
22120	girl		3	3	?	5		5	
22132	girl	5	1	5	?	5	1	3	1
22110	boy	3	2	4	I don't know.	2	1	4	4
22124	girl	1	5	1	?	1	3	1	1
22117	boy	3	4	3	That it is boring.	3	4	5	5
22107	boy	5	4	5	That it's nice.	5	3	5	5
22106	girl	5	1	5	That it's a lot of fun.	5	1	5	5
22123 C2	girl	5	4	4	That two of the girls fought a lot.	5	1	3	5
22131 C1	girl	5	1	5	That we have to help each other.	5	1	5	5
22125	boy	5	2	5	Nothing.	5	2	3	1
22119	boy				That it is very fun.				
22130	girl	3	5	5	That it is a lot of fun.	5	5	5	5
22116	boy	4	4	5	That it is great.	4	1	5	5
22112	boy	5	3	5	That it is a lot of fun.	5	1	5	5
AVERAGE SCORES		4,15	2,5	4,4		3,9	2,3	3,9	3,9

Table2. Posttest: Student responses about collaboration

Looking at the average scores of the above table we can see that collaboration was addressed as interesting, not very challenging and fun by the students in general. Most students reported that working with others is fun and some students highlighted something like the most important rule: we have to help each other and that we have to work as a team. These findings seem to be an important contribution of the workshop in collaborative learning as students discover its fun; they emphasize the importance of helping each other instead of competing or struggling alone; they seem to realize the necessity of collaborative work ”we have to work as a team”. This last statement can be connected to the demanding task of constructing a robot in the sense that the task is not easy to be carried by one student alone, instead there is need for collective contribution.

Looking at the individual responses we realize that there are students that have a different view than the one described already. These views came mainly from boys (see blue and green coloured cells) with one exception: girl 22124. In attempting a closer look at this entry we observe that the specific girl found the whole collaboration process not interesting, very difficult and not fun. She did not respond in the question “what you learned about working with other people and she gave the lowest scores (1) in the questions regarding work as part of a team, being good at listening and helping someone. The responses that show that the student did not work as part of a team and mainly worked on her own (3) reflect a situation whereas the responses I was not good at listening and I did not help someone reflect student's responsibility in the sense that they can be reasons (especially the response I was not good at listening) for the bad collaboration within the group. We have to note that the specific girl gave the lowest evaluation in the workshop (2) -being one of the few students that did not give a five star evaluation- and she found the problems and the work with robots difficult. So overall we can say that her evaluation on collaboration was part of an overall not so good experience.

What draws our interest in the other three students is mainly the responses in the question "what have you learned about working with other people": One student said "it sucks" (boy 22111) the other said " it is boring" (boy 22117) and the third stated that he learned nothing (boy 22125). However two of these students gave high scores in the question about how interesting fun and not difficult is working with other people. With the exception of boy 22117 who stated that he found the collaboration difficult (score 4) rather interesting and fun. When it comes to the questions that reflect the actual student behavior in collaboration, it is interesting to see that student 22111 evaluates that he did not work as part of a team (1), he worked mainly on his own (5), he was not good at listening but he was good at helping someone (5). These scores depict a student that despite the fact that he finds collaboration interesting, he does not demonstrate those qualities that are important for group work: i.e. working as part of a team and listening to the others. Student 22117 on the other hand shows that he worked more on his own (4) but he also worked as part of a team (3), however he portrayed behaviors that facilitate collaboration i.e. listening to others (5) and helping someone (5)

There is another boy (green colored cells) who is treated differently than the above cases because his responses seem to indicate a low participation student as opposed to the other three students described earlier. Specifically, the student stated that he does not know what he learned which is different from stating that he learned nothing (as student 22125) in the sense that he might have learned something but he cannot specify it. This boy found collaboration rather interesting, fun and not so difficult. Next, he stated that he did not work very much as part of a team but he also did not work on his own which might indicate that the student did not participate very actively in the final output but he was a good listener and he had the opportunity to help someone. These responses portray a student with behaviors that are compatible to group work but with no active participation in the team.

The focus group (orange colored cells) found collaboration very interesting with one exception (girl 22113) who gave score 3 and did not gave any rating with respect to its difficulty and fun dimension. Girl 22123 found collaboration difficult (4) but also interesting and fun. If we combine this answer to the response that she learned that two of the girls fought a lot (open question) it seems that this situation within the group revealed the difficulty of the collaborative work. Despite the arguments in the group, the girl estimates that she worked as part of the team (5) being however a not so good listener (3). In general three of the four members gave them a score of 3 to their skill to listen to what the others have to say. This can be considered an interesting self-criticism especially in the light of the interview where students identified two major problems in their collaborative work: a) one of them undertook a leading role in the construction which did not include the rest of the group (see section on participation) and b) that two of the students argued a lot. Overall the focus group responses to the open question and the specifics of their collaboration (working as a team, helping each other, listening etc.) show that collaboration was a challenge not easily met with the students acknowledging their weaknesses. The robotics workshop seems to contribute into realizing the challenges of collaborative work as it set a complex but achievable task. The specific task created a context where collaboration was necessary but challenging, in this context differences and problems can become more salient and thus they can become subject for reflection and further teaching.

9.7.4.2 COMPETITION

According to the observation notes of the tutor –researcher, the class had a culture of competition mainly between boys and girls (see section on gender). Based on a discussion the tutor – teacher had with the teacher, it appears that the classroom teacher used competition as a method to engage student interest. According to the tutor competition took some nasty turns during the workshop – especially during the second session- as boys groups tended to make fun of the girls and criticize their progress. The tutor – researcher expressed her concerns about the influence of competition in the overall experience of the workshop. However, students appeared to consider the workshop a success (see section " student evaluation of the workshop") including the collaborative work (see average scores in Table 1).

The competitive culture cultivated in the classroom was transferred and emerged during the workshop although there was no such intention for the workshop organizers (to trigger competition between boys and girls). Furthermore, when we discuss collaboration we need to consider the classroom culture- especially if it is competitive- because it is expected to influence the way students interact not only between groups but also within a group.

9.7.4.3 VISITORS – LEARNING FROM OTHERS?

As a result of the competition we mentioned earlier the tutor –researcher in her observation notes mentioned that groups would send spies to other groups in order to check on their work and their progress.

> *Girl groups were frequently sending a "spy" to check what the boys are up to and at what stage of their project they are. Boys were doing this as well, but with other boy groups also.*
>
> Observation, Session 1

Extract 1

This "visitor- spy" behavior was something we spotted during the analysis of the video data in session 1 and 2. However, this "visit" seemed to have different incentive depending on the task. Specifically during robot assembly and programming students seemed to have more the role of a spy whereas during the mind mapping students were having a look and they were sharing material (i.e. colored pencils)

Fig 8 Student visiting a group right after they finished their robot

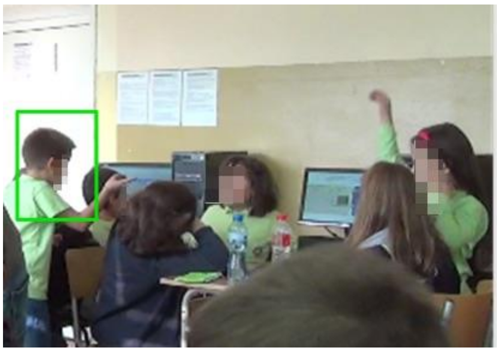


Fig. 9. Student visiting the FG and engaging in a discussion with them

The pictures above depict the same student visiting two different groups during the robot assembly session. In the left picture the student visited the mixed gender group, which was close to the camera right after the students declared that they finished the assembly of their robot. On the picture at the right hand-side the same student visited the focus group and he seems to be engaged in a short discussion with them. After a while C1 pushes him away (see Fig.10), which is an indication that the discussion might be disturbing for the group, especially if we take into account the tutor's comments about the competition between boys and girls

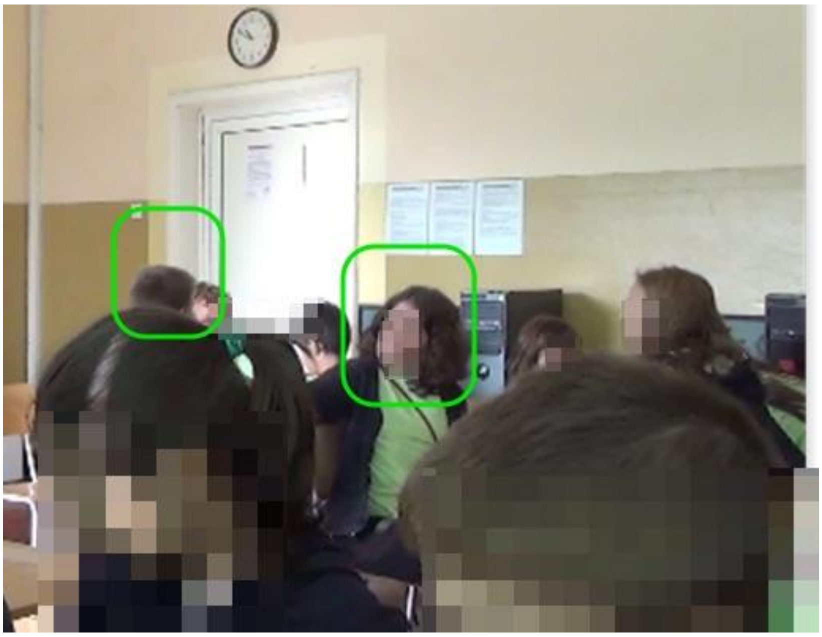


Fig. 10. Pushing the "spy" away from the group

Exchange of knowledge - ideas, or groups providing help to other groups, is something that can be encountered in robotic workshops (see for example the form of Collaboration in ECER 2016 Competition). Visitors can have this role. However the context in which these visits from one group to another is very important. Taking into account the competitive style of work of the classroom a "spy" does not visit a group to ask for help or to observe others in order to overcome an impasse and achieve their goal. In a competitive context, the "visitor" is more like a spy because the incentive for getting to know what the others are doing or how they have progressed is not to gain more knowledge but to make sure that the others are not ahead of us and that they are not going to be better than us. This intention makes visits not pleasant (as the one depicted above) and does not cultivate a culture of exchange of knowledge and ideas, thus in a competitive context when ideas "travel" between the groups, it happens more as result of stealing something instead of sharing knowledge. Thus this activity is unwelcome and undermines the free sharing of ideas and common construction of knowledge, which is crucial in a collaborative environment. The students perceived the tasks of assembling and programming the robot, as competitive and that is why the tutor noted that competition was very high during these activities:

> *there was a distinct competition between girls and boys in the class. Girl groups were frequently sending a "spy" to check what the boys are up to and at what stage of their project they are. Boys were doing this as well, but with other boy groups also.*

Observations, Session 1

> *The competition between girls and boys continued throughout the programming session as well, but boys became a little bit mean towards the girls – they were making fun of their progress, or their ability and the tutors at multiple occasions had to attempt to stop this. This really had a negative effect on the programming session as children weren't in general feeling very positive towards the experience. I am afraid that some of the students will be left with negative impressions about programming, because of this unreasonable competition. In my opinion, today's session was not successful partially because of this competition*

Observations, Session 2

Extract 2

From the extract above we observe that competition was present in both sessions: the first session, which focused on assembling the robot and the second session, which included programming the robot. According to the tutor this involved mainly intra group communication. However, we found instances of competitive behavior within groups, which was expressed through taking control in order not to lead the team but to ensure his/her individual contribution.

9.7.4.4 ROLES

Based on the data we analyzed, it seems that students did not formulate any roles within the groups. Thus there were instances where one student would do something with the robot or do something on the program and then another student would try to intervene or to take control. During the time that one student was in control the others might observe what he/she was doing comment or/and try to gain control for themselves. Thus, without the existence of roles students found a way to organize their collaboration between them by introducing turn taking. However, this happened in an non regulated way (when one had an idea would push the other to try it) but seemed to be functional for the group work. Taking into account what students said at their interview, in several occasions it evolved to co-construction and sharing of knowledge.

9.7.4.4.1 TAKING CONTROL

We mentioned earlier that analysis of the video data, but also the interview data with the focus group showed that students quite often claimed control over the task by taking the robot from another student or pushing him/her away from the keyboard to complete something to the program.

Fig. 11. Pushing away and claiming control of the robot.

In the picture above we can see an instance of where the student in the green blouse (C5) pushes the student next to him (C6) who is trying to look in the visual guide at the screen by pushing C5. C6 was working with the robot when C5 took one of the robot parts assembled it together and he put it on the robot. After that he took control of the robot and he did not leave it until he completed the construction. In this group the third student (C7) had minimum participation. Thus the game of control was between C5 and C6. Next we present a description of the change of control based on the video data:

Initially the two boys C6 and C7 seem to work together on constructing the vehicle with C6 being more active. C5 is engaged with a different part of the robot, which is the rubber cover over the wheels

Timespan 00:31:23:50 - 00:31:48:90

C6 is checking on the visual guide and seems more engaged than the other two. A short discussion follows between C5 and C6. Then they both look at the visual guide on the computer.

Timespan 00:31:48:80 - 00:32:27:50

After looking at the visual guide they seem to come up with an idea and they both rush to the robot. C5 takes the robot in front of him. C6 returns to the visual guide and points something on the screen. C5 looks at the screen again and pushes C6 (see fig. 11) when he tries to look at the screen passing in front of him. After a short C6 pushes C5's hand away from the robot. C5 keeps control of the robot. Then C6 pushes C5 back to look at the screen.

Timespan 00:32:27:50 - 00:33:11:90

C5 is now in charge of the construction again.

Timespan 00:33:11:80 - 00:33:35:10

C5 keeps being in charge of the construction, C6 has an active role and he participates. They both look at the visual guide. C7 seems to have a more limited and peripheral participation in the construction

Timespan 00:33:35:00 - 00:35:22:20

Extract 3

Fig.12. Using the body to exlude the others

Fig.13. Taking the robot from the middle of the table to keep control of it

In the pictures above we see how C5 takes initially one part of the robot and he uses his body to exclude C6 who is the one who was initially in charge of the robot. After that, C5 takes control of the robot until the end of the session (for 10 minutes approximately) leaving no space to the others to contribute. C5 did not give up and quite often he looked at the visual guide, made comments and he tried to get hold of the robot.

A similar situation is described by the focus group during the first session when student 22108 was part of the team instead of student 22113.

C3: At the beginning of the session, there was this girl (22108), she just wanted to assemble the robot but we explained that everyone should work together.

…

C1: Yes and also what C3 said, we kept explaining we should work together to this girl but she wouldn't listen.

….

C4: … and also explaining to the girl that we should do things as well. We got along in the end, she let us work too.

….

C1: She still did almost everything, though.

Focus Group Interview

Extract 4

In the extract above we observe a more extreme situation than the one we observed in the group of the three boys. In the focus group one girl wanted to assemble the robot and despite the group objections and explanations "*she still did almost everything*".

As a result of this attitude the persons who keep control of the "task" (be it the robot or the program) seem to claim ownership of the success, which is an expression of competitive behavior within the group:

Fig.14. Claiming ownership of success

In the picture above C5 has finished assembling the robot and he raises it above the table for others and the tutors to see that it is finished. In the mean time C6 tries to participate in the success by also holding the robot but C5 will not let him. However C6 and C7 who had the least contribution celebrate the group's successful construction much more than C5 but without them getting hold of the robot

Fig. 15. C7 celebrating without the successful construction while C5 keeps the robot away from the other members of the team.

As a result of this possessive behavior of C5 over the robot we observed in the video data that C6 who did not have the chance to participate in the final phase of assembling the robot, when he found a chance he returned to the desk and sneaked in to examine the construction because during the task C5 would not let him touch the robot.

> *C5 put the robot in the box and along with most of the other students he went out of the classroom. Then C6 returned to the table, he opened the box and he examined closely the robot. C7 returns and looks also at the robot. C6 keeps lifting the upper part of the robot. C5 returns with a mobile phone and he is more absorbed now with it (as opposed to the robot). The same has happened with the students from other groups*

Timespan 00:38:13:50 - 00:39:14:35

Extract 5

This instance is depicted in the following picture:

Fig. 16. Sneaking in to check out the robot

The behavior of C6 is an indicator that there was no actual sharing of knowledge and common construction between the students. We said earlier that C5 would not let the other students to get hold of the robot or to participate to what he was doing. So, probably C6 did not know how the construction was completed and he sought an opportunity to examine the robot so that he completes the missing knowledge. This incident is an indicator of the individualistic and competitive behavior of C5 but it is also an indicator of C6 interest to learn and understand how the group ended up to complete the construction. Thus C6 seems to emphasize not that much ownership over the success of the group but on the knowledge produced by the group. Another interpretation which takes into account the competitive relationship between him and C5 might be that he is inspecting the robot so as to make sure that what is done is not something above his abilities and understanding.

9.7.4.4.2 TURN TAKING

Turn taking appeared as a method to regulate claims of control. This was more apparent especially during the second session where students tested the robot taking turns. Testing involved pressing specific keys on the keyboard, putting their hand in front of the sensors and also performing some changes in the program.

C4: … and also explaining to the girl that we should do things as well. We got along in the end, she let us work too.

Interviewer: So you did manage to solve the problem?

C4: Yes.

C1: No.

C3: We took turns.

Focus Group Interview

Extract 6

In the extract above the focus group describes the transition from individual control to turn taking as a means to regulate individualistic behaviors (i.e when one person takes control of the task without leaving the others to try). Turn taking involves mainly individualistic activity: i.e. one student tests the robot for a while, then another student tests again doing the mainly the same routine which in some cases had deviations (e.g. changing something in the program or putting the robot to begin its route from a different starting point). These observations involve only the testing session where turn taking was more salient and there are no data to describe how turn taking took place in the focus group during the robot construction session. However, turn taking seemed to offer the ground for the emergence of co-construction where the group members contribute to the group work although they do not control the robot or the computer.

9.7.4.4.3 COLLABORATION AS CO-CONSTRUCTION

Collaboration as co-construction is a situation where team members participate with ideas, questions, hints and challenges in the final construction. The output is something that group members cannot identify their individual contribution because it is transformed through the group work. The focus group in a small extract of the interview demonstrates a collaboration process that evolves from turn taking to co-construction.

C3: We took turns. Someone tries to do it and if something is unclear the others help out.

C4: If no one knows - we start thinking about it.

Focus Group Interview

Extract 7

The situation described by the focus group shows that co-construction seems to emerge when turn taking encounters a cognitive impasse where the person in control doesn't actually know what to do next. Exactly at this point is where co-construction can emerge if others do not claim control and engage in making suggestions and exchanging ideas. C4 explains that the group starts actually thinking when no – one knows. This is an important finding because it indicates that breakdowns – in the form of impasses- at individual or group level can give rise to group contribution, participation and co-construction. The complexity of the robotic task seems to offer such opportunities even in competitive conditions, which do not normally allow co-construction and team participation to flourish.

9.7.4.5 PARTICIPATION

9.7.4.5.1 LIMITED PARTICIPATION

Student participation in the collaborative activities varied in each group. Thus there were active students who took control of the task, others who were also claiming control, others who where actively observing and contributing with comments and ideas and others who had limited participation in the group work. This is evident in the tutor observation and reflection notes but also in the videos analyzed:

Fig 17. Active participation and non participation in FG

In the picture above we have captured an instance of the focus group where C1 has explicitly excluded herself from the group work. This has happened after a dispute with C2 who was sitting next to her. In the video it appears that C1 wanted to try something, C2 wanted to try something else and due to the fact that C1 wasn't heard she decided not to participate for a while until C2 tried to engage her later on feeling guilty for her exclusive behavior towards C1 (according to tutor-researcher's comments in personal communication). In the situation above we can see that participation in the group is greatly dependent on the power relationships between the groups and if one student manages to dominate then it is likely that the other will limit his/her participation.

In the extracts below data from the tutor reflections offer us instances of limited participation in the group:

> *At times some of the male students got bored. One example is a student, who had a Rubik cube snake which he played with when he was bored.*
>
> Tutor Reflection Session1
>
> *At times there were students who were just walking around the classroom just observing the work of the others. However, during the mind mapping session, a lot of the students in this class got bored and didn't participate much and were distracting the other students.*
>
> Tutor Reflection Session 2

Extract 8

In the reflection of Session 1 the tutor seems to connect limited participation to gender. It appears that boys were those who would loose interest to the task (because they were bored) and they would not participate in the group work. In the second session limited participation is connected to the type of the task. According to the tutor, students considered mind mapping as rather boring task in comparison to robot construction and programming. This resulted in limited participation to group activities and in several cases it had as a result the distraction of other students.

To sum up, limited participation of students to group work was observed in the data we collected. Our analysis identified that limited participation might be connected to conflicts and power relationships within the group, gender, characteristics of the task. Of course this is not to say that there are no other reasons, which might play a role in limited participation (e.g. student character, difficulty of the task, group ability to include all students etc.)

9.7.4.5.2 ACTIONS OF INCLUSION

In the two groups we observed in session 1 we identified what we call actions of inclusion. These involve students who do not have an active role in the activity in general or for a specific time slot and are initiated by other group members. In the boys group we mentioned that C7 did not have an active role in the robot construction. When C5 progressed with robot construction C7 was holding one of the rubber laces that are used to cover the tank wheels. C5 had put the first rubber lace around the wheels of the robot and he left C7 to put on the second. It is interesting that C5 held back and he left C7 to put the final touch on the robot when he would not leave C6 to touch the robot. Our interpretation is that due to C7's limited participation to the task, C5 wasn't competitive with C7 because he did not feel threatened by him as opposed to C6.


Fig.18 Including excluded members in the group

C6 tried to also include C7 in the group after the completion of the robot construction. Specifically all groups put their robots in the front of the classroom and the tutors took pictures of the robots and of the groups. In this context C6 moved closer to C5 and he almost “dragged” C7 s so that he is also part of the group. It is notable that C7 did not actually want to be included in the picture but the reasons are not clear. Specifically, it is not clear if he did not feel part of the team or he did not want to take a photograph.

An effort for inclusion of C1 is also encountered in the focus group:

> *C1 and C2, were the ones fighting the. C1 was not participating, while the rest of the group made an achievement, prior to which C1 and C2 argue a bit (which is why C1 does not participate). C2 says a little arrogantly [Maybe C2 feels guilty], but in an attempt to include C1 "OK, look, we did this, now maybe you should start doing something also to help out". C1 becomes angry and says: "I wanted to work all along, but you never respect what I say"*

Tutor- researcher clarifications- personal communication

Extract 9

In the extract above C2 observes that C1 does not participate as a result of their dispute (See also Fig. 17). After following C2’s idea the group makes an achievement C2 makes an attempt to include C1 in the group work by suggesting to her to participate. This intervention by C2 is - according to the tutor’s interpretation - made out of guilt. Despite the fact that the intervention of C2 is not successful and causes the angry response of C1 it shows that C2 has a concern for the team and she feels responsible for the non-participation of C1. However such interventions to be successful need to respect the other, his/ her contributions and offer specific slots of actions. Here C2 seems to just pinpointing that C1 hasn’t contributed.

Overall we can see from the analysis of our data, that in the groups there were students that did not participate in the task and in the group work for various reasons. In the two groups we observed we identified that there are students who might undertake repairing or supportive actions so that to include in the group students who did not participate enough. This is not an easy task to do as we saw in the case of the focus group and these inclusive actions depend greatly on the reasons for limited participation. However, such actions show that there are students who consider part of their role as members of a team not only to work towards the common goal but also to include the other members.

9.7.4.6 STUDENT VIEWS ON COLLABORATION

In this section we discuss how students reflect on the essence of collaboration through their discussion with the tutor in the post workshop interview. Our analysis revealed two dominant views: one that addresses collaboration as a non-conflict situation and the other that describes collaboration as a context supportive to individual activity.

9.7.4.6.1 COLLABORATION AS NON-CONFLICT

The focus group faced two major challenges in the specific workshop one of which was the dominant role of one student who was replaced in the second section (see section on Roles) and the other was the dispute between C1 and C2. This challenge was depicted not only in focus group responses in the posttest questionnaires but also in the interview:

C2: Yes, that we're all a team and we shouldn't fight. To be friends.

Interviewer: Did you fight?

C3: They did a little, but they made up. (About C1 & C2)

Interviewer: How did you make up, what did you do to end the fight?

C2: We apologized to each other.

C4: They realized where they went wrong.

Focus Group Interview

Extract 10

In the extract above C2 who was one of the students engaged in the disputes, address conflict as a situation that should be avoided in a collaborative work. Instead friendship and practices encountered between friends, like apologizing, are described as desirable collaborative behavior. This comment brings into the foreground a practice encountered in schools and pursued by the students to formulate groups of friends. This is a practice quite often pursued by the teachers in order to facilitate collaborative work by minimizing the challenges that are caused by the differences in character and style. Furthermore, friendship apart from facilitating a smooth interaction between people that enjoy hanging out together and thus they agree in a number of things, it imposes also a set of behaviors that do not necessary facilitate collaborative work: e.g. you wouldn't say or do something different from your friend in order to not upset him or her etc. Along with the wide held perception that friendship is a good vehicle for collaboration goes the misunderstanding that good collaborative work is equal to good manners. This misunderstanding leads to a conception that collaboration is about avoiding conflict. However bibliography on collaboration asserts that new knowledge emerges from conflicts and situations where there is lack of balance, which reveals the differences in approaches and ways of thinking (this principle of disturbing the equilibrium, is used in collaborative techniques and collaboration scripts in CSCL). In this context apologizing is a practice that would be encountered between friends but it is not necessary something important in collaborative work. However, the comment offered by C4 which involves self-assessment (understanding where I am wrong) and understanding the other's point of view can be proven useful instruments for handling conflict and turning it to new knowledge.

9.7.4.6.2 COLLABORATION AS SUPPORTIVE ACTIVITY

We mentioned earlier that the style of working of the focus group was mainly based on turn taking – especially while programming and testing the robot which, according to group reflection, evolved, under specific circumstances, in co-construction. In the extract below when students highlight the importance of help in collaborative work.

Interviewer: What did you like the most about working together?

C1: That we all helped each other and it was a lot of fun.

…

Interviewer: Do you have anything to say, what did you like the most?

….

C1: That we all helped each other. And if someone didn't do something the other would explain.

Focus Group Interview

Extract 11

The emphasis on help within the group seems to imply a perception of collaboration as a context which provides support to individual activity which takes place within the group. Providing help is different to co-construction or sharing ideas in that help is a form of support in an already taken decision towards action: "I want to do that as an individual and the help I get contributes towards achieving my goal". On the other hand, common construction of knowledge consists of common shaping of action and the contribution of the group members shape the action they are not just help towards one's line of action. This interpretation of help between the group members fits well with the turn taking model of collaborative work implemented in the group. As we mentioned earlier, each student would take turns to test the robot (all members of the group repeating the same activity) or to try something in the program (an individual idea) and see how the robot responds. In this context we can see an individual line of activity formulated by the different group members and the collaborative mode of work provided support to students to try out their ideas. Furthermore, this view of collaboration should also be connected to the competitive culture cultivated in the classroom, which does not place emphasis on sharing but on aiming at better results. From another viewpoint, the robotics workshop, placed a challenge to the students where collaboration was necessary to complete such a complex task. In this context students begun to integrate their individualistic mode of work to a collaborative context: this activity requires a shift from the individual to the other person in the sense that the activity is now directed towards understanding what the other wants to do, respecting it, thinking about it and providing suggestions that support his/her goals. So we consider this view of collaboration from a group working in a competitive culture as an important step towards collaborative work.

9.7.5 Gender

Issues related to gender were mainly captured from tutor- researcher observations and in the "draw a scientist" activity. Specifically in workshop 1, the tutor identified strong competition between boys and girls. In a discussion with the class teacher she realized that this seemed to be a teaching approach adopted by the teacher to engage students in activities.

Gender was a dominant topic in this workshop – not very much spoken off, but there was a distinct competition between girls and boys in the class. Girl groups were frequently sending a "spy" to check what the boys are up to and at what stage of their project they are. Boys were doing this as well, but with other boy groups also. Later I found out from the class teacher that she often conducts girls vs. boys activities. I asked if she finds this as a well working approach and she noted that she considers it as such, as when a direct competition between girls and boys is not present, it is really hard to engage students and motivate them to perform in the classroom.

Tutor observations – session 1

Extract 12

The competition between boys and girls in the specific workshop appeared to be an established practice nurtured by the teacher. According to the tutor, competition was the reason that groups were sending spies to check on the status of the work and the approaches used by other groups (mainly boys vs girls). In the video data we captured instances where a boy approached the focus group to observe what they were doing, he also engaged in a discussion with them and at the end one of the group members pushed him away (see next picture).

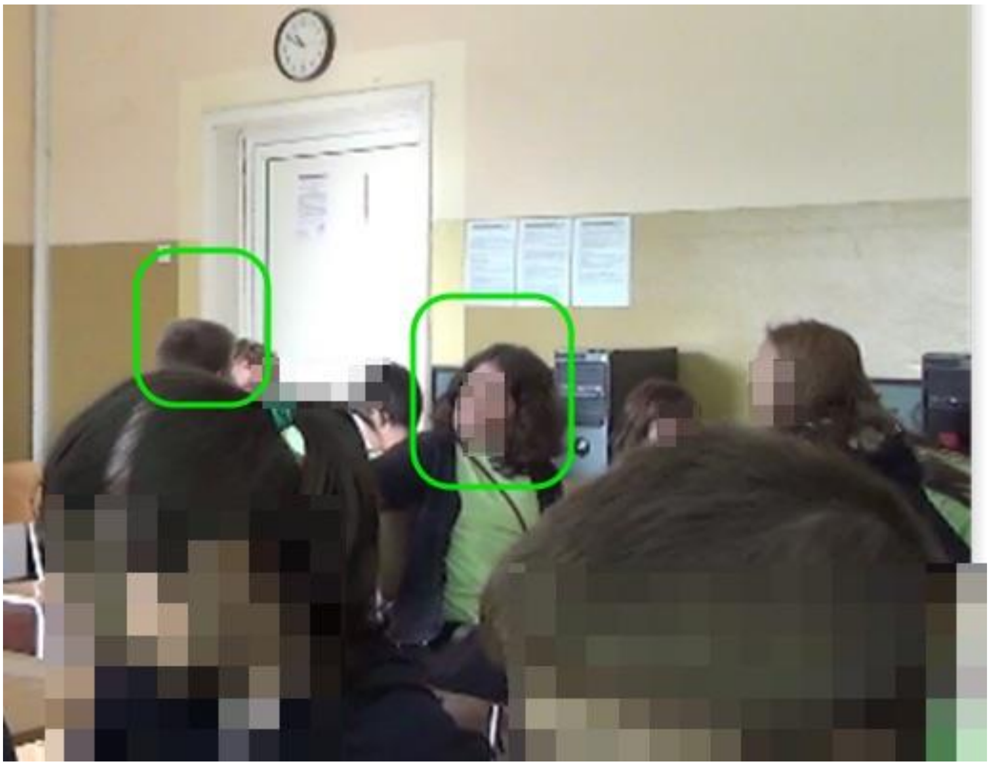


Fig 19. Pushing the spy away

The tutor considered that this competition between boys and girls was creating a rather toxic environment in the classroom and could even create negative attitude towards the task:

> *The competition between girls and boys continued throughout the programming session as well, but boys became a little bit mean towards the girls – they were making fun of their progress, or their ability and the tutors at multiple occasions had to attempt to stop this. This really had a negative effect on the programming session, as children weren't in general feeling very positive towards the experience. I am afraid that some of the students will be left with negative impressions about programming, because of this unreasonable competition.*

Tutor observations – session 2

Extract 13

The situation in the classroom as described by the tutor took a rather ugly turn with boys being mean against the girls and affecting the whole workshop experience. According to the same tutor, the most successful the part of the workshop was when students finished the programming activity and had the opportunity to be playful and have some fun. In this context students relaxed and thus, they were able to leave aside the competition and enjoy the activity.

> *It was successful for me as the play and the exploration that took place, took their minds of the competition between boys and girls that has become unhealthy. They had the chance to relax a little bit and have fun*

Tutor reflections – session 2

Extract 14

From the perspective of STEM and Robotics this competition between boys and girls cannot be related to the activity or the focus of the workshop because it appears to be an established norm not only in the specific class but also in the school as the tutor in another instance said that older students tend to be biased towards women scientists:

> *A denial of the authority of the female tutors was also at place. They showed significantly different attitude towards the male tutor – they still didn't want support, but they were more open to sharing their experience with him, showing off their robots and abilities. They mainly ignored me, unless otherwise possible. It is rare that we face such behaviour in the smaller grades but we usually see it when working students from upper grades.*

Tutor observation – session 1

Extract 15

In the extract above the tutor describes a situation where a group of boys in the third grade seem to be biased towards the female tutor avoiding to interact with her and accept help. This attitude is more striking if it is compared to the behavior the specific group exhibited towards the male tutor with whom they wished to share their achievements and experience. This negative attitude towards accepting help might be also connected to the competitive mindset of the group as asking for help might be considered as demonstrating weakness (see also section on resilience). However, when the female tutor demonstrated a humanoid robot, then the specific group seemed to showing more respect as they were sort of convinced for her abilities:

> *….*
>
> *Later during the workshop, when I showed them the humanoid robot and did a demonstration with it, they started respecting me more,*

Tutor reflection – session 1

Extract 16

Similarly, the camera captured instances of a mixed gender group working smoothly. Furthermore, the focus group drawings in the “Draw a scientist” activity showed that the bias of male dominance in science is not very evident:

Fig.20. Focus group draw a scientist results

In the picture above we can see that one of the girls (22131) seems to reproduce the stereotype of a male scientist with a chemistry lab beard messy hair and white robe. Another student (22113) has explicitly drawn a woman who seems to be paying attention to her looks as she is wearing red dress, red boots and she has long hair on the side. Additionally the student has added the computer to show her instrument of work. This girl in the post-test stated that she wanted to be an architect and that is maybe why she does not reproduce the original stereotype of a male scientist. Whereas for girl 22131 who draw the male scientist, she said in the pre test claimed that she wanted to become a "volleyball player" and in the posttest she said that she wanted to become a DJ. Using these data from the questionnaires we can assume that students who are interested in professions related to science they probably tend to update their images of scientists with information from the current situation (e.g. women being involved in science jobs, that science does not involve only chemistry labs etc). Whereas students not very much interested in science professions they probably keep the initial stereotype.

The other two students draw scientists in trousers and if we take into account their hair we could say that they draw female scientists. Girl 22123 also drew a figure that looks like a robot next to the scientist. If the scientists are women it is interesting that these two students did use the female stereotype: dress and long hair. When the tutor-researcher asked them during the interview what a female scientist would look like they all replied "Like you"

Interviewer: And can you imagine a woman scientist?

All: Yes.

Interviewer: What does she look like?

All: Like you.

Interview

Extract 17

The tutor in the first session was wearing trousers and a red blouse. She also had short hair. So probably the looks of the tutor-researcher might have influenced the drawings of the two students (22109, 22123) who draw scientists with “normal clothes”.

In the interview, students reflected on the draw a scientist activity. Interestingly enough their reference to this is very influenced by the drawing of student 22131 who drew a male:

Interviewer: How do you imagine a scientist?

C2 22123: Wearing glasses. Conducting experiments.

C3 22109: Wearing a white lab coat.

C4 22113: White lab coat, long beard and a spiky white hair.

C3 22109: Yes.

Interviewer: What about you?

C1 22131: With sort of short hair… with normal clothes.

C2 22123: With spiky black hair, lab coat, glasses and doing all kinds of experiments.

Interview

Extract 18

In this extract it seems that the common image of the scientist drawn by the group is male dominated and followed by the stereotype of experimentation. At this point we need to draw attention to the specifics of the Bulgarian language: The male and female scientist are stated with differentiated words, thus during the “Draw a scientist” the direction was: draw a male or female scientist. The wording in the interview does not indicate such differentiation and this may probably be the reason why students referred to the male stereotype. Interestingly enough, C1 (22131) who reproduced the male scientist stereotype in her drawing she was not the one to provide this description during the interview. Furthermore she seems that she has adapted some of the characteristics of the drawings of the other students: short hair, normal clothes (not a lab coat).

To sum up, gender issues that appeared in the specific workshop seem to be mainly related to the culture of the classroom, which was transferred and reproduced in the workshop. However students found the workshop as an interesting and fun activity (see next section) and this competition did not seem to influence their attitude towards the workshop. The tutor reflected that gender issues regarding not just the male dominance in STEM, but also girls’ competences in general, was reflected in student behaviors during the workshop. Furthermore, the tutor experienced a biased behavior towards her as a female from one boys group. The focus group in their drawings of scientists did not seem to have been influenced by the male dominance in STEM. Instead we identified possible connections to the image of the tutor - researcher and the type of the profession students are interested in. Specifically, one student with interest in science-oriented profession did not reproduce the male stereotype of a scientist.

9.7.6 Resilience

Resilience is not an aspect that can be explored widely. We found some elements regarding resilience in the observations of the tutor researcher and in the student responses on what they learned about themselves.

Specifically, the tutor-researcher's reflection on the boys team who demonstrated a gender biased behavior towards her (the female researcher) highlighted that it was a very competitive team (in relation to girls and other groups) and that it refused any support from the tutors. Our interpretation is that this attitude is grounded on the following beliefs: a) that accepting help is demonstration of weakness and b) in order to achieve pure success, you need to manage to complete the task without the help of others. This belief addresses progress and learning as a lonely process without interaction and help from the others. Furthermore, that help is a way that can facilitate learning but it is an acceptance of your weakness and lack of competence. A final observation is that such an attitude might be connected to beliefs that judge success from the final result only and not also from the process.

Elements related to resilience can be found in student responses in the posttest questionnaires and specifically in the questions that involve student views on what they learned about themselves.

STUDENT CODE	SEX	Q: WHAT HAVE YOU LEARNT ABOUT YOURSELF
22127	boy	No response
22128	boy	No response
22126	boy	With hard work everything is achievable.
22122	girl	That I can construct a robot.
22114	girl	?
22113	girl	That I have a great imagination.
22111	boy	That I am a programmer.
22109	girl	That sometimes I have to retreat to others but not always.
22120	girl	?
22132	girl	?
22110	boy	I don't know.
22124	girl	?
22117	boy	That I'm hard-working.
22107	boy	That I'm hard-working.
22106	girl	No response
22123	girl	That I'm very creative.
22131	girl	That I can achieve everything.
22125	boy	Nothing.
22119	boy	That I can robotize.
22130	girl	No response
22116	boy	That I have to work in a team.
22112	boy	That we are smarter than robots.

Table.3. Student views on their learning after the workshop

In the table above we identified four responses, which we consider relevant to resilience (in orange). The three of them highlight that during the workshop they realized that they work hard. One of the three students specifies hard work as the basis of achievement (boy 22116). From this perspective it appears that the imposing nature of robots as something very difficult and hard to achieve facilitates resilience in the sense that students realize that they can succeed through consistent work, devotion and numerous failures. This idea is connected to a belief that what can be considered a difficult task is not something to be pursued by the few clever ones or by those dominating the field (e.g. boys), instead what it requires is devotion and hard work.

One of the focus group girls (in violet color) has asserted the idea that after the workshop she realized that "I can do everything". This can be interpreted from two different angles. One is similar to the approach we described above i.e. I realized that I can do something that seemed impossible at the beginning and from this perspective it is a belief that can support the development of resilience. Taking another stance the same statement can be interpreted as a belief that undermines the development of resilience in the sense that it highlights a result (I can do everything) without the means to be achieved (i.e. hard work). Furthermore, it also imposes a wrong grounded self confidence which is to be proved wrong in life in many occasions.

Overall, when it comes to resilience, the robotics workshop seems to provide a good ground for its development. Our interpretation is that the imposing effect a robot has on the students (it seems something very important, hi-tech, difficult to do) first creates a sense of an extremely difficult task beyond their reach. Then through the workshop students seem to realize that through consistent and hard work they can achieve something they did know they could.

9.7.7 Attitude towards stem

Student attitude towards STEM is based mainly on data that are drawn from the pre and posttests and from the questions that involve student future professions. In the table below we can see juxtaposed student responses in the pre and post test.

		PRETEST	POST TEST		
CODE	SEX	PROFESSION	PROFESSION	SHIFT	STEM
22106	girl		An engineer	1	1
22107	boy	A scientist	A scientist		1
22108	girl	A nail artist	NOT PRESENT		
22109	girl	To help animals in need	A pilot	1	1
22110	boy	A chef	A chef.		
22111	boy		A gamer	1	1
22112	boy	A handyman	A handyman		
22113	girl		An architect		1
22114	girl	I don't know	So and so, yes.		
22115	girl		NOT PRESENT		
22116	boy	With mathematics	To build robots	1	1
22117	boy	Trainer/Coach	A fireman		
22120	girl				
22121	boy	Mathematician	NOT PRESENT		
22122	girl		A dancer		
22123	girl	A babysitter	A babysitter		
22124	girl	A dentist	?		
22125	boy	Football player	A football player		
22126	boy	A developer	A programmer		1
22127	boy	A policeman	An engineer	1	1

22128	boy	A policeman	A policeman		
22129	girl	A dentist	NOT PRESENT		
22130	girl	A hairdresser	A nail artist		
22131	girl	A volleyball player	A DJ		
22132	girl	Architect	A programmer	1	1
				6	**9**

Table 4. Student responses on future professions in pre and post testing

In the table above we can see that 9 out of the 25 students (i.e. almost 1 to three students) have expressed an interest in science related professions (in the broad sense including architects, pilots, gamers etc). Only three out of the nine students are girls.

Another interesting observation is that 6 out of the 9 shifted their view about their job. This shift might be from a non-science related job to a STEM related job or from not stating anything to a STEM related job. Two out of the six students who have shifted their views are girls. Furthermore, 4 out of the 6 shifts involve jobs related to robots, engineering and programming. In these 4 shifts where emphasis is on STEM there is an equal gender distribution: two are girls and two are boys This result, could be considered as an indication that the workshop offers to the students an incentive to consider science related jobs.

9.7.8 Student evaluation of the workshop

To infer students' view about what they think of the workshop we will be based on the questionnaire data and specifically to the questions that involve a) evaluation of the workshop in a five degree likert scale b) categorical expressions (interesting, difficult, fun) about the main activities held in the workshops i.e. problems and work with robots (work with others is discussed in detail in the collaboration session).

A/A	STUDENT CODE	SEX	Overall I would give this workshop: How many stars?
1	22127	boy	5
2	22128	boy	5
3	22126	boy	5
4	22122	girl	5
5	22114	girl	5
6	22113	girl	-
7	22111	boy	5
8	22109	girl	5
9	22120	girl	5
10	22132	girl	5
11	22110	boy	-
12	22124	girl	2
13	22117	boy	4
14	22107	boy	5
15	22106	girl	5
16	22123	girl	5
17	22131	girl	5
18	22125	boy	5
19	22130	girl	5

20	22116	boy	5
21	22112	boy	5
			4,789473684 (AVERAGE)

Table 5. Posttest questionnaire- Student likert scale evaluation of the workshop

In the table above we can see that for the students the overall experience of the workshop is rated with five stars (5 excellent). Only four out of the 21 students, gave a score different than five: two did not respond, one gave 2 (not so good) and one student gave four stars (very good). Based on this result we can consider that the workshop satisfied the students and from that sense it was successful. In an effort to further analyze the student evaluation of the workshop it is useful to consider what students think about the problems they had to solve during the workshop and how they perceived their work with the robots.

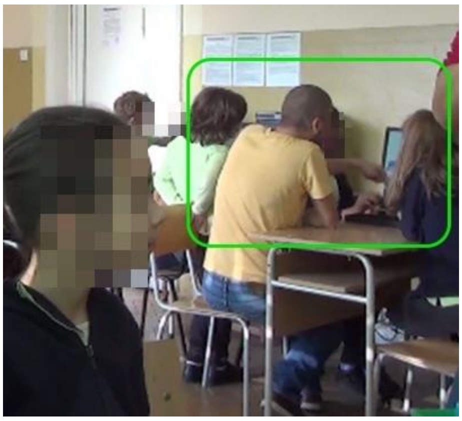
A/A	STUDENT CODE	SEX	The problems we had to solve were:		
			Interesting	Difficult	Fun
1	22127	boy	5	4	5
2	22128	boy	5	4	5
3	22126	boy	5	1	5
4	22122	girl	4	3	4
5	22114	girl	5	3	5
6	22113	girl	5		
7	22111	boy	5	1	5
8	22109	girl	5		5
9	22120	girl	5	4	2
10	22132	girl	5	2	5
11	22110	boy	3	1	3
12	22124	girl	2	2	3
13	22117	boy	5	1	5
14	22107	boy	5	4	5
15	22106	girl	5	1	5
16	22123	girl	5	3	3
17	22131	girl	5	4	3
18	22125	boy	5	1	3
19	22130	girl	5	1	5
20	22116	boy	5	3	5
21	22112	boy	5	1	5
	AVERAGE VALUE		4,714285714	2,315789474	4,3

Table 6. Posttest questionnaire – student categorization of the workshop

As we can see in the table above the majority of the students found the problems interesting (very much) with very few deviations (three responses giving 2,3 and 4). Similar is the situation with the fun category, i.e. students believe that the engagement with the workshop problems was a fun activity. Seven students gave scores other than five (i.e. five students gave a score of 3 which means that the workshop was fun but not so much, one student gave 2 and another one gave 4).

There is an interesting rating of the workshop with respect to the difficulty of the problems. The average value given is 2,3 which means that students did not consider the problems difficult. A look at the activity plan shows that the activities had a progressive difficulty and some of them could be considered as rather challenging for the students. Taking into account the competitive spirit of the specific class, one interpretation of these scores could be that students would not admit that they find a problem difficult because this would mean that they are not good enough. Another interpretation of this result is that the problems were well balanced in that they were difficult enough to engage the students but not that difficult so that the students could not solve them.

A closer look at the individual responses in the problem difficulty shows that five students out of the 21 found the problems difficult. The other three deviations from the mainstream response, which found that the problems were not difficult, came from the focus group. One student (22131) rated the problem difficulty with four, the other (22123) rated the problem difficulty with 3 and the other two did not give any rating in the specific question. Based on the interview and the description of the activity, the problems the students had to solve with the robot involved mathematical concepts. Students in the interview were unanimous in saying that the math involved, were not difficult for them. In further pursuing an explanation for these scores we looked at the observation data from the video recording sessions. We conjecture that the focus group found some difficulty in assembling the robot, based on the observation that one of the tutors (the male tutor) was in several occasions in their group and in two occasions he sat with the students in order to help them.



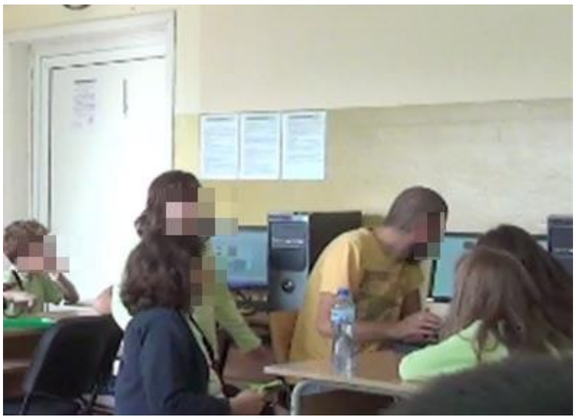


Fig.21. Tutor intervention in focus group during robot assembly (session 1)

However in the respective question of the questionnaire students did not state that: “Working with robots” was difficult for them (see table 7: Two students did not respond to the question and the other two gave a score of 1 and 2 in difficulty)

STUDENT CODE	SEX	Working with robots was:		
		Interesting	Difficult	Fun
22127	boy	5	1	5
22128	boy	5	1	4
22126	boy	5	1	5
22122	girl	4	3	4
22114	girl	5	3	5
22113 C4	girl	-	-	5
22111	boy	5	1	5
22109 C3	girl	5	-	5
22120	girl	5	3	-
22132	girl	5	3	5
22110	boy	4	1	3
22124	girl	5	5	1
22117	boy	5	2	4

22107	boy	5	4	5
22106	girl	5	1	5
22123 C2	girl	5	2	5
22131 C1	girl	5	1	5
22125	boy	4	1	3
22130	girl	5	1	5
22116	boy	5	3	5
22112	boy	5	1	5
AVERAGE VALUE		4,85	2	4,45

Table 7. Posttest questionnaire – student categorization of the experience with the robots

Working with robots was at the heart of the workshop. Looking at the average scores in the table above we observe that student responses show that there was a good balance between interest, difficulty and fun. Looking closer at individual cases we can see that there are two responses indicating that they found the workshop very difficult and difficult (scores 4 and 5). Those were given by a girl (22124) and a boy (22107). The boy had also found difficult the problems they had to solve. The girl on the other hand, found the problems rather easy (gave a score of 2) but she found that working with robots was not fun (1) and she was one of few the students who gave the workshop less than five stars (she gave 2 stars).

To sum up, an analysis of the student responses to questions that involved an evaluation of the questionnaire showed that the workshop according to the students was very good and successful (the majority gave 5 stars). Furthermore, students estimated that the activities of the workshop were well balanced in the sense that they were fun and interesting but not so difficult so that students would not be able to solve them.

9.7.9 Discussion

The overall experience of the workshop appeared to be interesting and fun for the students. Specifically the analysis of our data showed that the students appeared: to appreciate the importance of collaborative work in complex tasks, to highlight that hard work is important for achievement, to demonstrate a positive attitude towards robotics (considering them interesting cool and fun). All these are important contributions of the workshop towards not only a positive attitude towards stem but also towards developing important meta-cognitive skills and emotional intelligence.

More specifically, based on the analysis of the pre and post questionnaires, the video data, the observations and reflections of the tutors and the interview of the focus group, we highlighted in our report the following aspects: the characteristics of learning engagement, the model of collaboration developed, gender related issues, student attitude towards STEM and the overall evaluation of the workshop from the side of the students.

Learning engagement: Students focused more on the characteristics of the robots as a result of their learning and they expressed positive attitudes towards learning about robot addressing them as an interesting and fun topic (post test questionnaires). Further analysis of learning engagement should be seen in relation to the analysis of collaborative work because the model of collaboration quite often offers a good background to explain student' learning actions. Specifically, our analysis captured instances of articulation of ideas and reflection through explanations; expressions of strong incentive and interest towards the construction which was expressed through student analysis of a robot after the construction was completed in an effort to complete the gaps of what was supposed to be shared knowledge for the group; development of a sense of ownership over the robotic constructions – an important aspect for constructionist learning connected to agency and student interest- which was expressed through student amazement with their constructions and with student playful activity with the robots they constructed. The robots constructed during this workshop is something that students could play with, it is something they were proud of and worth to be captured with a camera (the teacher, the researchers took photos of the robots constructed. The students did the same when they were given a mobile phone during the workshop to handle).

Collaboration: Collaborative work appeared to be a challenge in this workshop as the specific class was nurtured in a competitive culture between boys and girls. This background helped us to further analyze and understand the role of visitors as spies of others' progress and approaches, to formulate a model of collaboration which started from individual contribution that excluded to others (taking control), evolved into turn taking where one member is in charge and the rest offer a supportive role to his/her decisions and reached instances where students worked as a group sharing ideas and contributing towards the group goal. The central role of the individual is also depicted in the interview with the focus group where students addressed collaboration mainly as a context for support of the individual activity. Participation of the group members in the workshop activities raged from active roles to limited participation. The latter appeared to be related to the task (mind mapping activity) to gender (behavior more often encountered with boys) and to power relations within the group. It is important to mention here that we encountered actions of inclusion by group members although this would be not expected in a culture of competition and individualistic activity. An analysis of the student responses in the posttest questionnaire showed that in the context of the workshop, students came to realize the challenges of collaborative work. Our interpretation is that the focus of the workshop created a context where collaboration was necessary but challenging, in this context differences and problems can become more salient and thus they can become subject for reflection and further teaching.

Gender: In this workshop gender issues emerged and specifically they took the form of a competition between boys and girls. This competition was part of the classroom culture, which was reproduced in the workshop. Tutor reflections depicted a situation where gender issues took two different forms: one was the use of spies between groups of different gender which replaced the sharing of knowledge; the second form was mean criticism mainly coming from boys and challenged girls' competences; the third from was biased behavior from a group of boys towards the female researcher who did not accept interventions from her because she was a female. However, student drawings, in the draw a scientist activity, did not follow the general stereotype of male dominance in STEM – with the exception of one student.

Resilience: Analysis of resilience was based on the posttest questionnaire data that involved mainly student self-awareness. Student responses showed that in the robotics workshop they realized the importance of hard work (i.e. hard work as the basis of achievement). The workshop seems to have contributed towards the development of resilience in the following way: the imposing effect a robot has on the students (it seems something very important, hi-tech, difficult to do) first creates a sense of an extremely difficult task beyond student reach. Then through the workshop students seem to realize that through consistent and hard work they can achieve something they did know they could. Video data analysis seem to corroborate this view especially when we discussed the amazement students felt when they saw their robot demonstrating interesting behavior. We need to point out however, that the competitive culture of some of the groups undermined the whole concept of resilience as this mindset has focus on the result only, in the sense that competence is judged in relation to result and does not address other important aspects of learning like sharing, asking and giving help, the importance of the process etc.

Attitude towards STEM: The analysis of student attitude towards STEM was based on a comparison between pre and posttest questionnaires. Specifically our focus was on student responses about their future jobs. The comparative analysis of the responses to these questions showed that some students shifted their interest towards STEM related jobs and more specifically to jobs related to robotics, engineering and programming. Interestingly enough in the observed shift (4 responses) there was an equal gender distribution (2 boys and 2 girls). These results can be indicators that the workshop had a contribution in raising student interest into STEM.

9.8 APPENDIX H: BULGARIA CASE STUDY 2

9.8.1 Description of the activity

The second workshop organized by the ESI-CEE team involved the implementation of the activity plan with the title: "Visualizing mathematics with the mathbot". The workshop was carried out in two sessions on two different days with one week distance between them and –according to the activity plan- the sessions lasted 8 hours in total.

The activity plan focuses mainly on the learning of mathematics and it specifically focuses on concepts that are part of the Bulgarian national curriculum for 4th grade students. In the activity plan the workshop team stresses three other foci of equal importance with mathematics: problem solving, communication, flexibility and adaptability". From the description it appears that problem solving is part of the tasks designed for learning mathematics and the other two are connected to the challenges of the collaborative work:

> *The goal of this workshop is to introduce and exercise mathematical concepts, which are covered in the national school curriculum for mathematics for the fourth grade in Bulgarian schools, using programming and robotics.*
>
> *Participants play 5 different games with the robot. Every game builds on the previous one and is broken down into quests, through which they exercise their knowledge on mathematics and adopt new concepts while exercising them. Children program to make the robot move and they make the robot move to solve a mathematical problem.*
>
> *In addition, and of equal importance to the subject of mathematics, this workshop is specifically designed to support and encourage the development of the following skills:*
>
> *1. Problem solving skills are stimulated by encouraging students to solve different kind of problems in conventional ways, but also to seek innovative ways to find solutions. Children are stimulated to identify and ask significant questions that clarify various points of views and lead to better solutions.*
>
> *2. Communication is important for the successful outcome of the games. This includes the ability to articulate thoughts and ideas effectively in a group. Groups consist of student of diverse points of view, knowledge and abilities, which requires a certain ability to communicate complex ideas clearly, effectively and patiently.*
>
> *3. Flexibility and adaptability is a skill, which is greatly incorporated on many levels. Students have to be flexible in order to incorporate feedback from other team members and tutors effectively, and furthermore to understand, negotiate and balance diverse views and beliefs to reach workable solutions.*
>
> *Within the sessions, students are required to shift roles within their group, which consist of different responsibilities, aiming to ensure that flexibility and adaptability skills are fostered. During the second session, students are not reminded to shift roles, which encourages communication, as well as provides students the chance to fall back into the most comfortable role within their team.*
>
> Short description of the activity plan, Del. 4.2

The specific objectives stated for this workshop were the following

Mathematics:

- Learn more and exercise knowledge on angles and how to measure them using protractors;
- Engage students in brief discussions about different types of triangles by length of sides (scalene, isosceles, equilateral) and by width of angles (acute, right, obtuse) to enable them to learn from one another;
- Engage students in brief discussions about circles and the elements of a circle (radius and diameter only).

- Exercise knowledge about circles through games with the robot.
- Exercise arithmetical functions - multiplication addition, subtraction and division by including them as part of the games;
- Exercise the use of measuring tools such as ruler and protractor;
- Showcase the difference between positive and negative numbers without going into theory;
- Showcase the difference between whole numbers and decimal numbers without going into theory;

Technology:

- Students gain understanding of what a robot is and know some common robotic parts;
- Students understand that robots are programmable;
- Students apply sequences of actions to program their robot.
- Students gain knowledge on sensors and some different types of sensors;
- Students understand that different sensors serve different purpose;
- Students understand that sensors are controllable;

Social and action related:

- Develop problem-solving skills;
- Exercise effective communication skills;
- Encourage flexibility and adaptability;
- Foster collaboration skills;

TECHNOLOGY USED: The technology used for this workshop was a Finch robot and scratch programming language. In the pictures below we provide a snapshot of these technologies and the main functionalities of Finch (Fig.1), which involve a light sensor, an accelerometer, a temperature sensor, led lights, a light sensor and obstacle sensor.

Fig 1. Finch anatomy


Fig 2 Finch looks

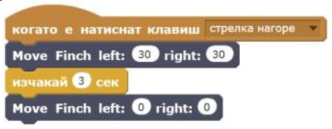


Fig 3 Scratch for Finch

During the workshop the organizers added a pencil in the back side of the Finch so that it could draw and in a sense performed like the Logo Turtle:

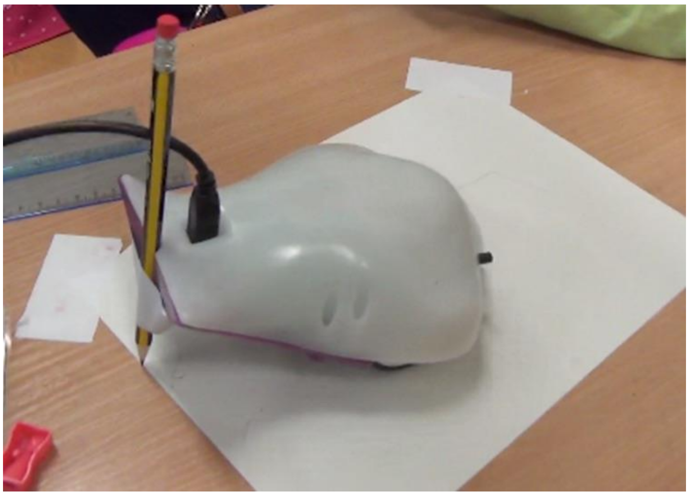


Fig 4. Modified Finch for Drawing

We mentioned earlier the workshop was structured around five small tasks- quests which were given to the students in the form of cards. Each time a task was completed the team would change roles. Each task was designed so as to gradually build on the previous tasks. A quick overview of the tasks is offered next:

Task 1- Game 1: Moving the robot (builds on knowledge from year 1 workshop) with the keys of the keyboard – Example provided

Additional challenge (no example): detecting turn and turning on the leds with the different colors: (e.g. red nose when the Finch turns left)

Task2 – Game 2: Time dependent stops (moving for specific time e.g. 3 seconds) use of the repeat command. The example provided gives the commands and their structure. Students need to adjust the values of the parameters. Example provided

Additional Challenge (no example): Uses all the above: repeat, time dependent stops and turn triggered led lights

Task 3: Game 3: Draw a line of 10 cm and stop when the distance is covered. Rulers are provided for students to ensure that the robot has covered the specific distance. Question on the relationship between time and distance (measure time for distance of 10 cm and time for distance of 20 cm). Example provided

Additional challenge (no example): Draw geometric shapes: triangles and square.

Task 4. Game 4: Robot turning: Angles and time. Students write a program to make the robot turn on its right wheel for a specific time (0.5 seconds, 1.2 seconds etc) and then they are asked to measure the angles drawn. Example with the main structure of the program is provided.

Additional challenge (no example): students are asked to find the relationship between the turning time of the robot and an angle of specific degrees (e.g. 135); to find the speed if they know the turn and the turning time; to find the time if they know the speed of the left wheel and the turn.

Task 5- Game 5: draw a circle by playing with the speed of the left and the right wheel. Example provided

Additional challenge (no example): Students use their knowledge of mathematics to measure the radius and the circumference of the circle they drew with the robot

During the interview with the focus group students mentioned that they found the last task- game as the most difficult and they said that they did not manage to complete it due to time restrictions. Their interpretation for this problem was that there was something wrong with the robot and its interpretation of time "The time was bugged". Tutors mentioned that overall the tasks were not difficult for the students (in the sense of being beyond their skills and abilities). However some groups needed some help more in the form of consultancy, others required some explanations and help at some points e.g. explaining some things in scratch or how to interpret the algorithm of actions in the first session.

The design of the workshop had foreseen specific roles for the members of each group: i.e. Role 1: writing the code, Role 2: holding the cable and helping with the program, Role 3: Reading the task and making sure that everything is correct, Role 4: Making sure that the rules are followed. Students are expected to change roles at the end of each task. During the first session students were reminded to change roles, whereas during the second session this responsibility was left with the group. The rules of the workshop (which include the shaping of the teamwork) were depicted in a mind map which was given to the students and is presented below:

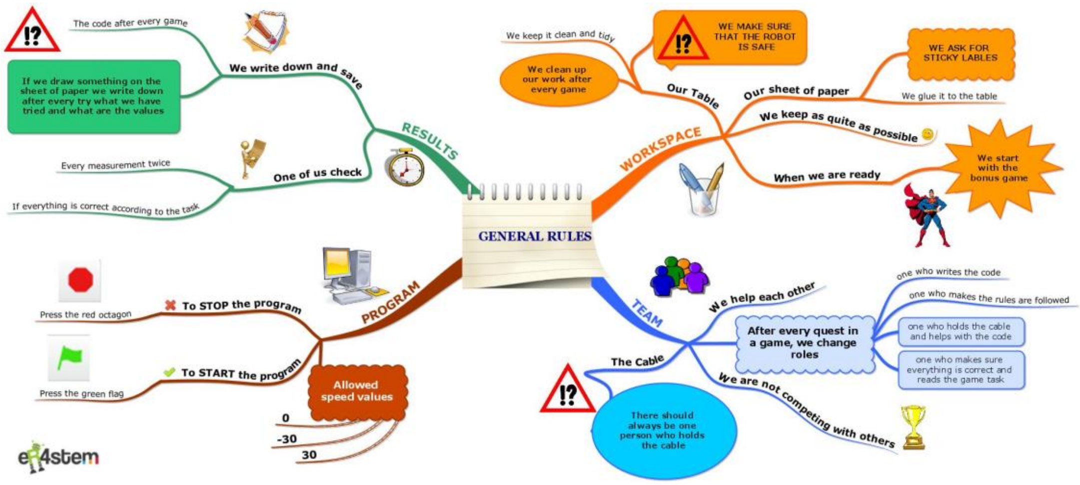


Fig.5. The rules of the workshop

9.8.1.1 COMMENTS ON THE ACTIVITY PLAN

The activity plan integrates very well the knowledge of mathematics in the various tasks and introduces students to the way robots turn (by controlling the speed of the wheels). The concept of the additional challenge is very good and could be used for the final version of the activity plans because this way they handle the different working styles of each group especially in terms of time. Thus one group that finishes before the others can engage with the additional challenge. This way there are no groups doing nothing while the others are still struggling. Furthermore, the structure of the tasks in main and additional challenges is a design according to which all groups have worked with the basic concepts and then those groups that can handle the basic challenges easily, can continue with the more advanced tasks.

One line of criticism for this activity plan is that it consists of a set of tasks, which are more like exercises rather than games or constructions. In order to formulate an activity in the constructionist spirit all these small tasks should contribute to one construction (like motion in a labyrinth) with a personal meaning for the students.

Another thing that needs to be addressed in the activity plan and especially the reflection on the practice is the role of support – especially to technical partners like companies- for learning. Support is not something indicating that if/when needed the activity plan is not appropriate for the students (age, abilities etc). Instead when an activity is carried out in an educational setting the support provided can give students a push to advance their learning (zone of proximal development, scaffolding). Furthermore, different types of support need to be described (e.g. demonstration, challenging existing solution, suggestion of a method of work instead of telling the solution etc) so as to be easily used according to the different circumstances encountered each time.

9.8.2 Contextual information

9.8.2.1 STUDENTS PARTICIPATING IN THE WORKSHOP

In the workshop participated 29 students from 9 to 10 year olds (4th Grade), 14 of which were boys and 15 were girls. In the first session only one boy was absent and in the second session one boy (different from the one of the first session) and one girl were absent.

The specific class participated for second time in the robotics workshop organized by ESI-CEE. The first time the workshop was carried out one year before (2016) when students were in the third grade. The first year workshop involved student acquaintance with robots and focused on assembling a robot, doing some simple programming and finding uses for workshop in real life.

In the second year workshop, students formed the same 7 groups with the year one workshop (i.e. group composition was the same). Six groups consisted of four members and one group (group 7) consisted of three members. No further information is provided for the criteria of group formulation. There was one differentiation in the focus group, which is presented later in more details.

9.8.2.2 FOCUS GROUP

The focus group initially consisted of two boys and 2 girls. According to the researcher observation the two boys were arguing a lot and C1 during the first session left the group and joined another group (group 2). During the second session C1 was not anymore in the focus group and he was replaced by C2 (21248).

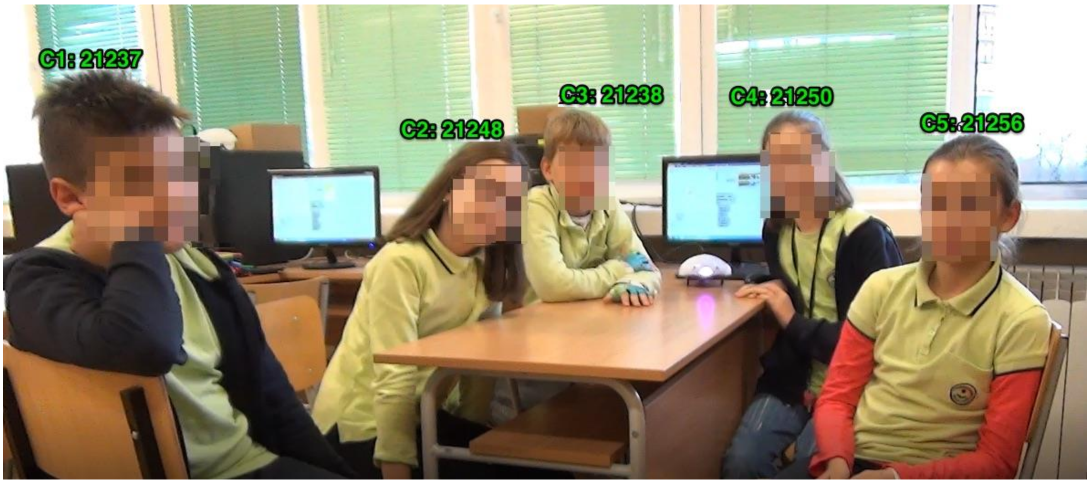


Fig. 6 Focus Group with the final synthesis (22113 in place of 22108)

In the picture above we can see all students who were part of the focus group including C1 who left and C2 who replaced him. According to the tutor – researcher the group in the first synthesis (C1, C3, C4, C5) – worked very well last year. However in the year 2 workshop the researcher reflected that C1 was not very much into the task and engaged in a lot of fighting with the other boy C3. The limited video data available for this workshop has captured a 20-minute continuous work in one task, were C1's participation is limited. Arguments between C1 and the rest of the group are discussed in the interview and further analyzed in the collaboration section below.

9.8.2.3 SCHOOL INFORMATION – ROLE OF THE TEACHER

The workshop was carried in a public school and as we mentioned earlier it was fully aligned with the national curriculum for 4rth grade mathematics. The teacher was present in both sessions and according to the researchers, she mainly helped with student discipline. The researchers mention that she was very supportive during the implementation of the workshop but they do not further explain what were the types of support offered.

Spatial arrangement: Groups of three or four were sitting around a desk at the far end of which there was a desktop computer. Usually 2 students were sitting on the one side of the desk and one or two other students were sitting on the other side of the desk. This setup required that if one student who was sitting two seats away from the computer had to get up to try something on the programming.

9.8.2.4 ROLE OF RESEARCHERS – TUTORS

In both sessions, there were present three tutors (plus the teacher).. The role of the tutors was to introduce the activity to the students, to orchestrate classroom discussions and to intervene in group-work when they judged that students needed it or/and when students asked for tutor help. In tutor reflections it is noted that due to student participation in the first year workshop students needed limited support and were able to act independently. It is also noted that the one group who participated in the pilot of the year 2 workshop offered support to other groups. The role of peer support between groups might be an interesting set up to further investigate in robotics workshops (e.g. older students helping younger students etc).

9.8.2.5 DATA ANALYZED

The analysis we report here is based on the recorded video sessions, the pre and post questionnaires, the interviews with the focus group, the observation notes of the tutors-researcher, the reflection notes of the tutors and the mid point reflections of the groups completed before the beginning of the second session.

The video data collected for this workshop were limited due to technical reasons. There was however one 20 minute video which captured focus group work on a task and there were several video capturing student demonstrations of their robot: the finch moving on their desk with its nose having different colors according to the robot turns and the finch drawing on paper different geometrical shapes. Last there were several short, class walkthrough videos probably captured by the students. In these videos the camera was moving throughout the classroom and students who were entering the frame of the camera were either waiving or putting their hand in front of the lens. The camera captured in some frames the finch drawing, the finch with the pencil and some ofthe finch drawings (e.g. triangles). These walkthrough videos were not used for our analysis.

9.8.3 Data Analysis

The analysis of our data focus on the following aspects of student activity in the robotics workshop: learning engagement, collaboration, resilience, gender issues and attitude towards stem.

9.8.3.1 LEARNING ENGAGEMENT

Student learning engagement is based on the analysis of the interview data, of the posttest questionnaires and of the tasks they were given to the students. The analysis of the tasks helped us to elaborate on: a) what were the concepts the organizers expected to be explored during the construction b) what was given to the students as a guide or as an example and what was expected to be the student production or final output. Based on this analysis we were able to infer what were the new things students were expected to explore and what was the existing knowledge applied in the workshop.

9.8.3.1.1 STUDENT VIEWS ON THEIR LEARNING

In this section we analyze student responses in the questions that involved metacognitive thinking (what have you learned about yourself), and domain learning i.e. reference to robots.

STUDENT CODE	SEX	What have you learned about yourself?	What have you learned about robots?
21247	boy	That I'm good at maths.	What they consist of.
21231	girl	That one has to work in teams.	That they can do a lot of things.
21248	girl[7]	That I love to program robots.	That it is hard and people who work with them perform a hard task.
21241	girl	That I can program and build.	It was very interesting to me and I learned a lot of new things.
21235	girl	That I'm fussy.	I can't decide.
21093	girl	That I have to work in a team.	I can't decide.
21251	girl	That I can be in a team.	They can do a lot of things.
21239	boy	It is fun.	That they are hard to make.
21230	girl	That I work better in a team.	That we can make programs.
21245	girl	That I can work in a team.	They can do anything we tell them to.
21229	girl	That I'm smart.	They are very fun.
21240	girl	That I'm smart.	They are a lot of fun.
21243	girl	That I can work in a team.	They can move the way you want them to.
21242	girl	That I'm relatively good at robotics.	That they are very interesting and fun.
21256	girl	That I can program a robot.	That I have to program them and build them.
21253	boy	That I can programme.	They obey orders.
21232	boy	Nothing.	Going around obstacles.
21255	boy	Nothing.	Programming.

[7] In grey we mark the focus group students

21252	boy	I'm good.	
21254	boy	I learned that I can programme.	Robots are interesting.
21246	boy	I'm good at programming	They are great
21238	boy	It is very fun	That they are programmed and fun.
21244	boy	I'm good at robotics.	That it is a lot of fun.
21237	boy	That I work hard.	That they are complex.
21249	boy	That I became good.	They are interesting.
21250	girl	That I can work with robots.	They are awesome.

Table 1. Posttest: Student responses on their learning after the workshop.

With regards to student responses, which refer to what they learned about themselves, we can see that the majority of responses (14 out of the 28 responses) refer to the skills students feel that they gained i.e. I can work with robots, I can program, I am good at maths. Some of these responses express a general evaluation of student ability (I am good, I am smart) instead of focusing on specific skills acquired. These responses can offer indications for a positive contribution of the workshop towards supporting students to gain confidence in STEM related tasks. The second most popular set of responses (6 out of the 28) involve collaborative work: i.e. I can work in a team, I better work in a team etc. These responses show that the design of the workshop to define and distribute specific roles beforehand and to introduce consistent turn taking, seem to have contributed into raising awareness to some of the students, about the importance of collaborative work.

The student responses to the question what they learned about robots, can be organized in three broader categories. One category involves student feelings and attitudes towards robots (i.e. interesting, awesome, fun). The second category of responses is in essence a reference to the functionalities of robots (i.e. what robots can do) which more or less reflect what students did with the robots (in terms of robot behaviors) during the workshop: i.e. they programmed the robots defining their behavior (they obey orders, they can do anything we tell them to) and made them move in specific trajectories. The answer “avoid obstacles” is not something that was included in student activities but it was one of the functionalities of Finch and students discussed it in an activity that analyzed “Finch anatomy”. The third category includes only two responses and expresses what we could call as evaluation of the engagement with the task “it is hard”. Of the three categories of responses those that involve the functionalities of the robots are domain specific and more or less they reflect a concrete knowledge about robots although some answers are too general (e.g. they can do a lot of things) to include some specific knowledge. From these responses we can say that in general students have more or less a concrete and rather accurate idea about robots and a positive stance towards STEM and robotics.

Further elaboration on student learning about robotics is offered by the mid point group reflections. Specifically, students right at the beginning of the second session were asked to complete a set of three questions that involved their challenges, and learning gains about themselves, the others and robotics. Students were expected to work as a group and decide in common about the answers they were going to provide. Next we present a table with the group responses:

GROUP	Biggest Challenge	Greatest Achievement	Learning about yourself, the others, robotics
1 (Focus group)	Following the rules and deciding who should start a game.	When we did the long sequence of actions.	The cable is very heavy and the robot can’t drag it by itself, so you have to hold the cable. Also, it is much easier this year as we know

			that it is going to be fun.
3	Everything, especially the things that we already did last year, but we couldn't remember initially how to do them with this robot.	That we didn't need much support.	It is very nice this year, as the robot doesn't disconnect all the time and we can reconnect it by ourselves.
6	Nothing, it was a lot of fun.	To make the nose of the robot blink in purple. It was very hard as we had to combine other colors to have purple.	Robots can teach you many things about art to – how to combine colors for instance!
7	To follow the longer text of the games.	Working together and taking turns.	: Robots are not only for constructing, but for programming also.

Table 2. Mid point group reflections on learning

Student responses on what they found challenging or what they consider greatest achievement help us to formulate an idea about breakthroughs and breakdowns in the learning process –according to the students. Thus the focus group and group seven coincide in the challenges posed for them, Task 2 with the long algorithm of robot actions. Group 6 highlights something very specific – making the nose of the Finch purple- and explains the solution they gave (combining other colors). We consider that this group demonstrates a very good example of knowledge gained through the workshop as it does not refer only to the task but shows that students have a good awareness of the solution to the problem. Furthermore, their answer on what they learned about robots shows that the specific activity of the workshop gave the opportunity to the students to see the multi-disciplinary nature of robots and identify principles of art in what they did. From this perspective we can infer that the specific task drew student interest and offered multiple entry points to robots. Another worth noticing answer is that offered by group 3. The specific group states that all the tasks were very challenging and they could not easily built on the experience gained from their participation in the workshop held during year 1. So, while the group struggled with all the tasks, the students consider as the greatest achievement that they did not need much support. This shows that students perceive support from the tutors as an indication of weakness and it appears that support diminishes the feeling of achievement for the students (it is important not to just complete the task but also to do it without the support or the help of anybody). One explanation for this perspective is related to the type of support offered: e.g. if the support is in essence offering the solution to the problem then it can create a feeling of dependence. As we mentioned in the comments about the activity plans, special attention needs to be paid on the different types of support provided to the groups and the role of help and social interaction in relation to achievement. Other explanations can be related to the culture of the classroom and the norms established between the teacher and her students (e.g. promoting the idea that when support is provided then it is not a "pure win" for the students which is related to a rather competitive culture).

9.8.3.1.2 CONSTRUCTIONS

Student constructions on this workshop focused on programming the robot behavior taking into account its functionalities (sensors and way of moving and turning) without engaging into robotic construction. However student this does not mean that students did not engage with robotics, as they had to take into account the different functionalities of the robots in order to make them to perform the tasks. The acquaintance with robotics was depicted in student responses in the posttest questionnaire, which showed that students have a clear idea of what robots can do and the role of programming in their behavior.

The construction process included the following steps, which were followed iteratively many times within a task: Program the robot according to the requirements of the task; Test the robot behavior; Analyze feedback, revisit the program and check the program against the requirements of the task.

9.8.3.1.3 TESTING THE ROBOT

We mentioned the iterative process of robot construction where when part of a program was completed then it was tested with the Finch to check the actual behavior of the robot. At the end of the first task where the nose of the Finch was shining according to the turns students engaged in demonstrating what the robot could do and these instances were captured in the camera.

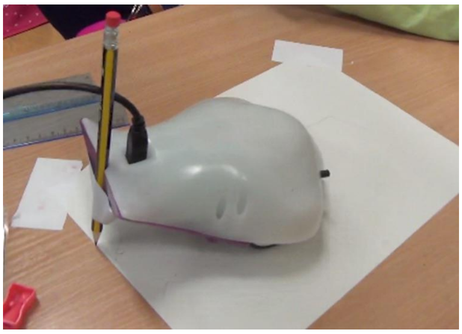


Fig. 7. Finch configuration to draw

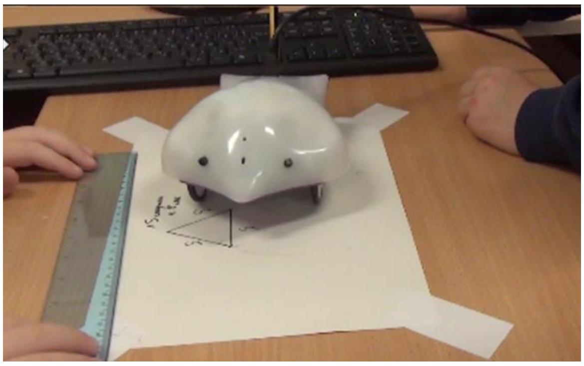


Fig. 8 Finch drawing an equilateral triangle

Part of the student work was to measure the distance covered by the robot taking into account parameters of time and speed. Then progressively students entered into making the robot to turn in order to create triangles and then they moved on into circles, which proved to be the most difficult task for the focus group. Students did not manage to complete the task and they attributed their failure to problem with the variable of time.

Interviewer: … What was most boring for you?

All: The circles.

C5: They were a pain.

C3: (The robot) always made a circle, he went forward and then stopped.

C2: Yeah and then he would spin in one place and go off straight again! It never worked. Whatever programming we did, it didn't work.

Interviewer: So did it work in the end?

C2: No.

C5: Time was up.

C1: No, we gave up, because it kept turning at the wrong time the time was bugged.

Focus group Interview

Extract 1

It is not clear from C1's response if the problem was within their program or if they attributed the bug to the response of the robot. In any case the fact that students finished the workshop without having a clear idea of what went wrong with one of the tasks they engaged, is something that needs to be considered for the next phase of the design of activity plans. The suggestions is that towards the end of the workshop it would be useful for the organizers to discuss solutions offered by the students to the tasks, so that all students have a clear idea about the validity of their approach to the problem.

9.8.3.1.4 PROGRAMMING

Based on an analysis of the five challenges- games, it appears that the main concepts introduced and practiced by the students were "if then" structures (e.g. when "D" is pressed then move left) and repeat a sequence of actions. Students were introduced also to robot turns, which are expressed in terms of time and wheel speed.

When we were discussing the activity implemented to the workshop we mentioned that the organizers provided students with an example program which could implement one part for part of each task. In the pictures below we present a description of Task 2- Game 2 and the example provided to the students.

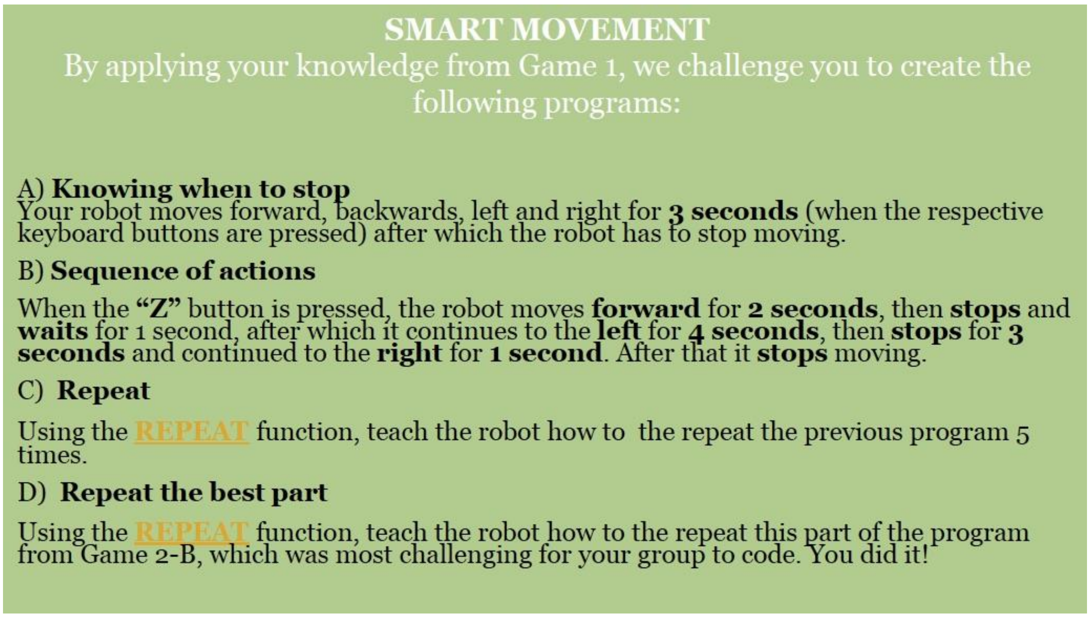


Fig 11. Description of the second Game- Task

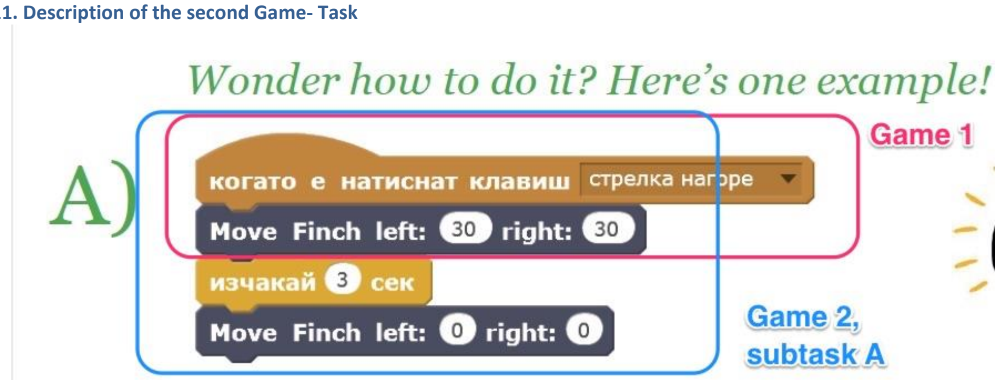


Fig 12. Example program for Game - Task 2.A.

In figure 12 we present the example students have as a basis to start programming their robot so as to demonstrate the behavior described in task 2. The example covers only the first part of the task (subtask A). The part of the program within the red rectangle is part of the program students used during task 1 to make their robot move without time restriction. In this subtask the behavior of the first task is extended so that the robot stops after it has moved for 3 seconds (see the last 2 lines of code in fig 12). From the analysis of this example we can see a) how each task was gradually integrating and building on knowledge from previous tasks and b) that the examples offer a basic example program, which students were expected to extend in various ways: a) by simply modifying values (e.g. make the 3 seconds 1 second) b) by combining in new ways known commands (e.g. instead of attributing one type of movement in one keyboard key, they attribute a series of actions in one key) and c) transferring the use of a command in a different situation (instead of moving for 3 seconds to stop for 3 seconds). These examples, which are open for expansion and modification show that the activity was designed so that students had to think about – in a structured way- how to work with the program and that students did not just repeat the example by simply changing the values of the commands

Furthermore, there were the additional challenges for which the activity did not provide any support, which means that the students were expected to explore also the programming language to find out how to construct a program that generated the described behavior:

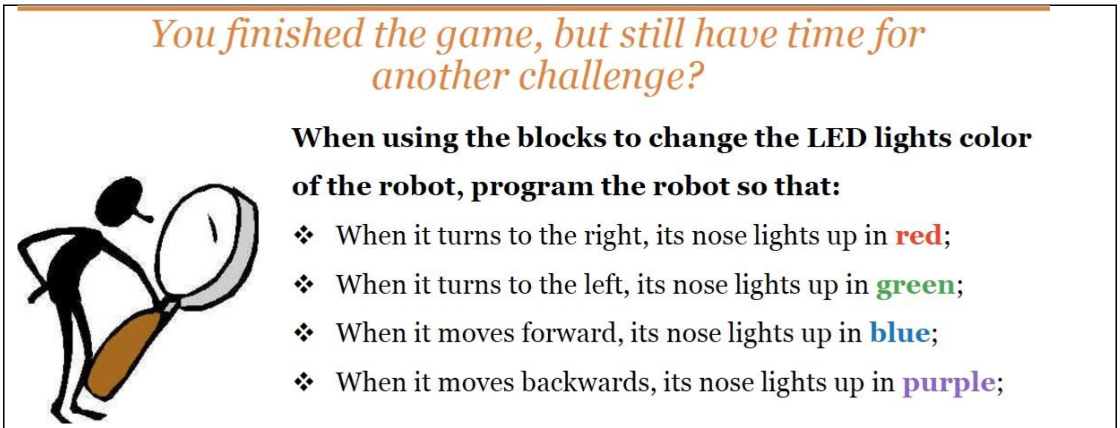


Fig. 13 Additional challenge for Game 1

In this additional challenge students were expected to extend the initial program, which made the robot move when they pressed specific buttons on the keyboard. This basic programming of the robot behavior was exactly the same with the task that followed the robot assembly in the introductory workshop (workshop 1) in the previous year. Now students have to explore the programming language in order to find how to use the colors and to use the Finch anatomy to identify which sensor to use in order to trigger the specific color of light in Finch’s nose. Recalling student mid – point reflections, the purple color was not available and students had to combine other colors in order to produce it. This shows again how the tasks became progressively challenging for the students and required exploration of alternative solutions, transfer of knowledge from other domains (e.g. arts) etc. Of course there are no data to indicate how students managed to handle the additional challenges, how many students completed them and what kind of supported needed by the students. However, the additional challenges as we mentioned earlier was a very good approach to handling different timings in group-work and to advancing student engagement with robots and programming.

9.8.3.1.5 DOMAIN KNOWLEDGE

The focus of the activity plan was on mathematics and specifically measurements, angles and construction of geometrical shapes. According to the tasks of the workshop, the students were expected to measure the distance covered by the robot (initially) and then they were expected to measure the angles of different triangles so as to be able to draw a triangle with the robot.

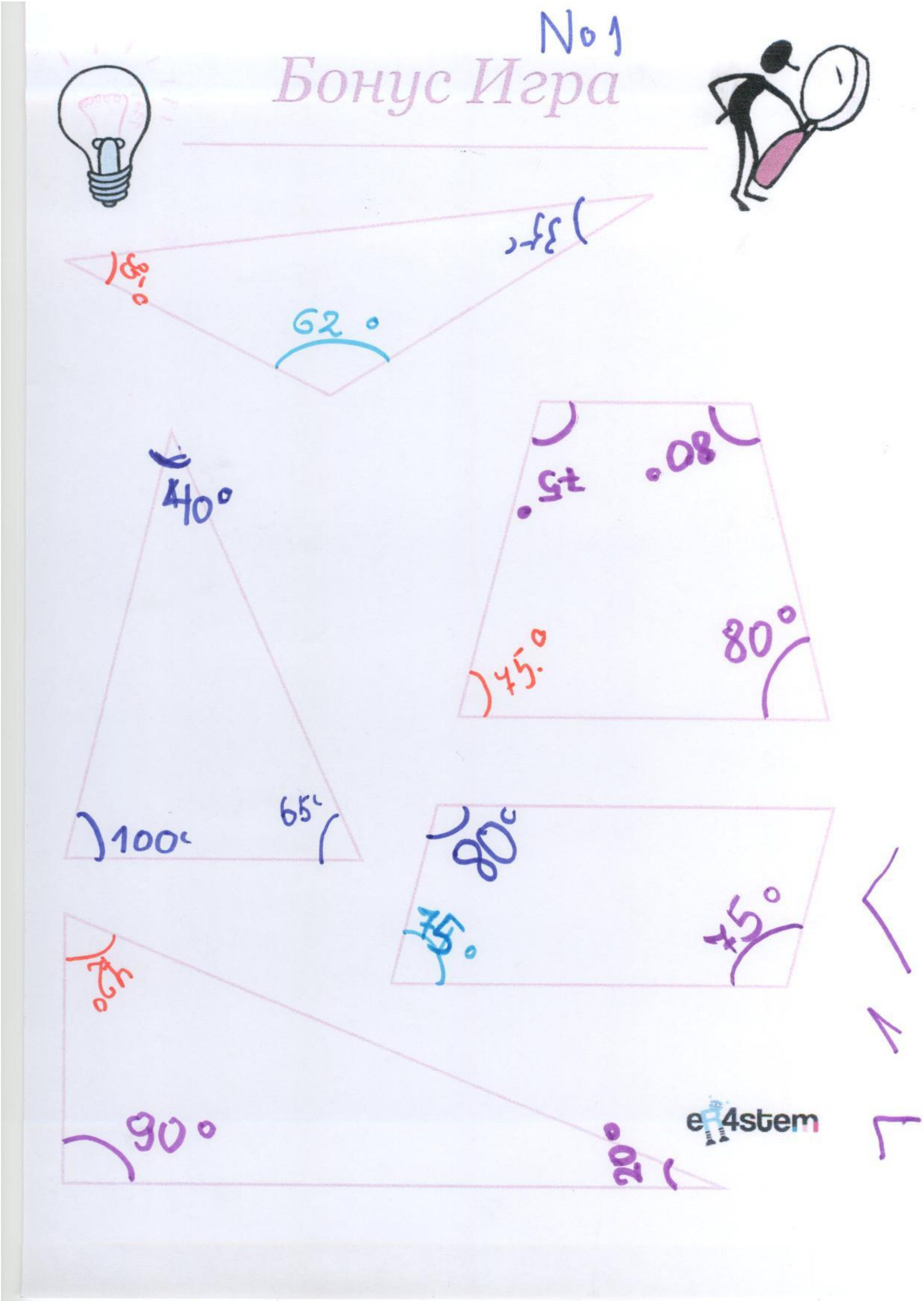


Fig 14. Focus group practice with triangles

In the figure above we present the worksheet where students used a protractor to measure the size of the angles in the different triangles and trapezoids. Then they used these measurements as a basis to construct a program that would draw the specific triangle (see. Fig. 8). Interpreting the design of the activity in the workshop our view is that students found in these activities a ground to practice existing knowledge about mathematics in the sense that robotics were not used for the students to learn something new (e.g. the relationship between the angles in a triangle). Next we present an extract from the student interview, which focuses exactly on the mathematical knowledge students think they acquired.

> *Interviewer: Hold on a sec, i have one final question.[children making noises, looking at robot in awe] I'll leave you to have some fun after that. Do you think robotics can help you with math? Do you think the exercises today were good for you and you learnt something new, as far as math is concerned?*
>
> *C1: Yes, I learned something new and I'm sure robotics is a big step forward for humanity and will be a lot of help.*

C2: I definitely learned a lot more about math. And I think in the future robotics will become very popular, maybe I'll find a profession that's connected with robotics. This course is helpful.

…

C4: We learned how to program the robots today. Last year we learned how to assemble a robot. We learned that angles are measured with a protractor. And I think robots will spread commercially very quickly.

Focus Group Interview

Extract 2

In the extract above students claim that they learned knew things about mathematics but they do not specify the new knowledge they acquired. There is an exception of C4 who asserted that the new mathematical knowledge was sort of methodological: "the angles are measured with a protractor". So it appears that the robotics workshop offered a very rich context for application of existing mathematical concepts and by giving an emphasis on measurements, students placed some special attention on the instruments used for these measurements. This interpretation is in a sense corroborated by the data presented in tables 1 and 2 (student evaluation of their own learning). Specifically in table 1 where students evaluate what they learned, there is only one reference to mathematics and in table 2, mathematics were not included in the greatest achievements and challenges of the group mid point reflections.

9.8.3.1.6 CHECKING THE TASK AGAINST THE PROGRAM

We mentioned earlier that the tasks were distributed to the students in the form of cards. According to the model of division of work, one student had the role to read the task to the rest of the group. Quite often students had to return to the task to check their program and the robot behavior against the requirements. This was a behavior demonstrated by the tutors when students asked for help or when the tutor monitored student work. Video data showed that students demonstrated also this behavior. We do not have enough evidence to claim that they reproduced tutor's behavior or this behavior was something that emerged in both tutor and student behaviors.

Fig. 15. Tutor checking the task

Fig.16: Students checking the task

Paying close attention to the requirements of the task is an important skill to be acquired by the students as quite often student failure is connected to misinterpretation of the requirements of a problem. With regards to the role of the workshop, it appears that complexity of the tasks contributed into cultivating student attention to the details despite the fact that the tasks were not difficult to interpret as they just consisted of many different things, which were not necessarily logically connected between them.

9.8.4 Collaboration

The design of the activity implemented in the workshop included a focus on collaboration which described a set of roles for the members of each group and emphasized a concept of support between the learners as opposed to competitive behavior (see section on roles) . In this section we describe collaboration at two levels. In level one we provide a general overview of student collaboration based on student responses in the post questionnaire. At the second level we attempt a closer look to collaboration analyzing the focus group. For the second level analysis we use data from the videos, the interviews, tutor reflections and observations.

9.8.4.1 STUDENT EVALUATION OF COLLABORATION

The posttest questionnaire included a number of questions that involved collaboration i.e. stating how interesting, fun, difficult was working with others, what students learned about working with others, if students worked as a team, worked alone, if they were bored while working as a team if they felt that they were good at listening and if they helped someone:

QUESTION	AGREE	NEITHER	DISAGREE	NO RESPONSE
Working as a team was				
Interesting	26	0	0	
Difficult	5	2	19	
Fun	25	0	1	
I worked as part of a team	24		1	1
I worked on my own		1	24	1
I was good at listening	23	2	1	
I helped someone	19	5	2	

Table 3. Overall student responses on post test about collaborative work

The presentation of results in table 2 shows that all students found teamwork as interesting and 25 students out of the 26 found it as fun. One student did not found collaboration as fun activity and this response will be further analyzed next. Most of the students (19/26) found teamwork as a not difficult activity and only 4 students identified difficult challenges in it. In a further investigation of the specifics of collaboration, most of the students stated that they worked as part of a team (and thus they did not work on their own) they were good at listening and that during the workshop they helped someone. In the table below we present the answers in the above questions per student in order further investigate some individual cases which deviate from the main trend:

		WORKING AS A TEAM WAS:							
STUDENT CODE	**SEX**	**Interesting**	**Difficult**	**Fun**	**What have you learned about working with other people?**	**I worked as part of a team**	**I worked on my own**	**I was good at listening**	**I helped someone**
21247	boy	4	1	5	That we have to help each other.	5	2	5	5
21231	girl	5	4	5	That we have to help each other.	5	3	4	5
21248	girl	5	3	5	That it is interesting and fun.	5	1	5	4
21241	girl	5	5	5	That it is fun to work in a team.			5	5
21235	girl	5	1	5	That it is very fun.	5	1	5	1
21093	girl	5	1	5	That I have to work in a team.	5	1	5	3
21251	girl	5	1	5	We help each other.	5	1	5	4
21239	boy	5	4	4	It is hard.	4	1	4	4
21230	girl	5	2	5	It is really nice.	4	2	4	3
21245	girl	5	2	5	That it is merrier with other people than by ourselves.	5	1	5	3
21229	girl	5	2	5	It is really interesting.	5	1	5	5
21240	girl	5	2	5	That it is very fun to work with them.	5	1	4	3
21243	girl	5	1	5	It is fun.	5	1	4	5
21242	girl	5	1	5	That it is in fact very fun.	4	2	3	2
21256	girl	5	4	5	That I can work in a team.	5	2	5	4
21253	boy	5	1	5	That teamwork is interesting.	5	1	4	4
21232	boy	4	1	5	That we have to listen to each other.	5	1	5	5
21255	boy	5	2	5	It is nice.	5	1	5	5
21252	boy	4	1	5	It is interesting.	5	1	4	3
21254	boy	4	2	4	Teamwork is good.	5	2	4	4
21246	boy	5	1	5	It is interesting	5	1	3	5
21238	boy	5	1	1	(not understandable)	1	1	1	5
21244	boy	5	3	4	To programme	5	1	5	5
21237	boy	5	2	5	That it is important	5	1	4	4
21249	boy	5	2	5	It is easier.	5	1	4	4
21250	girl	5	2	5	It is great.	5	1	4	4

Table 4. Posttest: Responses about collaboration per student

A close look at the table above allows us to observe the following: the student who rated teamwork as not fun at all was one of the focus group boys who however, gave some conflicting answers next: he said that he did not worked as part of a team (1: strongly disagree) but he also did not work on his own (I worked on my own: strongly disagree) which indicate that he might have not used appropriately the rating scale or that he was not that concentrated while completing the questionnaire.

Three of the five students who found the collaboration difficult marked with high scores their experience and their collaborative skills. Specifically, girl (21231) the focus group girl (21256) who found it difficult to work as part of a team (Score: 4) gave high scores to the other questions about teamwork. A similar picture is also drawn for boy 21239 who not only stated that collaboration is difficult but he also described it as the lesson learned for team-work. These results are not discouraging because they show that students acknowledged the challenges of collaboration however, they are able to work as part of a team (which includes being a good listener and helping each other) and they find the experience interesting and fun. A similar case is the girl (21241) who addressed collaborative work as very difficult (strongly agree:5), she gave a 5 score to all the other questions that involved the team work however, she did not respond at all to the questions that asked if students worked on their own or as part of a team which is not easy to explain according to the data we have at our disposal.

A critical view of the student responses on the question involving the lessons learned about working with others shows that there are two main categories of responses: one that focuses on student attitudes towards collaboration which is based mainly on their experience and the other that focuses on something like a main rule. The first category involves answers: it is interesting, it is fun, it is great it is easier and the second category includes answers like we have to help each other we have to listen to each other. There is one student who stated that working with others is important.

All these responses to the open question and the student rating of the collaborative experience show that the workshop contributed in creating a positive attitude towards collaborative work, revealed to a student its importance, and highlighted some important rules for collaboration (listening to each other and helping).

9.8.4.2 ROLES AS DOMAINS OF RESPONSIBILITY

The organizers of the workshop had foreseen specific roles, which were described to the students in the rule-book that was given to them at the beginning of the workshop (see Fig 17 which demonstrates the part of the rules that involve teamwork) The roles foreseen for the students of each group according to the activity plan were the following: a) person who writes the code b) person who makes sure rules are followed c) person who holds the cable and helps with the code d) person who makes sure that everything is correct and reads the game task. Students were expected to change roles when a subtask of a game was completed. The tutors made sure that students shifted roles during the first session of the workshop. In the second session students were left alone to undertake the responsibility of changing roles according to the rules.

Fig. 17. Workshop rules for collaboration

The analysis of the video data showed that the focus group followed the specific distribution of work.

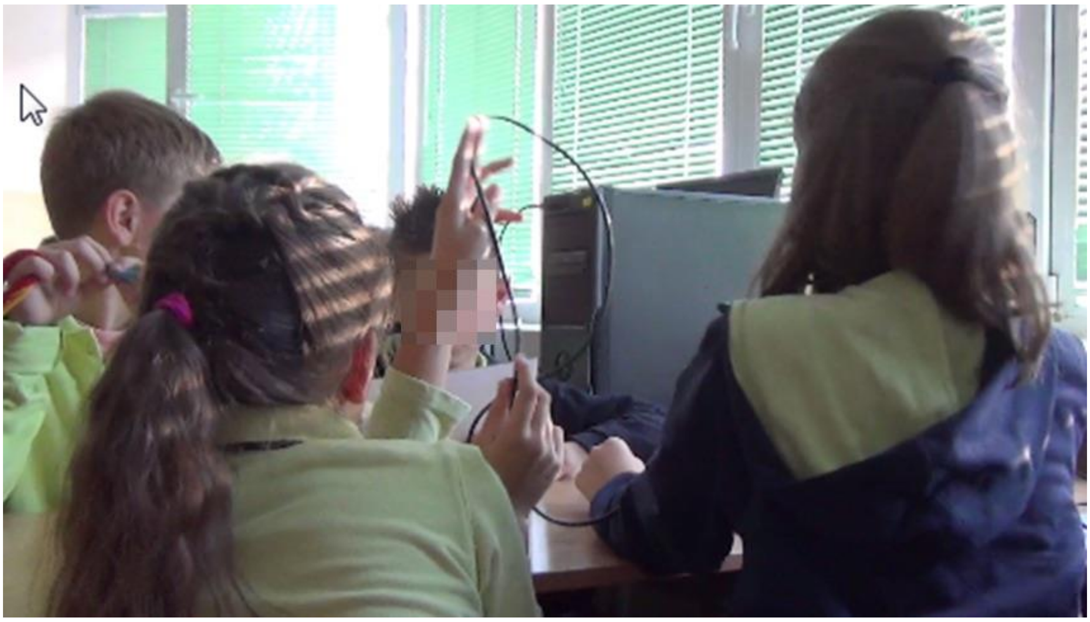


Fig. 18. Distribution of roles in the focus group

In the picture above we can see one student holding the cable and another student (C1) holding the card with the task description, which he was supposed to read to the group. Our observation of the video data which, come from the first session, showed that group members engaged actively in the main task, which was the programming, although they had other roles (see fig 19).

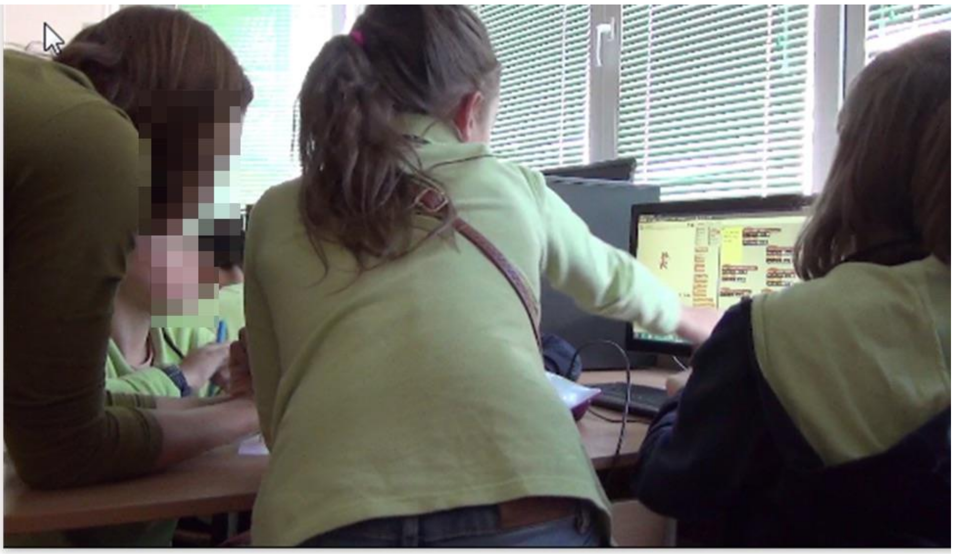


Fig. 19. Contributing actively to programming while holding other roles

In the picture above we observe that the girl who was holding the cable seems to contribute actively in the process of programming as she is showing something the group has done to the tutor. Of course in the description of roles the "cable person" was expected to help with the code a similar stance was held by C3: observing, contributing with comments, even typing something on the computer, reading the task checking the task against the program etc. Based on these data we assume that group students do not see only boundaries in the roles assigned to them i.e. restricting their activity and resulting in co-operation instead of collaboration. Instead they see the roles assigned as the domains of their responsibility while they actively contribute to the main task of the group. Roles as domains of responsibility (instead of boundaries of activity), is a collaboration model, which allows for co-construction and active contribution of all group members towards the common goal. Furthermore the design of the tasks where one task builds on the previous in a sense required such attitude because the person who would do the programming next should understand what the group did before. Our suggestion is that the roles as domains of responsibility instead of boundaries of activity should be explicitly discussed with the students so as to all engage in co-construction instead of co-operation.

However, roles were not always interpreted as domains of responsibility and students either devalued some roles, which were not that active (like holding the cable) or they held on one role and they wouldn't change. C1 who joined group 2 in the second session mentioned in the interview the example of a student who wanted only to read the task. The other members of the group prompted him to engage more actively and do at least one subtask but he wouldn't change his mind. The group decided to let him read. In this case the student seems to "hide" behind a specific role, which is not very demanding and does not result in exposure (fail with the program) or failure. The fact that this role was not that crucial for the group like the role of the person responsible for the programming, did not result in serious conflict as it happened with the case where one student devalued one of the roles he was having (see next session).

9.8.4.3 CONFLICT

The focus group faced a challenge, which was connected to the division of labor between the members of the group. Specifically, one of the tutors reported that student 1 (C1) could not fit in the group and was fighting with the other male member of the group (C3). The result of this situation was that C1 went to another group (group 2) to work at some point during the first session and in the second session he left completely the group and he was replaced by another student. Thus in the second session the group composition changed also gender-wise as there were now 3 girls and 1 boy in the group (in the first session there were two boys and two girls).

> *However, our target group was fighting and 21237 (C1) left to work with group 2 at one moment. They were fighting with 21238 (C3) but this year, 21237 was not that much into this and eventually left.*
>
> *…*
>
> *For some reason, this is one of the few student groups I remember from last year and they made a very serious impression to me. I was really proud in a way to be working with them again and I was really sad to see that they fell apart and the boys were fighting.*

Extract 3

Observation notes, researcher

We mentioned at the begging of this report that the groups were formulated following the same synthesis from the first year. The researcher in her notes, points out that in the first year workshop the specific group had worked very well together. What happened during the second year in the group shows that collaboration is a very challenging process and what works in a specific setting might not work in another. Her interpretation for this situation focuses mainly on C1 who did not seem to be that engaged with the task the second year and as a result did not fit well with the specific group. In the limited video data we have available of the focus group the camera capture a moment of C1 being off task.

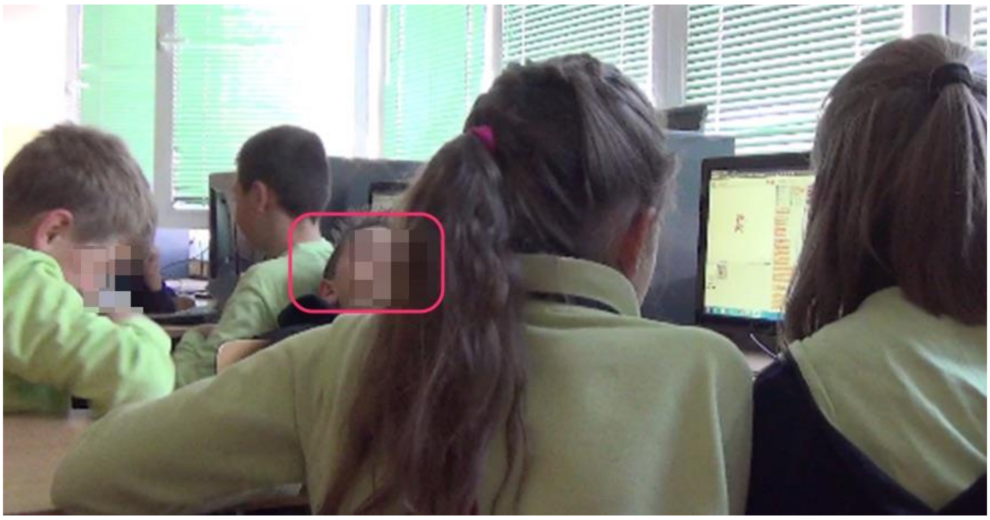


Fig 17. Camera capturing C1 off task

However the student chose another group to work with (Group 2) but there is no data from his collaboration with the other group. In case that C1 managed to work better in another group the engagement with the task might not have been the problem in the collaboration with his first group. The problem of collaboration was discussed between the researcher and all five members of the focus group (including C1) in the post workshop interview.

> *Interviewer: You guys were one team before, why did you split up today? Answer, by raising your hand, please.*
>
> *C1: I left, because most of the time I just held the cable.*
>
> *C4: Not true.*
>
> *C1: I hardly did anything.*
>
> *Interviewer: So, you think you worked less than everyone else? [Other kids start talking at the same time] OK, ok, will you tell me why you think your team split today?*
>
> *C3: I think there are lots of reasons. I think (inaudible 0:38)*

Focus group Interview

Extract 4

The reasons C1 gave for leaving the group was that he worked in a role that he considered less important in terms of contribution. "*Most of the time I just held the cable … I hardly did anything*" His comments show that he had devalued the role of holding the cable. C4 who was not the one C1 was fighting with challenged his response. However the data we have do not offer sufficient information on what the rest of the group thought about the conflict with C1 as after the comment of C3 that there were lots of reasons another question followed about how conflict can be handled in the group. Furthermore, the structure of the workshop foreseen that students would take turns in the different roles and thus the one who was holding the cable would do this for only one task. Especially in the first session tutors reminded the groups to change roles when they moved on to the next task. Another situation that might challenge C1s response is based on the analysis we made on the roles in the previous section. Specifically, students would contribute, by observing commenting, in the process of programming which was the main focus of the activity although they had a different role (e.g. reading the task or holding the cable). The interviewer later on asked the new student who replaced C1 how did she find her collaboration with the group

> *Interviewer: Did you like working in this group?*
>
> *C2: Yes, a lot.*

Interviewer: Was it better for you, then the last session?

C2: Yes.

Interviewer: They let you work?

C2: Yes, they do.

Focus group Interview

Extract 5

C2 in her discussion with the interviewer shows that she did not have with the group the same problem with C1, i.e. being stack with a devalued role. On the contrary C2 mentions that she enjoyed working with the group and she did not have any problem in contributing in the group. Her comments show that in the group there was not an established relationship, which excluded one or more members from contributing. However we need to consider here that the tasks in session 1 and session 2 were different (more advanced in session 2) and C1's feelings might not be invalid as in the first session the group had to adjust in the pre-defined collaboration model.

9.8.4.4 REGULATION OF COLLABORATION

The conflict between C1 and the rest of the group became one of the discussion topics in the interview. Specifically, the researcher apart from asking students what actually happened she also asked them what is the best way to address conflict in a group. Students gave different answers as strategies to regulate the behavior of the group members so their collaboration is functional:

Interviewer: What do you usually do when you have a conflict in the group? When you get in a fight, how do you get over it? What do you do? Everyone give me a piece of advice, what should I do when I get in a fight with a co-worker or what do you do to end a fight amongst yourselves? What's the best advice you can give?

C1: Don't pay attention to him.

C5: Give him what he wants. Let him work.

Interviewer: Don't you think I won't get to work that way? Maybe I want to work too.

C5: You go after that person.

Interviewer: You mean take turns?

C5: Yes.

C4: Make up.

Interviewer: How do we do that? If we had a big fight, what should we say to each other?

C4: I'm sorry. Do you want to work together? And you offer this to the person that's most disgruntled with you.

C3: The smarter one always backs down. I think so.

Interviewer: Why?

C3: Because the smarter one can make a better decision.

Interviewer: And the better decision is to back off?

C3: Yes.

Interviewer: Even when it's something you're strongly convinced about.

C3: Yes.

C2: Listen to them, so you can understand what the problem is and then forgive them or apologize. The other person should do that as well.

Focus group interview

Extract 6

The students in the group propose different strategies of re-balancing group work when conflict emerges. So C1 who left the group suggests that a solution to conflict would be to ignore the “troublemaker”. This suggestion implies that the problem is with the person not with the group and is a strategy quite often followed in classes and families as the behavior is interpreted as an attempt to attract attention. If the person does not get what he/she wants by causing trouble then it is expected that the conflict will cease.

Another approach offered by C5 is to back down to the requests of the person that creates a turbulence in the group. C5 refers to the specific situation encountered in their group i.e. C1 complaining that he did not have a contributory role in the group. Thus the suggestion she makes is not a general rule but a way to address the specific situation. So the idea is to back down and let the other person work. She further explains her position after a prompt by the researcher by saying that she would use turn taking and specifically she would give her turn to the person who wanted to work more. This clarification shows that C5 suggest an arrangement that makes use of the collaboration rules (turn taking) in order to bring a balance in the group without in essence violating the rules (leaving C1 to take complete control).

Backing down is brought in the discussion by the other boy of the group C3. C3 refers to backing down as a general strategy and not as a strategy adapted to the situation (as it happened with C5). Furthermore, C3 presents backing down not as a group strategy but as a personal attitude towards the other and he connects this attitude to the intellect of the person (the smart one backs down). Interestingly enough the student insists that backing down is the best solution even if the other person is convinced that he/she is wrong. This concept of collaboration seems that it does not take into account the outcome of the group work -you back down to someone who has created a conflict in order to bring a balance in the group even this might cost to the productivity of the group. Interestingly enough this solution is offered by C3 who according to the tutor argued quite often with C1 during the first session. This means that C3 did not actually follow the suggestion he made here.

C2 who was the newcomer in the group focuses on listening to the other person. Learning to listen to the other and trying to understand the problem is a functional strategy in collaboration especially when individuals with very different personalities are involved. C2 seems to offer the most mature suggestion for balancing again collaborative work. On the other hand, she seems to address conflict as something that should not happen in the group and that is why she introduces friendship norms: both members apologizing but only one of the two should listen to the other.

It might be useful to investigate next year the role of disagreement in the group work, design to bring into the foreground its productive nature and elaborate on strategies- like listening, offering convincing arguments, testing different solutions- that can support its productive use. The investigation of alternatives (i.e. trying out different solutions) and the adaptation of different viewpoints (C5), was mentioned later on in the interview when the researcher asked for the most important qualities in collaboration:

Interviewer: OK and what do you think is the most valuable quality, when working with other people?

C2: To listen to everyone else. (Stops, remembers to raise hand and repeats.) To get along and divide the work equally.

Interviewer: OK, anyone else?

C5: To give good ideas how things could work. For example we put a few (inaudible 6:55) and it doesn’t work. Then someone else tries it their way and it works. Finding different ways to make things work properly.

C4: When you're angry you shouldn't look for fights with everyone else, give a reason why you're angry and the others will listen to you and make the necessary changes.

Interviewer: Good point.

C5: And if someone doesn't have anything to do, the others should give him something to work on. (inaudible 7:43-7:55) (all laugh at C3 playing with the robot).

Focus Group Interview

Extract 7

We integrate the discussion of important qualities in teamwork, in the section about ways of regulating collaboration because student responses are in essence strategies of ensuring a smooth collaboration. So here apart from the exploration of alternative solutions as a means of resolving disagreement (if there is one), students stress the importance of listening to each other, explain feelings of distress when they emerge (feeling angry) instead of picking a fight and wise division of labor. An interesting observation here is that C5 addresses division of labor as a responsibility of the group, which has to ensure participation of all its members towards the common goal.

Student responses in the interview show that: a) division of labor is a good structure for team work, however it is important in constructionist work that this does not turn into cooperation where one does his/her bit without being involved in the whole team project; b) Students have a knowledge of strategies that could employ in the context of collaborative work – like listening to the other but they do not elaborate on how this can be done (active listening in team work might mean asking elaboration questions, or asking for convincing arguments etc); c) Students seem to have a negative attitude towards disagreement and they do not acknowledge its productive side d) Students seem to bring in collaboration norms from their friendship relationships and family (like apologizing, ignoring the troublemaker etc).

9.8.5 Gender

Our data do not contain information about issues related to Gender

9.8.6 Resilience

Resilience in the specific workshop is based on an overview of the student responses in the posttest questions that involve mainly the student responses about the effort they had to put, their attitude in difficulties and their evaluation of the workshop as boring. The latter question is not directly related to resilience but it can provide some explanation for giving up quicky and that is why it is included here.

During the workshop…	AGREE	NEITHER	DISAGREE
I gave up quickly	0	1	25
I worked hard	22	2	1
I was bored	1	1	23

Table 5.Student responses on questions related to resilience

In the table we can see that almost all of the students who completed the posttest questionnaire feel that they did not give up easily. Only one student offered an intermediate answer. Similarly the majority of the students (22/26) stated that they worked hard with only one student disagreeing and with two students situated between agree and disagree. We consider these responses encouraging in relation to the contribution of the workshop in fostering resilience. Our interpretation is that the workshop offered opportunities to the students to engage in tasks in which they had to work hard to achieve their final goal. Furthermore, hard work was integrated in a context – group work, an attitude of helping each other instead of competing, structured activities with gradual difficulty- that supported students to not give up and insist until they achieve their goal.

9.8.7 Attitude towards STEM

Student attitude towards STEM is based mainly on data that are drawn from the pre and posttests and from the questions that involve student statements about subjects related to science and maths as well as their statements on their future professions.

STATEMENTS	AGREE	NEITHER	DISAGREE
I like using computers	28	0	0
I like science	25	2	0
I like maths	23	3	1
Math is easy	20	4	4
Maths lessons are boring	7	3	18
I have fun in maths lessons	20	6	2
Maths is important	27	0	1
My teacher says I am good at maths	25	2	1
I have to work on my own in maths	16	3	9
I am good at maths	24	3	1
My friends are good at maths	20	8	0
	YES	*NO*	
Would you like to study maths when you are older?	*19*	*5*	
Science is easy	18	5	4
Science lessons are boring	4	5	18
I have fun in science lessons	21	4	2
Science is important	26	1	0
My teacher says I am good at science	17	9	1
I have to work on my own in science	11	12	4
I am good at science	21	5	1
My friends are good at science	20	7	0
	YES	*NO*	
Would you like to study science when you are older?	*21*	*6*	

Table 6. Pretest: Student statements about STEM

In the first part of the table we observe that all students stated that they liked computers (28 /28) whereas some more students like science (25) in relation to mathematics (23). In the statements about mathematics there was one student who claimed that he/she does not like mathematics.

In the more detailed exploration of student attitudes towards mathematics almost all students think that mathematics is important (27/28) and only one student disagrees. Similar is the situation in science. The majority of the students state that they are good at maths, according to their opinion (24 students) and according to their teacher's opinion (25 students). However, in science there is an interesting discrepancy between student and teacher opinion about achievements in science. Specifically more students believe that they are good in science whereas their teacher does not have the same opinion. This is an interesting observation to be further explored as it might be related to the evaluation system used or to students find a personal interest in science, which is not assessed in school.

A large proportion of the students (2/3 i.e. 20/28 students) consider that mathematics is easy and fun, they have friends who are also good in mathematics and they say that they would like to study mathematics when they are older (19/28). Similar is the situation in the statements about science.

An interesting observation in the table above is that more than half of the students agree that they have to work on their own in mathematics. In the statements about science the situation is different: less than half of the students believe that they need to work on their own in science projects and an almost equal number does not have a preference and only four students disagree. In an attempt to interpret this statement we need to consider the school culture, the epistemology around mathematics and science (i.e. how they are taught) and the type of problems students are engaged with. For example mathematical problems with only one solution, which have the form of exercises tend to have a competitive character, which requires individual work. On the other hand science projects where students engage in an experiment, explore a concept or construct something is closer to a collaborative way of work.

We mentioned earlier that indications about student attitude towards STEM are also drawn from student statements about their future professions in the pre and posttests. In the table below we present juxtaposed these statements indicating if the profession is related to STEM and if there is a shift in student statement.

STUDENT NUMBER	SEX	In the future, what job would you like to do?		STEM	SHIFT
		PRE TEST	POST TEST		
21093	girl	I still don't know.	I don't know	N	N
21228	boy	A hockey player		N	N
21229	girl	A photographer	A photographer.	N	N
21230	girl	A vet	A vet	Y	N
21231	girl	A gymnast	A lot of things	N	N
21232	boy	A researcher	A researcher or a programmer.	Y	N
21233	boy	A programmer	ABSENT	Y	N
21235	girl	A dentist	A dentist	Y	N
21236	girl	A dentist	ABSENT	Y	N
21237	boy	An architect		Y	N
21238	boy	Auto repairman		Y	N
21239	boy	A football player		N	N
21240	girl	A singer		N	N
21241	girl	A gymnast	A gymnast	N	N
21242	girl	A singer	A singer	N	N
21243	girl	A dancer	A dancer	N	N
21244	boy	A football player	A football player	N	N
21245	girl	A teacher	A teacher	N	N
21246	boy	A programmer	A programmer	Y	N
21247	boy	Pilot	A pilot	Y	N
21248	girl	A designer	Designer	N	N
21249	boy	ABSENT	A doctor	Y	N

21250	girl	A vet	A vet	Y	N
21251	girl	An architect	An architect	Y	N
21252	boy	A football player		N	N
21253	boy	A football player	A football player	N	N
21254	boy	A mathematician	A mathematician.	Y	N
21255	boy	A researcher	A programmer	Y	N
21256	girl	A culinary chef	A pastry chef	N	N

Table 7. Student responses on future professions in pre and post testing

I the table above we can see that 13 out of the 28 students expressed their interest in a STEM related profession in a broader sense (including professions like architect, doctor, vet, car repair etc). The numbers in the posttest are a little bit different. Specifically, less students (10 students out of the 26) express an interest for a STEM related profession however, this is due to the fact that 2 students who stated STEM related professions were absent and six students did not give an answer in the post test. In this group of students there is no shift observed in the student statements from a non-STEM profession to a STEM related profession and vice versa. Even though there are no changes in student statements about their future professions we have to say that the specific class expresses a high interest in STEM which is apparent not only in the number of STEM related professions (almost half of the students) but also in student statements about their relationship to STEM subjects in the school: the majority of the students finds science and mathematics important, fun, they state that these are subjects they would like to explore further, and they feel that they are good at these subjects. These high percentages in student interest for STEM have to be considered in relation to the fact that students participate in the robotics workshop for a second year. In the light of this observation we can assume that the workshop might have played a role in cultivating a positive attitude towards STEM in the specific students.

9.8.8 Student evaluation of the workshop

Students' opinion about the workshop was captured in the posttest questionnaire where they evaluated the workshop using a 1 to 5 stars scale, and in an open question justified their score.

STUDENT NUMBER	SEX	HOW MANY STARS	BECAUSE:
21247	boy	4	Because I want to work on my own.
21231	girl	5	Because it was interesting.
21248	girl	5	It was very interesting and fun and I want to program robots because they are fun and interesting.
21241	girl	5	
21235	girl	5	It was fun.
21093	girl	5	It was fun.
21251	girl	5	It was fun and interesting and I learned a lot of new things.
21239	boy	5	It is fun.
21230	girl	5	It was really nice.
21245	girl	5	It was fun.
21229	girl	5	They taught us a lot of things.
21240	girl	5	They taught us something.

21243	girl	5	It was fun and interesting.
21242	girl	5	Because I liked it a lot. It was fun.
21256	girl	5	It was very fun and the teachers were good.
21253	boy	5	It was very interesting.
21232	boy	5	
21255	boy	5	It is fun.
21252	boy	5	
21254	boy	5	It is very interesting.
21246	boy	5	
21238	boy	5	
21244	boy	5	It is very fun.
21237	boy	5	
21249	boy	5	Because it is fun.
21250	girl	5	It is fun, interesting and exciting.

Table 8. Posttest questionnaire- Student likert scale evaluation of the workshop

In the table above we can see that 25 out of the 26 students gave 5/5 stars to the workshop. Only one student gave the workshop 4 stars. If we look at the justification question (next to the scoring) we will see that this boy was mainly troubled by the context of teamwork as he stated that he preferred to work alone. The rest of the students justified their score based on how the experienced the workshop i.e. saying that it was interesting, fun, exciting and nice. A smaller number of students (3, all girls) added to this experience the dimension of learning new things. These results are very encouraging for the quality of the workshop because students considered it as an interesting, fun activity which offered opportunities to learn new things and challenged some of the students to move out of their comfort zone (student 21248 who stated that he prefers to work on his own).

9.8.9 Discussion

The overall experience of the workshop was highly scored by the students (5/5 stars) who considered it (i.e. the workshop) as fun and interesting and as context where they learned new things. In this report we further elaborate and analyze this experience based on the analysis of the pre and post questionnaires, the video data, the observations and reflections of the tutors and the interview of the focus group. Our analysis highlighted the following aspects: the characteristics of learning engagement, the model of collaboration developed, resilience student attitude towards STEM and the overall evaluation of the workshop from the side of the students.

Learning engagement:

The overall evaluation of the learning experience by the students in the posttest questions showed that students gained a rather concrete and accurate knowledge about robots (what they can do and what are their characteristics) although some responses were too general. Furthermore, when it came into what students learned about themselves, half of the students focused on skills they gained from the workshop (e.g. I can program I am good with robots etc) and a smaller but considerate number of students (6 out of the 28) referred to collaborative work (e.g. I can work in a team, I better work in a team etc). These results offer indications for a positive contribution of the workshop towards supporting students to gain confidence in STEM related tasks and to appreciate the importance of collaborative work in complex tasks such as robotics. The analysis of mid point student reflections showed that one of the groups identified elements of art in the tasks they were assigned and they were excited with their achievement to produce purple light by mixing other colors. A further analysis of student constructions based mainly on video data and on analysis of the tasks, showed that students followed an interative construction process which involved programming, testing the robot behavior, analyze feedback, revise and check the program against the requirements of the task. Students needed to consider in their programming the functionalities of the Finch robot (sensors, way of moving etc) although the workshop focused mainly of programming and there was no robot construction activity as in the workshop for year1. Student engagement with programming involved if then structures and basic loops with repeat. When it comes to domain knowledge our analysis of the task showed that students probably used already existing mathematical knowledge and they did not learn something new apart from the instruments of angle measurement (based on the focus group interview). Based on this analysis the robotics workshop demonstrated a balance between acquiring some new knowledge in programming and applying existing knowledge in mathematics. Furthermore, this might be the reason (applying existing knowledge) that students did not consider mathematics as the main learning outputs of the workshop or as one of the greatest challenges or achievements in their mid point reflections.

Collaboration

The analysis of collaboration was mainly based on the interview data and the posttest questionnaire data. Student responses to post-test questionnaire showed that that the workshop contributed in creating a positive attitude towards collaborative work, revealed to a student its importance, and highlighted some important rules for collaboration (listening to and helping each other).

In the activity plan implemented in the year 2 workshop, the organizers had foreseen specific roles for each group member and helped students during the first session to change roles in each subtask. This configuration allowed us to observe a situation of functional collaboration where students perceived the roles as domains of their responsibility which allowed them to participate in the main activity (co-construct) and it did not restricted them only in the activity they were assigned with.

A conflict that emerged in the focus group with one student complaining of being stuck with the same role brought in the fore ground different student strategies about regulating collaboration. Specifically, analysis of the interview data showed that: a) Division of labor is a good structure for team work, however it is important in constructionist work that this does not turn into cooperation where one does his/her bit without being involved in the whole team project; b) Students have a knowledge of strategies that could employ in the context of collaborative work – like listening to the other but they do not elaborate on how this can be done (active listening in team work might mean asking elaboration questions, or asking for convincing arguments etc); c) Students seem to have a negative attitude towards disagreement and they do not acknowledge its productive side d) Students seem to bring in collaboration norms from their friendship relationships and family (like apologizing, ignoring the troublemaker etc).

Resilience

The analysis of resilience is based only on two questions of the posttest questionnaire, which involved hard work and insisting on your effort until you reach your goal. The majority of the students stated that they worked hard during the workshop and that they did not give up quickly. Our interpretation is that the workshop offered opportunities to the students to engage in tasks in which they had to work hard to achieve their final goal. Furthermore, hard work was integrated in a context – group work, an attitude of helping each other instead of competing, structured activities with gradual difficulty- that supported students to not give up and insist until they achieve their goal.

Attitude towards STEM: The analysis of student attitude towards STEM was based on the pretest questionnaires about student preferences in STEM and a comparison between pre and posttest questionnaires about student future jobs. More specifically, students showed in general a positive attitude towards STEM as the majority of students (2/3) stated that they like mathematics, sciences and working with computers. A majority of the students stated that they would like to study Sciences and Mathematics when they are older.

Although these results come only from the pretest we have to consider that the specific students participate in the robotics workshops organized by ESI-CEE, for a second time. Thus their engagement one year before with robotics might have contributed in the high percentage of positive attitude towards STEM. When we juxtaposed student preferences for future jobs we did not observe a change between the pre and posttest. However, it can be considered as a positive result that almost half of the students who completed the questionnaire where interested in a STEM related job.

Best practices- focus of attention for the next year:

- The additional challenges offered in each task was a good idea to balance the different group learning styles in a workshop.
- Offering basic examples that could be expanded and modified was a good method to help students to think about – in a structured way- how to work with the program and not not just repeat the example by simply changing the values of the commands
- Modifications of examples which were used in the activity: a) modifying values (e.g. make the 3 seconds 1 second) b) combining in new ways known commands (e.g. instead of attributing one type of movement in one keyboard key, they attribute a series of actions in one key) and c) transferring the use of a command in a different situation (instead of moving for 3 seconds to stop for 3 seconds)
- Our analysis showed that the concept of support should be further analyzed and clarified so that it is not considered by the tutors and the students as something that should not be happening
- Design for disagreement: Students seem to consider disagreement as an abnormal collaborative situation and they bring in norms from friendship and family to balance team work again which in some cases impedes the productive power of disagreement to unfold
- Roles as domains of responsibility instead of roles as barriers of activity: Distribution of roles is functional within the groups, however it is more productive if all students engage in the activity which is the focus of the task (e.g. programming) and they all participate in it (co-construction instead of co-operation)

9.9 APPENDIX I: AUSTRIA CASE STUDY 1

9.9.1 Context and activity plan

In this case, we investigated the “ER4STEM Workshop Robot Video” in Austria in which the main content was robotics. This activity plan was designed for children aged 13 and 14 years old, including children with no prior knowledge of robotics or programming. However, 14 female students who participated had prior experience building a robot as part of a workshop activity.

The subject-related objectives were as follows.

Technology related:

- Using a robot and proper employment of its functions.
- Using a camera.

Business related:

- Making a video with a given amount of time and resources.

Engineering related:

- Solving several assigned problems given specific constraints related to making the video.

Arts related:

- Telling a story in a video.
- Developing a design for the robot.

Further objectives related to social skills included the children being instructed to collaborate and organize the necessary exchange of information on their own.

Twenty-three students aged 13 or 14 years old—17 girls and 6 boys from a secondary school—participated in the workshop. The primary language of students are german, but some students spoke a second language at home: Turkish, French, Persian, Greek, Serbian, or Bosnian. Fourteen female students had previously built a robot as part of a club activity. Two male tutors from the university and one teacher from the school oversaw the workshop and supported the students during the activity.

The workshop took place at the university, during regular school time, and was conducted in a computer lab with 12 computer stations. Each station included a mouse, a computer monitor, a keyboard, and a Thymio robot. Working in pairs or groups of three students, the participants shared a monitor and the computer software. In the front of the room were a blackboard and a whiteboard with a projector.

The duration of the workshop was six hours consisting of two phases of three hours each. In the first phase, the students read the exercises at the computer and completed the first one on paper.

Phase 1 was called knowledge/skills acquisition. In this phase, collaboration was not necessary. Instead, instruction of technical functions about the Thymio robot. The focus was on 21st century skills, such as creativity and critical thinking. The teaching method was instructive.

The students chose their own working partners and followed the exercises on the computer by reading the instructions and working with Thymio together. They learned the functions of the robot in step-by-step fashion, including how to program the robot with the program Aseba.

The students covered six exercises in this phase: (You can find details in delivery 4.1)

- Exercise 1 – Measurements with Thymio
- Exercise 2 – Drive through maze
- Exercise 3 – Start stop event
- Exercise 4 – Stop at table edge
- Exercise 4 – Avoid obstacles
- Exercise 6 – Reach point

The children learned what a sensor is and how it reacts, how to write a program, and how to work in a group. The learning arrangement alternated from the instructive teaching method to constructive, then back again. To begin, the students were given instructions on paper, after which they tried in their pairs or groups to write a program and use their robots. The students' previous knowledge was how to use a computer and handle a measuring tape.

Phase 2 was called making a video. In this phase, the students were assigned to one of two different groups. Each group included three subgroups: a technician group, a design group, and a regie group. The technician group was responsible for programming the robots. The design group was responsible for designing the robots as well as the background and arena in which the robots would move. The regie group was responsible for coordinating the technical and design groups, including managing their time, making the video, and coordinating the story. The 21st century skills focus was collaboration, teamwork, and communication, all of which are necessary to arrive at a positive result. The teaching method was constructive in this phase.

9.9.2 Observations

The position of the camera was in front of the students on the right-hand side of the blackboard. As a result, it was difficult to observe the last row of students. In the following description, all positions are explained from the point of view of the focus camera, which was aimed toward the back of the room (see Figure 1: Seating Chart).

PHASE 1

At the beginning of the session, the students concentrated on filling out their pre-questionnaires. Next, a tutor explained that the students needed to find their own working partners and take a seat at a computer station. After each pair or group was formed, one member of the group had to come to the tutor to get one robot and the instructions. When given permission, the students began to choose their partners.

The teacher at the school who was supporting the workshop went around the room and helped the students form their working groups. Initially, seven groups of three students and one group of two students were formed. Ultimately, the students formed into five groups of three students and four groups of two students. Only one group included mixed genders (see the right-hand side of the first row in Figure 1: Seating Chart).

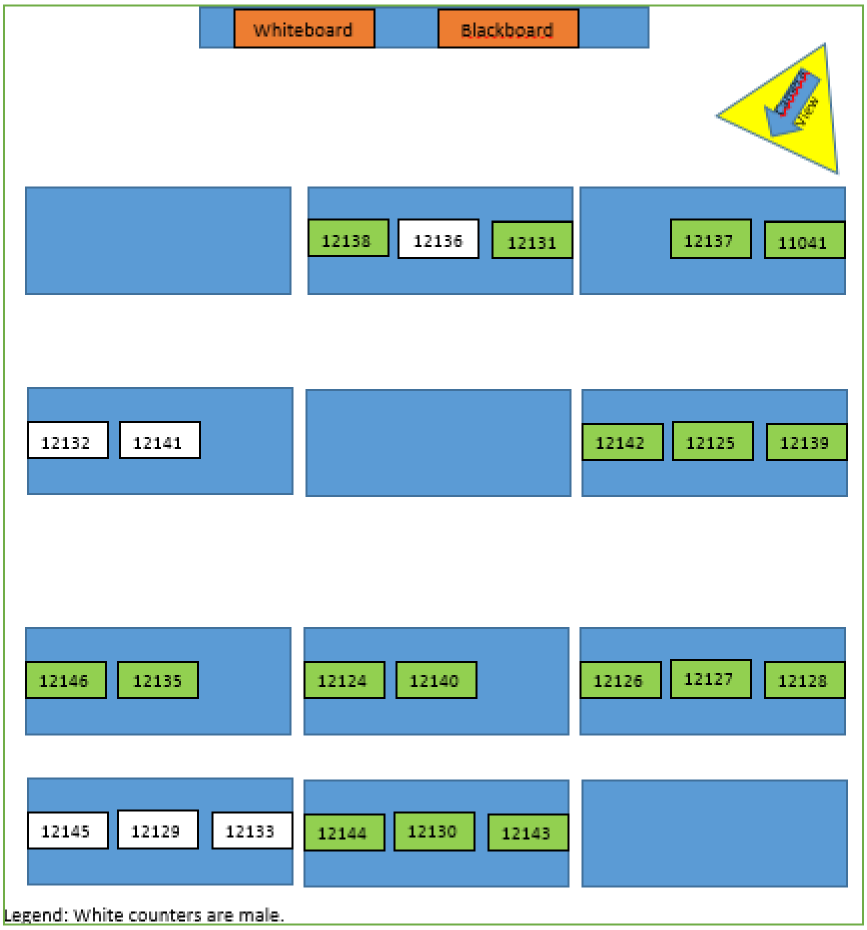


Figure 5: Seating Chart

At permission from a tutor, the students started their computers and read their first exercise on paper. The next exercises were presented in PDF format on the computers. When some students did not understand an exercise, they asked for help from the tutors. The observations indicated that the students worked together and switched between reading the instructions on the computer and doing the activities with the robot. The teaching methods switched from instructive to constructive during this part of the phase.

In this first phase, the groups worked on the computer and with the robots. Figure 2 shows the robots in action during exercise 2. This exercise was called “drive through maze.” Students 12137 and 11041 programmed this robot.

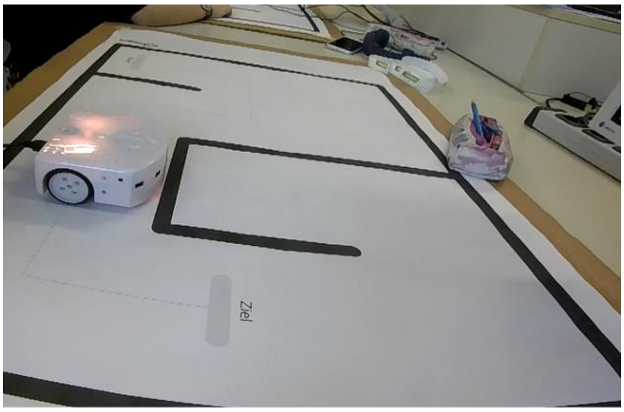


Figure 6: Activity during exercise 2.

The students learned at their own pace as a group how to program the robots, which could be considered independent working. The observations indicated that, after some time had passed, the groups were working on different exercises. For example, in Observation_TUW_01022017_00168 at 20:57, the group on the left-hand side of the first row was working on exercise 2, while the group next to them was working on exercise 3.

At Observation_TUW_01022017_00170 at 0:26, student 12131 was resting her head on the table, and student 12136 was yawning, indicating that, at this point, the students were tired from the exercises.

The end of part 1 can be seen at Observation_TUW_01022017_00170 at 1:30, indicating that the students were finishing part 1 after 180 minutes. Thus, the action was based on the activity plan.

PHASE 2

The tutor split the students into two main groups. Each group had three subgroups: the technician group, the design group, and the regie group (see Tables 1 and 2).

Table 1. Subgroups in Group 1.

Group 1		
Technician group	**Design group**	**Regie group**
F; 12124	F; 11041	F; 12131
F; 12125	F; 12137	F; 12138
M; 12132	F; 12140	F; 12139
M; 12136		
M; 12141		
F; 12142		

Table 2. Subgroups in Group 2.

Group 2		
Technician group	**Design group**	**Regie group**
F; 12127	F; 12130	F; 12126

M; 12129	F; 12143	F; 12128
M; 12133	F; 12144	
F; 12135		
M; 12145		
F; 12146		

The regie group was responsible for coordinating the design group and the technician group to ensure that their actions were synchronized. The design group was responsible for designing their robot with Legos as well as the background for the movie. The technician group was responsible for programming the robots. The challenge was to produce a movie of 40 to 60 seconds showing a story about two fishes. Each regie group was given ten minutes of camera use to record the group's movie.

Each group was given a story called Roboter-Blockbuster to read. Next, the students discussed how to design the movie with the robots. One tutor helped to form the groups and start phase 2. He explained to the regie group that they had to control the information flowing to the technician and design groups to ensure they were working toward the same goal. The technician groups began programming their robots, and the design groups developed a design for the robots and the arena for the story. Figure 3 shows one of the design groups working on their robot. Figures 4 and 5 show the end results of robot, background, and arena.

One group can be seen communicating about the process at Observation_TUW_01022017_00170 at 17:15 to 23:10. One girl (12138) led the discussion and organization. The group members found a solution in which the design group would build a house while the technician group would program the robot. Next, each subgroup began working on their targets.

In phase 2, collaborative work and communication can be seen. The design group was guided to work creatively with the robot and paper. However, the regie group cannot be seen making the video, because this action occurs outside of the focus camera frame. Final results from the different groups can be seen on the results videos (see Figures 4 and 5).

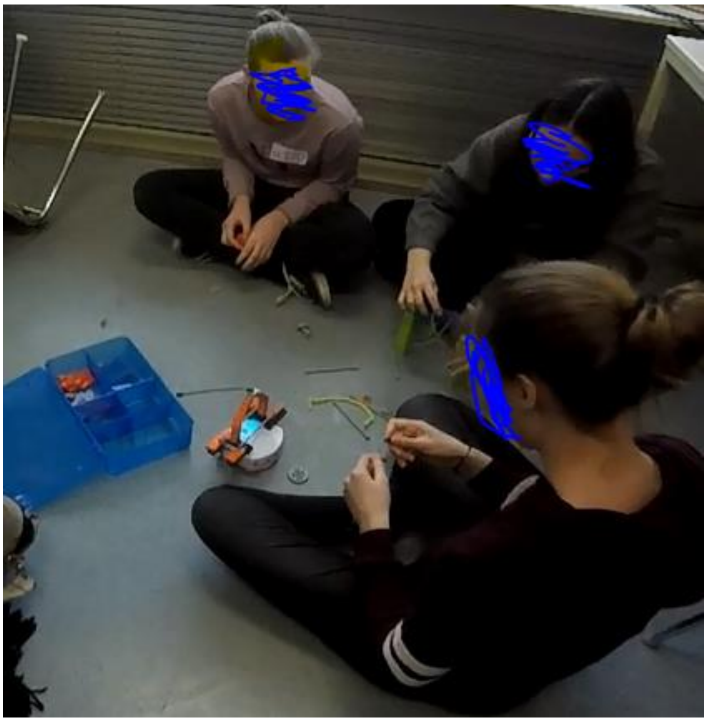


Figure 7: Design group working on their robot.

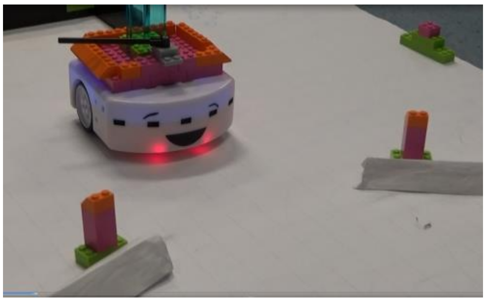


Figure 8: Results video 1.

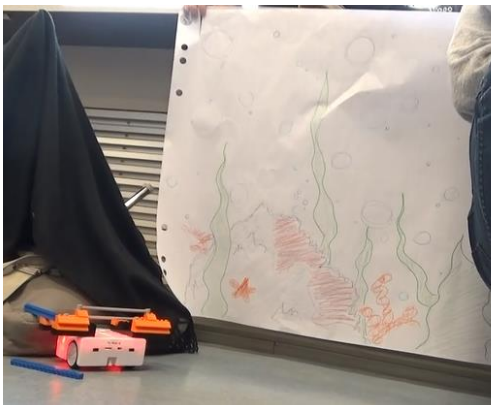


Figure 9: Results video 2.

9.9.2.1 Observation discussion

The focus camera could have been more useful during the workshop. In particular, it could have been better to have a focus camera that could reach the last row of students, because the groups in the first row were the primary subjects of the focus camera.

It could be seen that the teacher took photographs of the activities at the workshop. Analyzing those photographs could reveal interesting insights.

Finally, in the future, the focus camera could be used to record the regie groups while they are recording their videos.

9.9.3 Tutor reflections

After the workshop, the tutors answered questionnaires that contained several questions about the workshop and what they would recommend changing. Before answering the questions, the tutors were instructed to take time to reflect on the highs and lows of the workshop. Tutor 1 said that some students had a positive influence on those who were not really interested in the activities. Tutor 2 said that students were interested and worked very well together. In particular, group 2 seemed well organized and completed their video very quickly.

Tutor 1 said that he gave the students very little support. No group found the activities too difficult, and no students were disengaged from the workshop. The most successful part of the workshop was that the students worked together. In a future workshop, he would change his approach by instructing the students more clearly what to do.

Tutor 2 said that he also gave the students very little support. No group found the activities too difficult. One female group seemed disengaged from the workshop, appearing to be very distracted and uninterested. The most difficult thing to teach the students was how to understand the Aseba program. The most successful part of the workshop was that it was a good class, with good understanding and good teamwork. The tutor would adapt his approach in a future workshop to ensure that the students had better understanding of the instructions and goals at the outset; for example, teaching the whole class the first steps with the projector instead of individual teaching. This tutor learned that the older the kids are, the less they need their teacher to keep them quiet and maintain their attention. He learned to make clear announcements and always give information to the whole class.

9.9.4 Interviews

Two girls from the regie subgroup of group 2 were invited to participate in a short interview of 11 minutes. The interview began with questions about why the students had joined this workshop, followed by asking them to describe what they had done during the workshop and what they had liked most.

The students explained that they had joined the workshop as a contrast to the school. During the workshop, they tried different means of programming by touching the robot directly or using the computer. Together, they worked on creating a story.

When the interviewer asked who had decided the direction for the main group, the girls answered that the whole group had collaboratively decided what to do, but that the regie group had mostly driven the decision-making.

The girls explained that they had built a robot in school during a workshop. Everything in the workshop was new to them, and the most difficult exercise was number 2, “drive through maze.” To them, the most interesting activity was to be in the regie group during phase 2.

The interviewer asked the girls what they would change about the workshop. The girls answered that the workshop was “cool” and “good.” They repeated that they had learned teamwork, but they were not interested in technical things and got not more interest during the workshop. One girl said that she learned that logical thinking was not her strength. Instead, her perception was that she was very quick in troubleshooting.

> *Interviewer: ”Yeah? Okay. What did you learn about yourself?”*
>
> *12128: “That logical thinking is really not my strength. Yeah, this complicated troubleshooting is something where I give up very quickly..”*

Both girls had a background in technical work from their fathers. The father of 12128 works in information technology (IT), and the father of 12126 makes films.

> *Interviewer: “Did you do things with computers before?”*
>
> *12128: “My father in the IT branch and from him some little things but not really much.”*
>
> *12126: “My dad does make films () banal things like.”*

12126 shared that she wonders about the details of how things work, but her interest is not in technical subjects. Both girls felt that the workshop would encourage others to become interest in technical subjects.

9.9.5 Questionnaires

The pre- and post-questionnaires provided useful background information about the students and their perceptions of the workshop. All 23 students completed the pre- and post-questionnaires. One boy (14 years old) changed his answer from no record at pre-questionnaire to industry designer at post-questionnaire in response to the open question “In the future, what job would you like to do?”

Fourteen of the female students reported that they had previously created robots in a club or workshop. None of them said that science is their least favorite subject. However, seven said that math was their least favorite subject.

Eighteen of the 23 participating students liked using a computer, and none of them knew a great deal about robots. Most of them liked both working in teams and on their own.

Table 3. Pre-questionnaire: students‘ Likert responses to statements about themselves.

Statement	**Agree**	**Neither**	**Disagree**
I like using computers	18	2	2
I know a lot about robots	0	7	16
I learn best with other people	9	5	9
I like science	9	7	6
I like math	2	8	13
I like working on my own	12	4	7
I like working in teams	15	3	5
I like trying to solve difficult problems	7	10	6
I need help solving problems	3	14	6
I am good at solving problems	6	15	2
I want to understand more about mechanical things	9	8	6
I want to solve problems that can help people	17	4	1
I prefer tasks that only have one correct answer	11	9	3
I like to keep working on a project until it is perfect	15	4	4
I like it when I can solve problems quickly	19	4	0
I think it is important to learn about science	12	8	1
I like learning about how things work	16	5	1

Notice: If the amount of answers is different, than it had no record from a student.

The students were asked to respond to a series of statements on a Likert scale to reveal their perceptions of math and science (see Tables 4 and 5). In this case, 15 students stated that they would not like to study science when they are older. However, six understood after the workshop how important science is. Two students indicated they would like to study science when they are older. And, 21 of the students have no interest in studying math when they are older, but four understood after the workshop how important math is.

Table 4. Pre-questionnaire Likert responses to statements about math.

Statement	**Agree**	**Neither**	**Disagree**
In general I find math easy	5	6	10
Math lessons are boring	13	6	3
We have fun in math lessons	4	5	13
Math is important for the job I want to do	2	4	16
My teacher thinks I am good at math	7	4	11
I get good grades in math	7	6	9
I think math is difficult	9	9	4
I have to work on my own in math	5	9	7
Math is the most interesting subject in school	1	3	18
Math is important to learn	14	6	2

Notice: If the amount of answers is different, than it had no record from a student.

Table 5. Pre-questionnaire Likert responses to statements about science.

Statement	**Agree**	**Neither**	**Disagree**
Science is the most interesting subject in school	4	8	9
In general I find science easy	5	6	8
Science lessons are boring	7	6	8
We have fun in science lessons	3	11	7
Science is important for the job I want to do	4	3	15
My teacher thinks I am good at science	9	9	4
I have to work on my own in science	4	11	5
I think science is difficult	9	6	7
Science is important to learn	15	6	1
I get good grades in science	14	4	4
Most of the students in my class are good at science	4	12	6

Notice: If the amount of answers is different, than it had no record from a student.

Reviewing the students' Likert-scale responses to the statements about math and science indicates that most of the students do not have a positive attitude about either subject, although they get good grades in science. Table 4 reports that most of the students had the perception that math is boring, yet important to learn. Table 5 indicates that most of the students earn good grades in science and think that science is important to learn.

Another notable difference between the children´s perceptions of math and science is their reported self-efficacy in terms of ease or difficulty of the subject. It is clear that math and science are not easy, but, rather, are difficult for most students.

After the workshop, the students completed a second questionnaire, which aimed to assess the impact of the workshop. Table 6 reports the students' perceptions of the problems that they had to solve during the workshop.

Most of the students reported that the problems were interesting and fun. Likewise, table 7 indicates that most of the students found working with robots to be interesting and fun.

Table 6. Post-questionnaire Likert responses about the workshop problems.

Statements	**Agree**	**Neither**	**Disagree**
The problems we had to solve were interesting	19	4	0
The problems we had to solve were difficult	7	14	2
The problems we had to solve were fun	17	5	1

Notice: If the amount of answers is different, than it had no record from a student.

Table 7. Post-questionnaire perception of working with robots.

Statements	Agree	Neither	Disagree
Working with robots was interesting	20	3	0
Working with robots was difficult	7	11	4
Working with robots was fun	16	6	0

Notice: If the amount of answers is different, than it had no record from a student.

When asked what existing knowledge they had used during the workshop, 5 students mentioned science, 10 students mentioned math, 22 mentioned technology, 2 mentioned art, and 13 mentioned their knowledge of how things work. When asked what they had learned about, 2 mentioned science, 2 mentioned math, 20 mentioned technology, 1 mentioned art, and 11 mentioned they had learned about how things work.

Table 8 presents an overview of students' responses to statements about what they did during the workshop. These statements cover the workshop activities, the students' own actions, and teamwork.

Table 8. Post-questionnaire Likert responses to statements about the workshop.

Statements	Agree	Neither	Disagree
During the workshop I identified a problem to solve	18	5	0
During the workshop I worked on something that I was interested in	19	2	2
During the workshop I tried to solve an important problem	12	9	2
During the workshop I worked as part of a team	19	4	0
During the workshop I worked on my own	7	3	13
During the workshop I helped create a robot	10	3	10
During the workshop I helped program a robot	22	1	0
During the workshop I was able to choose what I wanted to do	4	13	6
During the workshop I feel that other people did not listen to me	7	6	10
During the workshop I did most of the work	7	8	8
During the workshop I was encouraged by my team	10	8	5
During the workshop I gave up too quickly	4	3	16
During the workshop I worked hard	11	10	1
During the workshop I was bored	4	6	12
During the workshop I helped someone	15	7	1
During the workshop I liked sharing what I had done with other people	11	5	6

Notice: If the amount of answers is different, than it had no record from a student.

Most of the students reported that they had identified a problem to solve, worked on something that they were interested in, and worked as part of a team. Almost all reported that they helped program a robot. Four reported that they would like to build and program robots to solve problems in the future, and four reported that they would like to use robots to learn new things in the future. Six students stated that they knew how important math is, while nine reported the same for science.

Fourteen students reported that they would like to do more activities like this workshop. The students gave the workshop 3 to 5 stars, with positive comments such as, “we had a lot of fun,” “I have learned a lot,” “the workshop was really interesting,” and “it was funny but also difficult.” Some negative comments were “I didn’t like the story” and “it was funny, sometimes it was frustrating, because the robot didn’t work in the beginning, but I have learned a lot.”

9.9.6 Teamwork

Table 9 shows clearly that the students had fun working on a team. Most of them are interested in working on teams.u

Table 9. Post-questionnaire perceptions of working on a team.

Statements	Agree	Neither	Disagree

Working in a team was interesting	14	7	2
Working in a team was difficult	11	3	9
Working in a team was fun	20	1	2

The students' perception was that they learned about teamwork during this workshop. Table 3 shows that just 15 students mentioned in the pre-questionnaire that they like working on a team. By contrast, Table 9 shows that the number of students interested in working on a team declined, but the factor of fun (20) is high in comparison to interest. This contrast raises the question of what difference students perceive between interesting and fun.

9.10 APPENDIX J: UK CASE STUDY 1

9.10.1 Context and Activity Plan

In this case we are looking at an 'Introduction to SLurtles' workshop in the UK. Three versions of this activity plan were created: 1) For primary school children aged 8-10 with mathematics as the primary domain; 2) For secondary school children aged 12-13 with mathematics as the primary domain; and 3) For secondary school children aged 11-12 with computing/IT as the primary domain. In every activity plan the assumption was that learners had no prior knowledge of robotics, programming or virtual worlds.

The goal of the workshop was for students to develop an understanding of what a virtual world is; how to move and interact within a virtual world, including communicating with others; to programme a SLurtle (programmable turtles in a virtual world) using a graphical programming environment (Scratch for OpenSim) to solve mathematical problems relating to shapes; understand and use loops in programming. In the third version of the activity plan, the overall aim was that students would have gained sufficient familiarity of operating within a virtual world and controlling SLurtles to be able to use SLurtles in more creative workshops in the future.

In this case study we focus on the third version of the activity plan as the workshop was fully integrated into the school curriculum, which is unusual across the project and indeed research into educational robotics more widely. As part of the school curriculum, the workshop was to be implemented in 50 minute lessons, delivered twice a week, every 2 weeks over one half term. In total this meant 6x 50 minute lessons. The first lesson was delivered on a Tuesday and the second on a Thursday, every second week. The advantages and issues of this are discussed in the tutor reflection.

The number of participants varied across the 5 weeks of implementation due to illness and other school activities but tended to total 22 students. The class teacher decided that students should develop individual competency within the virtual world and using SLurtles, so students remained in their usual seats in the classroom (broadly based on friendship groups) and worked individually at computers. The aim was that each student should be enabled to develop all of the necessary skills before working in small groups to complete more complex tasks so that each member of the group could contribute effectively in future workshops.

While there were no pairs at the start of the series of lessons (or workshop), it was intended that students would later work in matched ability pairs for problem solving with more able and talented children acting as 'lead learners'. In this class there is an existing concept of a 'lead learner' as someone who has already successfully completed a task or gone on to find something new, who then supports others to learn in the classroom by demonstrating and explaining what they have done or working with a peer to help them (and importantly not show them) complete the task. While matched ability pairs were not created, lead learners were used regularly as students explored the virtual world and started to use SLurtles.

The lesson was led by the class teacher and supported by the researcher. As the students progressed each lesson the teacher reflected on their knowledge and gaps, discussed these with the researcher and redesigned the following lesson as necessary. The main changes to the activity plan were in response to children's unfamiliarity with a graphical programming environment (the teacher had presumed that they would each have some knowledge from primary school) and the ease at which they navigated the virtual world. This was appropriate as the focus of the workshop was on active exploration of the technology and the potential of robots.

The sequence of activities in the classroom began with students choosing the name of their avatar (the character that would represent them in the virtual world) and exploring the virtual world. In this workshop, the class teacher decided that as avatar names could be easily forgotten and the use of personally identifying information within a name would be problematic for research purposes, he decided to allocate students their avatar names. So each student's avatar has the first name 622 and a last name of two digits given in alphabetical order. These were also recorded by the teacher as he expected students to forget their number between classes as lessons were so short and there was almost a two week gap between the 2nd and the 3rd lesson.

Having created their avatar, students log in to the virtual world which is hosted on the teacher's computer. As each student logs in, an avatar which represents them is seen to appear on the orientation island (hello_world) and then move around the island.

IMAGE

With a physical guide, students learn to navigate and interact with the virtual world by freely exploring the orientation island that they first arrive on. During this process they will find the house with various clothes that can be used to customise their avatar. Once they are familiar with navigating the virtual world, they teleport to their class island via a red door on the orientation island. This sequence takes the whole of the first lesson and some learners may only be ready to move to the class island during the second lesson.

The second phase of activities is the introduction of SLurtles and Scratch for OpenSim (S4OS) through some sandboxing and more structured activities. These activities allow learners to gain familiarity with the tools and switching between programmes (S4OS and the virtual world) whilst discovering what SLurtles can do.

Having gained familiarity with the virtual world and controlling SLurtles in the first two lessons, two weeks later the lessons focuses on students developing the skills to work collaboratively in the virtual world. A particular focus here is communication via text. The teacher chose to randomly allocate pairs (10 mixed gender pairs, 1 female only pair), making sure that the pair were not already sitting next to each other so that they would have to use the text communication tools. The activities are an extension to the activities in the second phase, allowing all students to reach a minimal level and to avoid cognitive overload.

Having gained a variety of skills, in pairs students work collaboratively to complete some final challenges based on mathematics. In this phase, the students are introduced to the idea of iterations/loops by linking them to flow-charts which they have previously used, and encouraged to use them in their code.

Assessment relies on students recording their own code and constructions as part of the reflective activities of the workshop. Recording learning is particularly important in Welsh schools at this time. However, unlike physical robots which can be photographed or videoed by a teacher, the teacher using a virtual world is reliant on either the children capturing these images, or returning to the virtual world after the class and recording what has been created.

While this sequence of activities was supposed to be implemented over 6 lessons (5 weeks), in reality the first lesson was lost and therefore the activity plan was implemented in only 5 lessons over 5 weeks. The learning objectives focused on exploring the virtual world in a semi-independent manner and completing tasks.

9.10.2 Observations

The video data provides a clear view on the action that occurred at different points during the workshop in each of the lessons. The workshop takes place in a computer room, in which desktop computers are on benches around three sides of the room. Students sitting at the computers face the wall and away from the centre of the room. For the purpose of this research, the front of the room is considered to be the one side without computers, where the teacher has a projector screen showing their computer screen, their computer (indicated in orange in Figure 10) and a small whiteboard on the same wall. In the middle of the room are two smaller benches with computers. Sat at one of these computers, students face towards the middle of the room.

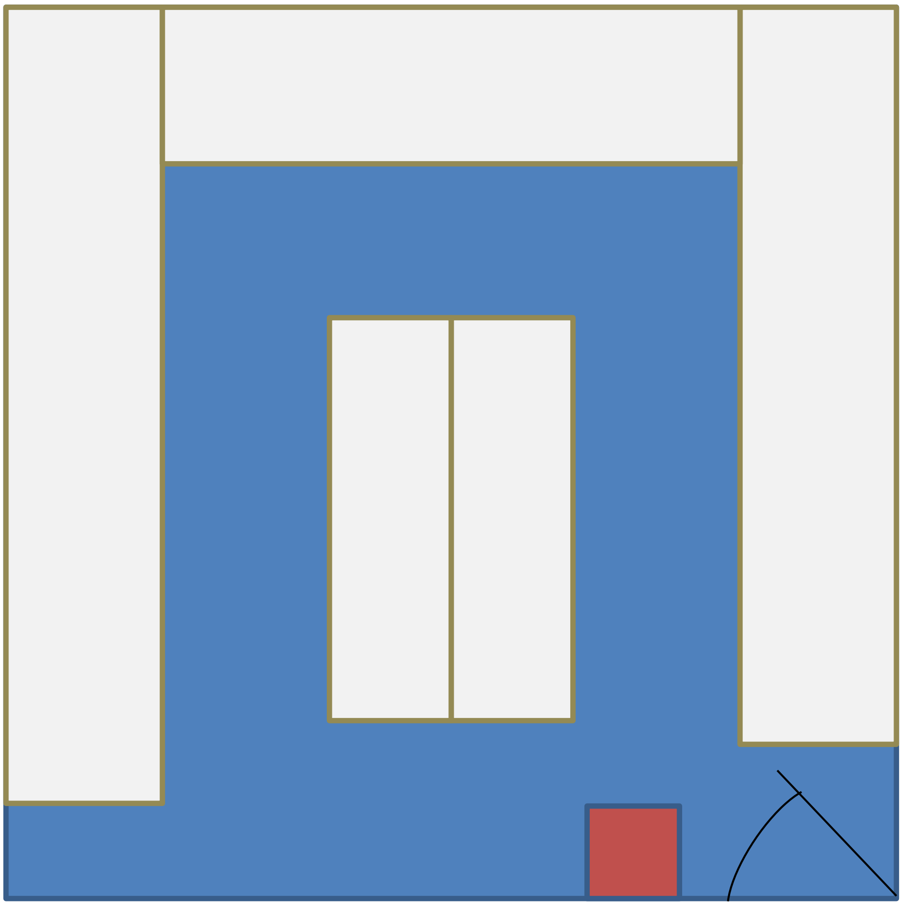


Figure 10 MIHS_1 classroom layout

Although planned to take place over 6x 50 minute lessons, the activity plan was only implemented over 5 lessons. This meant that students gained their first experience of using the virtual world in the second lesson of the first week and had to wait nearly two weeks for their second lesson. As a result a lot of students forgot their avatar names and passwords which had to be re-set and therefore they lost time during the now second lesson.

9.10.2.1 LESSON 1: EXPLORING THE VIRTUAL WORLD AND CUSTOMISING THE AVATAR – CAM A

Video only captured final 15 minutes of the lesson. There is a lot of noise from general conversation between students

- Whole class talk in the classroom
  - 00:10 Student 11 (female, sat on right side) almost as an announcement to the whole room, without turning round or looking to either side she says loudly (above the general noise in the room) "alright I'm about to walk into the clothes place no one laugh at me". Somewhere else in the room someone utters "hahahaha" Student 18 (sat two to her right) looks over and then back at her own computer.
  - 01:10 Student 20 (male, sat on left side) "who's 62204" standing up "yo who's 62204". Someone (female) in the room responds "no idea".
  - 01:58 Someone (female) "Guys, I'm going through the door, see you later".
  - 03:25 Student 21 (male, sat on left side) "Sir I'm in" without turning round from computer. Teacher is other side of the room.
- Peer-to-peer talk in the classroom
  - At distance from each other
    - 00:05 Student 21 (male, sat on left side) turns towards to 15 (male, sat at back) shouts name and when hears reply says "62215, have you got clothes on?"
    - 00:18 Student 18 (female sat on right side) says "what are you doing 62211?" with smile on her face as she looks at her screen. There is one person sat between these two students. 11 (female, sat on right side) continues to look at her own screen and laughs.
    -
  - Sat next to each other
    - 00:32 Student 05 (male, sat on right side) leans over and looks at 18's screen as he asks her a question. Unclear what he says but after they both study their own screens, she responds. The he says "tell me when I've got 'em on (inaudible)" and they both look at their screens. He then looks at her screen for a moment before returning to his own, he repeats this sequence again. She then looks at his screen and he at hers and then asks her "am I wearing them now?" referring to the fact that he has tried to put clothes on his avatar. They both look at her screen and she answers "no".
      - Image at 00:58 in PPT
    - 02:05 Student 18 (female) looking from 05's screen to own "there's three doors here". 05 turns from his screen to hers. 22 (female, sat at back, with back to these two) turns to look at 18's screen.
      - Image at 02:07 in PPT
    - 02:08 Student 05 to 18 "pick the green one pick the green one" turning from her screen to his. 02:11 "where is that? Got it" Returns to look at her screen saying "pick the green" and leaning over watches her screen. She fails to teleport and after some time (02:30) he says "it's the magic tree" which he had thought earlier was the doorway. She looks at his screen whilst taking quick glances at her own. At 02:39 she looks back at her screen and at 02:45 says "oh I think I did it", turning to look at his screen. 05 "How?" as he looks at her screen she turns back to hers. 18 "I think I'm there". He exclaims: "You're there" looking at her screen, at which point student 22 turns again to look at 18's screen, and student 11 (female, to the right of 05) looks over. As 22 turns away she says "Aw look it" and 18 turns to 22 and says at the same time "Is this it? I don't know". As 18 turns back to her screen 22 says "yeah, yeah that's it, that's it" turning back to 18's screen before returning to her own screen.

            - Image at 02:51
        - 03:40 Student 05 turns to teacher behind him who is talking to the other tutor and looking at other students' computers. "Sir, why won't it let me in the door?" Teacher comes over and student 18 leans over and says "you've done it too many times" the teacher then says "that's not the door to the world". As teacher walks off, 18 says "that's the door I went in"
        - 04:20 Student 05 looking at screen "How do you build?" 18 inaudible. 05 "oh, no, left click" turning and pointing at her screen. Returning to his screen "hold left". Then almost to self "how do you jump?" Then after a few minutes of focusing on the screen he says "create". "What?" 18 turns to look at his screen. 05 "Can you actually create things?" 18 inaudible looking at his screen. 05 "If you hold right click (pause) (18 focuses on own screen and teacher moves over to them) wait, on the terrain (teacher pauses behind them and watches 05's screen), about land, buy this land, no (18 looks at his screen) "sit here, go here" teacher says "is there anywhere that you can start writing some code (as he moves away and 05 turns to look at him) creating something (turns back) in there have a look (walks off)". 05 "create"
    - Sat next to each other but talking to self?
        - 03:30 Student 18 looking at screen "I'm here but I don't know what to do". Student 05 looks at her screen. She then says "what am I doing? Why am I wearing that, I've no clue". Although student 05 continues to look at her screen there is no interaction between the two of them and he returns to look at his screen.
        - 05:23 Student 22 (female, sat at back) draws in breath to make a noise "I'm under the sea"
        - 05:34 Unknown "I'm walking on water"
        - 08:37 Student 05 "No don't go there" whilst looking at screen and using keyboard
    - Peer with lead-learner
        - 06:22 Student 11 (female, sat right side) exclaims whilst looking at screen, 13 (female, lead learner) is stood behind her and leans in to someone else's screen saying "you're still not Jesus" glimpses 62211's screen and then moving hand to screen stepping back and looking away "don't, oh God" then to room "62211's character is flashing everyone, everyone, everyone cover your eyes" Teacher's response "please put some clothes on".
- Teacher whole-class talk
    - Progression
        - 01:25 One student (13) has shown the teacher that she has found the door to the next island. Teacher stops the class, tells them that she has found the door and asks the student to explain where the door is. He recaps this and the lesson aim 'to get to the other island by the end of the lesson'. During this time the majority of the class continue to look at their computer screens.
        - 04:00 Teacher asks 13 to become a lead learner by saying to her "can you be an expert and go show a couple of people?" and then announces to the class that she is coming round to be an expert
    - Referring to the virtual world
        - 04:20 "Who started the fire?" "Did someone spill the fire?" Then goes round room to boys on left-hand side and asks them if they started the fire, then to 13 (female, centre left) "did you start the fire?"
    - Directing
        - 09:00 "Year seven can we all listen please" (noise reduces) "3, 2, 1 listening shh, thank you" all quiet and looking at their screens. "Right, can you all do the following for me, I know you're very excited, I want to talk to you about what you have achieved, can you please though, close your world, can you log off, don't, I don't want talking, I don't want coats on or bags on nothing like that put your keyboard and mouse about the computer and face me please, let's hurry up let's do it." Class does as told.

- Reflecting & evidence of learning (?)
    - 09:50 Teacher reflects to class on what he has seen: "I've got to say first of all, on the whole apart from lots and lots of noise which was just excitement, well done. I'm so so impressed I'm just stood here watching people help each other, a lot of people persevere work out how to do things, all those skills that you're developing this year, remember when I first met you in September (it is now March), some people couldn't log on, some people couldn't use PowerPoint and were like 'Sir, Sir what do I do?' yet now you're in a virtual world, there are people creating things, really really good. So what skills did we use for the first learning objective 62213 (f)?" 13: "the first learning objective we were using how to control it how to make it use certain things and then flying flying to get round things" Teacher "and 62220 (m) did it all work?" 20: "Yeah most of it" Teacher "most of it?" 21 (sat next to 20) raises hand and is pointed at by teacher "sometimes we got stuck in places but then I found this map where you can teleport". Teacher "yeah you're in this virtual world there's lots of different options for things you've got to click on them see what they do and the same with programming when me and Miss are programming sometimes things don't work, right, where what else have we got can we go online and look for something is there something the programme will let us do where do we go and do this and that's what you're going to be doing when you make your worlds. That second learning objective (looking at student in centre left) how did the class achieve it?" Unknown student is not audible. Teacher "Yeah, I think everyone had a bit of help, whether it was me, whether it was Miss, whether it was a lead learner, that's good, we've got to do that, when you do your programming, you've got to work in groups you'll work in teams when you go out and work in industry you don't just make the next Facebook no you'll be working with a huge group of people and you need to learn how to work with people how to talk to people and I was really pleased that every single one of you talked to each other properly well done. The third learning objective, I was going to leave 62215 (m) behind but fair play every single person I think, well (pointing at 11 across the room) you didn't have any clothes on you couldn't go to the island, everyone else you all got to the island it was absolutely fantastic the only thing was there was one thing we did a little bit wrong when we were going round the world, what did we do, what thing do you all hate doing in school?" Unknown (m) "work" Teacher: "well apart from work, yeah" (points to student with hand up (F)) Student (f) "Reading the instructions" Teacher: "Yeah, reading the instructions. Please remember in the lessons coming up now we're going to do some complicated stuff. Miss has made some lovely worksheets for you, we're going to need to look through them, we're gonna start working it out, with the island you've gone to what's happened already, what's starting to go wrong already?" 21: "Fire" Teacher: "There is a fire, so I think someone started a fire right but no one's owned up to it, what's the other problem? What's the other problem with the island?" Points at 13 who has hand up. 13: "Like we don't know what like how to like we can add on certain things but we don't know how to like add on like buildings make certain items" Teacher "Ok, so we got to work out how we can start developing our world, yeah, good but what else?" 21 has hand up and is pointed at: "it's empty" Teacher: "It's empty what's gonna be the problem when we start building (bell goes but no movement in room) what's wrong at the moment?" Student (m) "We don't know programming". Teacher: "No not quite, that's not the problem yet" Points at 20 (m) who has hand up: "could you extend the world it's tiny". Teacher: "It's tiny and what could be the other problem on that bit of thing?" 13 raises hand, is pointed at: "Some people could like go onto other people's um parts?" Teacher: "Yes, some people can go on other parts so what me and Miss will try and do is set it up so that although you can go into other people's little areas you will have your own set area, so if 62215 wants naked land, he can have his naked land, well done, so pleased, tuck in your chairs and off you go.

- Teacher monitoring talk
    - Referring to action without judgement
        - 02:15 “You’re all busy getting outfits for your avatars”
    - Acknowledging progress
        - 02:22 “good good good” as he walks past and sees the screens of 05 (male) and 18 (female) who have been working together and have found the doors,
- Repair work
    - 06:36 ‘naked avatar’ 21 goes to 11’s desk, 05 and 11 usher him away. He is trying to tell her how to get through the door but she acts more concerned/frustrated that her avatar is naked. Then I arrive to talk her through the ‘repair’.
    - 02:05 (second file) another broken avatar.

Every lesson begins with a starter task, linked in some way to the main lesson activity. After this the teacher demonstrates a sklls or teaches a specific concept…..

05 (m) tends to direct 18 (f), even though he does not know himself (e.g. green door and create).

Identity – using “I’m” when describing the actions or experience of their avatar in the virtual world.

Free exploration on day 1 ends with the class on the class island discovering for themselves how to create items from blocks to ready-made trees.

9.10.2.2 LESSON 1 CAM B

At start 06 is seen flying her avatar around before learning over and looking at 10’s screen saying “how do you do that?”

1:13 10 (f) Looking at 06’s screen and points whilst saying “ah cool avatar”. 06: “where?” 10 gestures to top left of screen without giving any directions and 06 starts to click menu options.

9.10.2.3 LESSON 2 CAM A

00:14 Teacher calls on one student (m) to act as lead learner and demonstrate to the whole class what he has achieved, via the teacher’s computer which is attached to a projector. AS the student starts to work the teacher tells him that he will need to “talk to everyone” and the student begins to describe each action that he makes. Teacher then offers praise.

Noise levels remain high with children talking about what they are doing, showing friends or the teacher.

03:50 22 (f, sat at back) starts to type a message in local chat

04:55 CG comes to do repair work for 22 (f) using 02 (f, sat next to 22). CG then tells 02 that she will now be the person who can help others who get stuck (inside an object – solution was to teleport her out)

10:40 22 (f) shows frustration at being stuck again (avatar lagging at edge and not fixing)

12:15 Teacher asks 02 (f) to be lead learner and demonstrate to class but after she responds "um, I think so" as 22 (f) ask her for help, teacher turns to male student behind (centre right) who is saying at the same time that he knows how to do it, so the teacher asks him to show everyone.

12:55 After the student (m) finishes showing everyone how to offer teleports, the class teacher says "you can teleport to different people's locations, how's that gonna help you next lesson?" (to the class)

14:29 At end of lesson, teacher recaps the learning objectives noting that they will be staying the same for the next lesson (later that week) and asking students how they achieved them. LO1 - Student 21 (m) "we had whiteboards and we wrote the skills we will need to make a virtual world" Teacher: "someone tell me how did that help us why did we do that why didn't I just say go on there and do it why did I get you think about it, go on (points at 22 who has hand up) why?" 22 (f) "so we can have like people um more like people (inaudible) and people ideas" T: "so I could give you ideas, yeah I like that (pointing at student with hand up) yes" Student (f): "So we all have the image in our heads (inaudible)" Teacher "Excellent we know what we're looking for we're starting to think should I do this should I do that, what's the problem at the moment with the shapes we've been given, what's the problem with them (referring to shapes accessible via build tool) yeah" Student 13 (f) inaudible Teacher "Yeah, we've only got a couple of different shapes there what else is the problem" Student 21 (m) "um, they're quite basic they're like the normal shapes of er if we planned we could like make like a house and then copy that so it's always (inaudible) so you could make that" Teacher "Is it easy to put the shapes together at the moment?" Several students: "no" Teacher: "no, so this is where our next learning objective for our next lesson will come in, next lesson. We're going to show you how to use something, it's going to be a little bit like what you did in primary school you're going to use Scratch but it's Scratch for OpenSim. What it will do for us you will drag the different commands like you might have done in primary school say well when this happens do this, we're going to press a button, and this is where the programme is clever it will make some code for us and you put the code into your world and it will do it. We're going to have some challenges, we're going to have to be creating lines and squares in our work, why we starting with making li lines and squares why don't I just say build a house, why?" Student (m) "start off from the beginning (bell rings)" Teacher "Yeah and lines and squares will help us to build a house, we've got to build it bit by bit." Lesson ends.

9.10.2.4 LESSON 2 CAM B

01:00 06 (f, sat at back) begins to edit appearance after first lead learner. As she does this student (m, left side) student says that he is stuck underwater to which student 06 turns around telling him "you have to fly" student (m) "how do you fly?" she turns briefly to her own computer and then back to his pressing buttons on his keyboard.

02:08 06(f) then calls student two to her right (15, m) to show him what she has done with the appearance, he says that he knows and then asks her where (in the GUI) she went. 06 continues to edit the appearance of her avatar and sharing what she is doing with others until 07:32 She then starts to move around the island which has been built on in her absence, flying over to the sandbox and landing. When she lands the action of her avatar squatting (for landing) is repeated several times over by repeatedly pressing the down arrow on the keyboard. As she does this she tries to gain the attention of two other students to show them but they don't show much if any interest. At 08:46 she returns to flying around the island before editing her avatar's appearance again at 09:24.

9.10.2.5 LESSON 3 CAM A – USING SCRATCH AND SLURTLES TO CREATE A VARIETY OF OBJECTS.

Students sit in pairs of their choosing to discuss and draw what their area of the virtual world might look like. 22 (f) and 18 (f) sit together and the camera is pointed at them and their screens. The filming starts as the lesson restarts after this starter activity.

00:49 Having logged into their computers they return to their drawing and discuss what their area of the world might look like. They share ideas by describing and drawing their ideas and even moving through the orientation island and showing an example of what they would like (the tree house) with agreement expressed through phrases such as "if you want (with shrug of shoulders)" and "that's a good idea".

After one student reads the learning objective to the whole class (to use Scratch to build a variety of objects) the teacher asks who has used Scratch before. Only some of the class raise their hands. The teacher explains that they will use SLurtles and demonstrates the SLurtle building, asking the students to describe what they see and what problems they can see. He then demonstrates how to use S4OS and SLurtles before asking them to "experiment" in a square on the island (two per square – work with person sat next to.

After 7.5 minutes student 18 raises her hand for the teacher and when he comes over says "I'm not sure what a SLurtle is" at which point the teacher gives her instructions to find SLurtles and point to someone else's screen shows her what it looks like.

06:06 18 (f) "So basically you've got to find the SLurtles over there but I don't want anybody to take our box so I'll wait for you to appear" 22 (f) "ok" 22 is currently waiting for her computer to finish logging in to the virtual world 18: "and then once you arrive I go get the SLurtle and I'll come back and if you don't have one then you can go then"

Teacher realising that several students haven't got SLurtles in their inventories stops the class and tells them that some of them don't have SLurtles in their objects (folder in their inventories) and asks the class for the solution (go and get one) which is given. He then directs them to look at the code on the projector screen and asks them to think about how it works before explaining each part of his code, where he got the blocks and how he changed parts of the code (changing numbers). He then asks the class to return to their world "try things, make mistakes there's nothing wrong with it, go"

9.10.3 Tutor Reflection

In this case study we focus on the third version of the activity plan as the workshop was fully integrated into the school curriculum, which is unusual across the project and indeed research into educational robotics more widely. As part of the school curriculum, the workshop was implemented in 50 minute lessons, delivered twice a week, every 2 weeks over one half term. In total this meant 6x 50 minute lessons. The advantages and issues of this are discussed in the tutor reflection.

Having gained familiarity with the virtual world and controlling SLurtles in the first two lessons, two weeks later the lessons focus on students developing the skills to work collaboratively in the virtual world. A particular focus here is communication via text. The teacher chose to randomly allocate pairs (10 mixed gender pairs, 1 female only pair), making sure that the pair were not already sitting next to each other. The decision to avoid ability or mixed-ability pairings is due to the fact that all learners were novice in this environment.

Overall there is a tension between the activity plan and the teachers' own lesson planning approach. While the activity plan makes prominent some aspects which could be forgotten or glossed over, such as the formation of groups, it is closer to a scheme of work (which would cover a full term) than an individual lesson plan. Teachers in the UK must have both of these and the activity plan template very much falls between two stools in this context.

- Cam A 9th March 09:50 Teacher reflects to class on what he has seen: "I've got to say first of all, on the whole apart from lots and lots of noise which was just excitement, well done. I'm so so impressed at just looking around watching people helping each other, other people persevere work out how to do things, all those skills you're developing this year, remember when I first met you in September (it is now March), some people couldn't log on, some people couldn't use PowerPoint and were like 'Sir, Sir what do I do?' yet now you're in a virtual world, there are people creating things, really really good. So what skills did we use for the first learning objective 62213 (f)?" 13: "the first learning objective we were using how to control it how to make it use certain things how to (inaudible)" Teacher "and 62220 (m) did it all work?" 20: "Yeah most of it" Teacher "most of it?" 21 (sat next to 20) raises hand and is pointed at by teacher "sometimes we got stuck in places but then I found (inaudible) teleport". Teacher "yeah you're in this virtual world there's lots of different options for things you've got to click on them see what they do and the same with programming when me and Miss do programming sometimes things don't work, right, where what else have we got can we go online and look for something is there something the programme will let us do where do we go and do this and that's what you're going to be doing when you make your worlds. That second learning objective (looking at student in centre left) how did the class achieve it?" Unknown student is not audible. Teacher "Yeah, I think everyone had a bit of help, whether it was me, whether it was Miss, whether it was a lead learner, that's good, we've got to do that, when you do your programming, you've got to work in groups you'll work in teams when you go out and work in industry you don't just make the next Facebook no you'll be working with a huge group of people and you have to learn how to work with people how to talk to people and I was really pleased that every single one of you talked to each other properly well done. The third learning objective, I was going to leave 62215 (m) behind but fair play every single person I think, well (pointing at 11 across the room) you didn't have any clothes on you couldn't go to the island, everyone else you all got to the island it was absolutely fantastic the only thing was there was one thing we did a little bit wrong when we were going round the world, what did we do, what thing do you all hate doing in school?" Unknown (m) "work" Teacher: "well apart from work, yeah" (points to student with hand up (F)) Student (f) inaudible) Teacher: "Yeah, reading the instructions. Please remember in the lessons coming up now we're going to do some complicated stuff. Miss has made some lovely worksheets for you, we're going to need to look through them, we're going to start working it out, with the island you've gone to what's happened already, what's starting to go wrong already?" 21: "Fire" Teacher: "There is a fire, so I think someone started a fire right but no one's owned up to it, what's the other problem? What's the other problem with the island?" Points at 13 who has hand up. 13: "Like we don't know what like how to like we can add on certain things but we don't know how to like add on buildings make certain items" Teacher "Ok, so we got to work out how we can start developing our world, yeah, good but what else?" 21 has hand up and is pointed at: "it's empty" Teacher: "It's empty what's the problem when we start building (bell goes but no movement in room) what's wrong at the moment?" Inaudible male. Teacher: "No not quite, that's not the problem yet" Points at 20 (m) who has hand up: "(inaudible) extend the world it's tiny". Teacher: "It's tiny and what could be the other problem on that bit of thing?" 13 raises hand, is pointed at: "Some people could go onto other people's um parts?" Teacher: "Yes, some people can go on other parts so what me and Miss will try and do is set it up so that although you can go into other people's little areas you will have your own set area, so if 62215 wants his naked land, he can have his naked land, well done, so please, tuck in your chairs and off you go.

1st lesson. Teacher stated that he thought "*it went really well*" "*they achieved what we wanted them to in those objectives*". Tutor: "They got through that much quicker than I thought they would". In reflection

"*Learning objectives were achievable and realistic, pupils took ownership of the work via having their own avatar"*

2nd lesson. Teacher thought that the students needed to start thing about "the transferrable skills they're developing".

3rd lesson. Teacher had presumed that more would have used Scratch in primary school and so had expected many of them to be familiar with the programming environment. However this was not the case. In answer to the question on the tutor reflection form about whether any students or groups found the activity too difficult, he answered "*No as pupils were enthused to take a risk with their learning and try something new".*

His opinion was that "*All pupils made progress and were motivated to succeed" because "Pupils had the opportunity to try and produce something which was better than their peers, so pupils took ownership of the work."*

On reflection he stated that he had learned "*How pupils need scaffolding in terms of computational thinking as they're too use to the iPad generation whereby they just click something and they expect it to happen"*. Essentially this refers to problem solving.

9.10.4 Discussion

Across the workshop we see examples of students taking ownership of their avatars and constructions, both of which they create for themselves in the virtual world. These constructions, whilst personal are also done in collaboration with others and are shared with others. However, there is also a competitive nature amongst some members of the class observed by the class teacher who actively promotes a risk-taking culture.

Students tend to think out-loud/say what they see and the teacher uses this for monitoring and to support them. This also provides us with a valuable insight into what the students are consciously thinking as they create their avatars and are introduced to SLurtles for the first time.

Exploration, creativity and play are important aspects of this workshop for students. As they explore the virtual world, there is a sense of fun and play. Even when working on their SLurtle constructions, we see from the questionnaires that students had fun, even though they found the work difficult.

We see a lot of cooperation and peer support between teams. Additionally, in this class there is an existing concept of a 'lead learner' as someone who has already successfully completed a task or gone on to find something new, who then supports others to learn in the classroom by demonstrating and explaining what they have done or working with a peer to help them (and importantly not show them) complete the task. While matched ability pairs were not created, lead learners were used regularly as students explored the virtual world and started to use SLurtles.

9.11 APPENDIX K: COUNTRY ANALYSIS – GREECE

9.11.1 Engagement of all young learners

In this section we present the results of the analysis regarding students' engagement to the activities divided by the sub-questions mentioned earlier.

9.11.1.1 STUDENTS' INTEREST IN STEM EDUCATION AND CAREERS

More precisely with respect to STEM education it seems that after the workshops students became more interested in learning through robotics. There were many cases of students who argued that they would like to repeat an activity like this in the school concept and asked if something similar will be held next year in their school. One example worth mentioning is a student who says during the interview "*I didn't like technology as a subject…but through this project I understood that it is useful in life so I will pay more attention in the class from now on"* and after a while he argues that "*I would like this to be a school subject!"* , referring to robotics

With respect to students' interest towards STEM careers little evidence was present. Nevertheless there were some cases where students realized the importance of STEM knowledge for their desired future job and made a connection of STEM school subjects to their future careers. Some selected answers from the questionnaires and interviews that indicate this are the following:

- A young girl from a primary school (UoA422) argues in the post—questionnaire that "*robots are very **useful in jobs** and also it is fun to build them*".
- A boy from a middle schools (UoA423) says "*I realized that there are a lot of things I need to know about robotics which **will be useful for me when I grow up***"
- A girl from a middle school (UoA424) argued in the interview that "*we have gained some knowledge that we will probably use in the future, either in a similar activity or **if we want to have a job on computer science or on this field in genera***l"

In addition, during the analysis we did a comparison between students' answers on the question "What job would you like to do?" in pre and post questionnaires. The results showed that there were only 6 students who changed their answer towards a STEM-related career. Compared to the total number of students this is a very small number.

9.11.1.2 GIRLS ENGAGEMENT

With respect to girls' engagement in STEM education, the analysis showed that almost all the girls were actively engaged in the activities, even some girls who weren't very interested at the beginning. In most cases girls were more engaged in the constructing part but also contributed in the programming. It is quite interesting the enthusiasm and interest about robotics that was present in a large number of girls' answers. Bellow are only some of these answers coming from girls of different ages and different areas of the country.

42611: "Robots is an interesting hobby" (girl, age, workshop, type of school)

42111: It was one of the most great experience I have ever had in school!!!

42815: That I can create things (like a robot) that I didn't know I could

42819: Robots may seem difficult, but in reality they are quite easy

42306: Even if its hard, it is also interesting, fun and it is sure a big challenge

42411 It is a little bit difficult but very interesting. The most important thing is that I discovered how useful robots are and that if they evolve they will change many things in the world

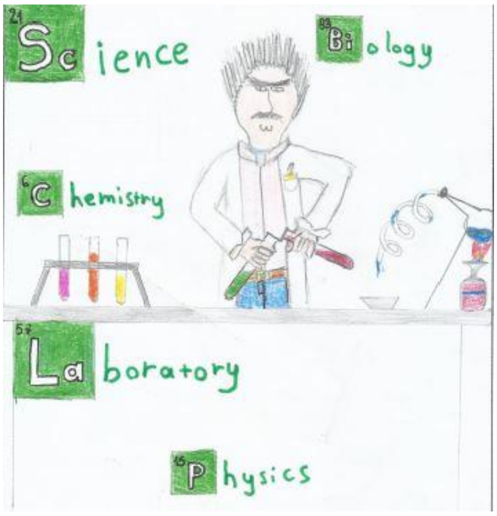
42604:I discovered my interest about robotics

9.11.1.3 POPULAR STEREOTYPES

In order to examine popular stereotypes about science we analyzed the drawing of students in the "draw a scientist at work" activity and their answers to the interview question "what do you think the best scientist is?". With respect to the drawings the vast majority of students drew a very stereotypical/popular image of a scientist: a person with crazy hair in a laboratory surrounded by chemical tubes, pcs and chemical equations, probably with a crazy or evil laugh. Some of the students actually drew Einstein or referred to famous scientist from famous tv shows. This reveals the strong effect that popular culture has on students' ideas about scientists, confirming the same result that also emerged last year. The second most common depiction of scientist was as a mathematician who writes equations and solves problems. Other representations include a doctor or a surgeon, biologist and computer scientist. It is worth mentioning that only a very small number of children (9/130) connected robots with a scientist's job in their drawings.

Something probably worth mentioning is that the kids from a primary school located in a village of Greek countryside were the only ones who connected science to nature. Some of them (5) drew scientists who are biologists or take care of plants and one student said that the scientist is the farmer who takes care of his trees. Also in that school the stereotype of the scientist in a laboratory was very limited. In contrast the majority of kids drew scientists that were either mathematicians or doctors.

Regarding the gender of the scientist the 66% of students drew a man scientist (86 out of 130) while 16% drew a woman (21 out of 130). The rest of the students (18%) didn't specify a gender, because they either didn't drew a person but only a laboratory or they drew a person but with no gender characteristics. Students were also asked to write a few words around their drawing to describe that scientist. The most common words include "chemistry, lab, clever, creative, experiment, crazy", confirming the above outcome about the



reproduction of a stereotypical image of scientists.

After the end of the workshops some students were asked through the interview what they think that the best scientist would be. Most of them mentioned patience, continuous trials and innovative thinking. Moreover they underlined the importance of a combined knowledge from different STEM fields such as mathematics, physics, engineering and programming.

9.11.2 Study of real-world societal problems

There were a few students who considered robotics as a vehicle to understand the functions of the world and also as a possible solution to some real-world problems. For instance a team from a primary school (UoA 421) noted during their interview that the best scientist will be someone who would find a way to build a robot that helps people and kids by doing household chores or their homework. Even those this is a very simplified thought due to the young of their age, it includes something very important about STEM and robotics: That they can be applied in everyday situations and they can be helpful for the peoples' lives.

Below are two more quotes that are related to the above.

42603 "Programming a robot helps you understand the structures and the functions of the world"

Part from an interview

42825: "I think they will be useful in my real life...For example when I grow up and live in a home alone if something breaks I have to know some things… and not every time to have to ask someone to fix it , the electrician or the plumber etc."

I: So to be able fix things?

42825: Yes or to help someone else…To have the knowledge to do it

However there was no clear evidence that students identified and discussed real-world problems through the workshops.

On the other hand there was some evidence on students' development of intrarelational skills and of soft skills. More precisely in the students' answers to interviews and to the post-questionnaire question "what have you learned about yourself?" we can see many of them appear to be more self-confident about their skills, their knowledge and their abilities and some others to have developed a self-awareness of the things they can achieve. This realization of themselves was related mostly to STEM knowledge, to robotics activities and to collaboration and communication skills.

Answers in the questionnaires question "what have you learned about yourself?"

42504: That if I try to solve a problem I will do it!
42830: That I can do it!
42812: I learned to be more patient, to cooperate better with the team, to learn by listening and to learn things from them

9.11.3 Learner engagement

From the data analysis we have evidence of students' engagement with different STEM concepts. The more common are programming, technology, engineering and mathematics concepts, while other concepts less common are related to natural sciences, physics, electronics and anatomy. It is worth mentioning that in comparison to last year's results, we can observe more engagement in mathematics probably because this year's activity plans tried to embed more STEM fields than last year. However the majority of concepts this year were also related to programming and engineering concepts.

42604: I developed my knowledge about constructing and programming
42614: I learned more things about technology

42825: I gained a lot of knowledge about science and I maintained a good collaboration with my team members throughout the workshop. I learned a lot about programming, problem solving, science and the importance of testing

42804: That event the smallest detail in the code, like the output, may change the result and that you need to double check in your code even the smallest things

*5 Stars: There was **a correct combination** of different fields that are connects to robotics with no pressure*

*42820: (robotics) It is something difficult but also interesting which sharpens your mind and helps you understand the world around you. It also allows you **to apply some mathematical knowledge***

Interview of UoA 425

Child1: During programming we used mathematical equations in a point, in order to be able to control the claw of the robot, so yes we used some mathematics and also I believe that we probably used physics when we tried to make the robot to have a specific center of gravity and not to be very heavy

From Interview of UoA428

I: Ok. What else did you said?

***42825**: That in programming is not everything as it is in real life. For example in the commands we couldn't use 360 degrees for the angles and we had to find another way to make it. We had to use something else and then we fixed the problem..*

I: When you turn the robot?

***42825**: Yes… Regarding mathematics/engineering I realized that I have to think better about the distance in space…for example to imagine better how much is 2 cm 5 cm etc*

I: Even if you are good in maths subject you saw that when you try to apply them in practice the things are different

***42825**: Yes sure*

I: And why did you put mathematics and engineering together?

***42825**: Because the numbers are mathematics and the practical part when you apply the maths I see it as engineering…For example when the architects create the plans of a building, they work like this*

I: Oh..I see.. So you see the applied part of mathematics as engineering

***42825**: Yes exactly*

An interesting finding from this year's analysis was that in some cases students didn't realized they used concepts from maths or science. There were a few cases from different workshop where students mention that *"they didn't use any maths"* or that *"maths is irrelevant to robotics"* despite the fact that they had clearly used specific mathematical concepts.

I: What did you learn through the workshop about any school subject or a combination of subjects for example about programming, about robotics

***42823**: I believe that when we did the activities we didn't think directly the related school subject…we didn't say "this is maths this is physics", but what happened was that combination…*

I: *What subjects do you think you combined?*

***42823**: Maths and physics for sure and…hmm…also logic…I think those*

From UoA424_b

Child1: Yes…but we actually didn't need to do any significant maths…only in programming that we had to think what was needed

Child4: Yes what we did was mostly the construction

Looking at the videos we can see the above students clearly using math concepts during their robot construction such as symmetry and analogy. The above observation is probably connected to the strong difference that some students mentioned between the theoretical teaching of a subject (i.e. maths) and its practical implementation in a workshop.

Child 2: Την άλλαξε γιατί είναι εντελώς διαφορετικά να κάνουμε μόνο θεωρία και αλλιώς να κάνουμε μόνο πειράματα όπως σαυτό το εργαστήριο

Child 1: Ναι γιατί είχες αρκετά υλικά για να πειραματιστείς και να δοκιμάσεις καινούρια πράγματα

Finally, another interesting outcome is related to the way that students worked and engaged in problem solving. We observed that in many cases, especially of older ages, they gradually developed a more scientific way of working during the workshop and by the end of the workshops many of them seem to have started thinking like 'proper' scientists. An example of this is that many students mentioned that robotics needs: patience, focus and detail, persistence, collaboration, trying and failing and continuous testing. All of these are characteristics of scientific work and it is quite different from the way they are used to work in school's homework.

Some representative answers from the post questionnaires:

42510: It needs to be careful and to think all the possible combinations

42823 (girl): It needs a lot of logic, patience, calm and composure, especially if you work in a team

*42422: We also cultivated a lot our patience because the robot had to be ready only in 5 hours, and **we had to be patient in order to give the appropriate time to every part of the process, the construction and the programming***

42823 *That it can be very easy or very difficult depending on the program the robot must execute. It needs a lot of logic, patience, calm and composure, especially if you work in a team*

42408 *That there isn't only one solution but many and that to understand if you have built it right you have to make a lot of tests*

And some interviews:

From UoA425

Child1: *I believe that when you try to make a robot usually it will not be completely right by the first try…you have to work continuously until you make your robot as good as possible so it would solve the task you want*

From UoA428

*C1: From the beginning because firstly you start by following the given instruction and then you start thinking and wondering when a piece doesn't seem right to you and then you look back at the instructions to see how it should be…and then at programming you have to think "the robot must do **that** movement so we have to put **these** instructions" and if it doesn't work "**what** we have to change"*

I:So to test and then try again..

UoA4428b

I: And do you think that you gained any new knowledge?

42823: For the school subjects no

I:For what then?

42823: Well…it makes you to think better, to think what is more logical…so you learn how to think

9.11.4 Changing and sustaining attitudes to STEM

As it turns out from the data analysis, there were a few cases of students for whom we can argue that a change of attitude to STEM was evident. Most of these were students who considered STEM subjects either too difficult for them or unrelated to their interests and to their future job. During the analysis we identified these students from their answers in the pre-questionnaires and then we evaluated and compared their answers in the post-questionnaires and interviews after the end of the workshops. A quite interesting result is that most of the students who indicate a changing attitude are female. A representative example is the 42309 is a female student who said in post questionnaire that see doesn't like maths and science and that she finds them boring and difficult. Then in the post questionnaire she says that working with robots helped her learn about maths and technology and that she would like to solve more challenges like this one. Moreover in the question "what have you learned about yourself?" she answers that "I can achieve a lot of things if I work". A boy from the same school says in the interview that "*I had a negative opinion. I didn't like maths but through this project I realized that they are important for life for any problem we may face*" .

A similar example is another female student (42411) who mentions "*I learned that I like programming more than I thought and that I can make it both in programming and in the construction of a robot*" and in another question "*It is a little bit difficult but very interesting. The most important thing is that I discovered how useful robots are and that if they evolve they will change many things in the world*"

42614 represents a typical student who didn't engage with STEM subjects because they are not related to the job he would like to do. However his attitude seems to have changed as in the interview he says:

I realized that I can cope with programming […] It was something completely different from the things I already knew and I was interested for
I: Now you are interested In robotics?
42614 :*Yes quite more.*
[…]
42614 :*The workshop increased my interest for those sciences I believe that other students may get interested in science like I did with this workshop*

And in the post-questionnaire he answers " *I learned more things about technology"*

42307 That programming is easier than I thought as a kid That I am better than I thought with technology I had fun and I liked working with robots and programming more than I expected, because it make you think and expand your knowledge!!

Based on his answers, 42308 finds science and maths difficult and not interesting according to his answers on the pre questionnaires. However on the post questionnaire he seems to become more interested in science because he realised it is connected with his future job. He answered that during the workshop he used his knowledge about science and he learned new things about science and technology. Also, in the open questions he said that "there are a lot of things I need to know about robotics which will be useful for me in the future".

Finally many students highlighted that they preferred the way they learned about STEM concepts through the robotics workshops compared to the way they are taught these subjects in class. One example is the answer of a student from a middle school in Athens during the interview that is presented below.

Interviewer: Do you believe that working with robots, in robotic workshops, may help other students to be interested in sciences like maths, physics, technology?

Child2: Of course! ***Because in robotics you use maths and science on something real and not on a blackboard and thus you see in an experimental way how all the things you learn in books are applied in reality***

A similar answer was also given from a female high school student of Northern Greece

Interviewer: Do you believe that working with robots may help other students to be interested in science, mathematics, technology, how things work?

Child 1: Yes of course they will become interested!

Interviewer: But why?

Child 1: Because the workshop was something very interesting! ***It is not just theory but also practice and I think that most of the students are more interested in the practical part of knowledge than in the theoretical one.***

Interviewer: So are you tire from the theoretical lectures of all these years

Child 1: Yes!! (all laughing)

From UoA 428

I: Do you think that in general this can help someone to be more interested in technology, mathematics science?

C1: Yes because if he doesn't like for example maths, he is able to see the part of mathematics that is more…playful to put it like this and then starting to like the

From the answers of those kids, it is evident the lack of practical and experimental activities in schools and robotics may be one appropriate tool to cover this need.

9.11.5 Connecting STEM to society

This part is related to the study of real-world societal problems that was described in an above section as it refers to the connection students are making between STEM concepts and society. This includes the realization of how STEM is present in real life, how STEM careers may be useful for society and how students can apply STEM concepts in their everyday life. As it turned out form the data analysis, some students mentioned the importance of robots and of STEM concepts, such as maths or programming, in everyday life.

42411: The most important thing is that I discovered ***how useful robots are*** *and that if they evolve* ***they will change many things in the world***

42207: Robots are ***useful in life***

42421: It is possible to construct them with very simple material

42603: Programming a robot helps ***you understand the structures and the functions of the world***

However there was no clear evidence that students expressed more specific ideas of possible ways in which STEM or robots may be helpful for society.

9.11.6 Engagement in creativity

Regarding creativity there was not so much evidence in this years' data. We identified some creative moments that happened occasionally mainly during the construction process. The biggest number of critical episodes related to creativity were spotted in two workshop (UoA 424_a and UoA 424_b) in which students were asked to build a robotic insect with Arduino and everyday material without looking at any instructions or given prototypes. This kind of free making/open activity led students to express creative ideas, such as making the cables to look like the wings of the insect. They also faced more difficulties during the construction process than other workshops and some teams proposed and followed creative solutions in order to solve them. This result indicates that in robotics creativity may be fostered in more open activities without specific building instructions given to the students.

Another result that may be considered as evidence of creative thinking is the extensions to the artefacts that a few students suggested either during the workshop or later at the interviews. For instance a group of students of a primary school suggested during the interview:

C3: To be able to talk

I: Other?

C2: to have a sound system

I: A sound system! So the robot will be able to make sounds also.

C1: To fly!

C4: Yes!!

I: What else would you like the robot to do? No we made a robot-explorer that can go to a planet and (). This goes to a specific path and understands.

C4 (interrupts): To take photos

C2: To make the led blink in different colors

C3: to play music when it detect something

Finally a small number of students across all the workshops mentioned creativity in their answers in the post questionnaires, like these two below.

Q "What have you learned about robotics?" 42511 "That it is very interesting and it helps you to increase your creativity"

Q: "What have you learned about yourself?" 42202 "That I am creative"

9.11.7 Engagement in collaborative work

In all of the 10 workshops students worked in small groups with the size of group being 3 students in average (2 was the minimum and 5 the maximum number of group size). In 7 out of 10 workshops there were almost the same number of mixed gender and same gender teams. From the other 3 workshops, one workshop had only male participants, one had only one female participant and one had only 3 female participants who wanted to form a team together.

In most case, the collaboration between team members can be characterised as effective and useful for the learning process. There were several incidents where students discussed all together a problem in order to find a solution, made suggestions and tested them or asked the opinion of their teammates on how they should proceed on a task. Most of the incidents that students expressed STEM related ideas was observed in discussions, disagreements or argumentation that occurred when a problem was faced either during the construction or during the programming of the robot. Thus, we can say that both the robots and the programs acted as conversation triggers between students especially when they had a "buggy" or problematic behaviour. Below are some selected quotes from the data which are related to the expression of ideas through collaboration.

> 42308*: That is more pleasant to work in a team than working alone. Other people help you and they probably have some useful ideas for the solution of problems*

Below is a part from the interview of UoA425 workshop where students explain how they solved the disagreements they had during collaboration.

> *Interviewer: Were you able to solve the problems you faced during collaboration?*
>
> *Child1: Yes of course…For example when we disagreed on the way that we would solve a problem, we saw which of the two solutions was the best and we did something in the middle or…*
>
> *Interviewer: About what did you disagree more often?*
>
> *Child1: More about the programming…how we will use the different parts in order to complete the program*
>
> *Interviewer: And in the end how did you decide what to do when you had a disagreement?*
>
> *Child1: We decided in which way…*
>
> *Interviewer (Interrupts): How you made your decision? I mean what method did you follow in order to decide? For example did you choose the suggestion of the one who was the leader?*
>
> *Child1: We tested both solutions and we saw which of the two was the best*

As it is evident from 2 other interviews below, also students from other workshop seems to have worked in the same way; expressing ideas, try them and choose the best.

Interview of UoA424b

Child2: All together we said our ideas and we all contributed to find a solution

Child1: In many cases ***we listened to the other's opinion and we trusted it, even though it may not work, but we tried it***

Child3 (Interrupts): We also ***combined our ideas,*** *especially during the construction*

Interview of UoA428

I: Was there some conversation between you and then you go to test your suggestions?

C1: Yes

I: Can you tell me an example?

C1: Yes for example someone said that it should turn 100 degrees we tried it, it didn't work, then we did it with more degrees and we did trials until we found it

Moreover, as emerges from the analysis, there was a large number of students who seem to realise the importance of collaboration in robotics or in the problem solving process in general. It is important to mention here, that many students said they hadn't participate in any team project in school before.

42604: I learned that through collaboration the efficiency and the productivity increase

42614: That ***in this field,*** *you will not be able to progress without cooperation*

42424: It is important in many areas of everyday life

42202: «Collaboration is necessary. Without I wouldn't be able to create such robots"

42610 Working in a team is helpful, you can achieve more things and you can listen to other ideas

With respect to the roles within the teams, there was no predefined roles or tasks distribution from the tutor in any of the workshops, thus the way they will work was based on students' decision during the activities. We couldn't find a specific pattern on how students worked in students. What was happening in most of the workshops was that some roles were formed and adopted by the students as the activities proceeded based either on students personal preferences (I like constructing) or on their performance at a specific task (He is good at programming so far, so he will write the remaining code). In those cases students usually divided the main task to smaller sub-tasks and distribute those between them. Sometimes the roles may change during an activity or between the different sessions of the same workshop. Moreover in some cases there was no evidence of a specific roles distribution, but all students worked together in every task.

Apart from the teams who had good collaboration between their members, there were also some cases of problematic collaboration. From the evaluation of students' answers in questionnaires, in reflection documents and in interviews we identified 9 teams that their members mentioned they faced problems within the team. It is interesting to note that 8 out of 9 teams were mixed gendered teams and all of these 8 teams had unequal numbers of females and males. By comparison there was no evidence of collaboration problems in any mixed gender team with equal number of female and male participants.

In the 8 teams that faced problems with collaboration there were both cases where girls took over and let the boys aside and also the opposite. Bellow two examples are presented which are representative for each case.

42510 is a girl in a team with two other boys. In the Likert questions of the post-questionnaire she answered "I disagree" on the question "I was able to choose what I wanted to do" and "Neither agree neither disagree" to the question "I feel that other people did not listen to me" and also to the questions "working in a team was fun", "working in a team was interesting". In addition to the open question "what have you learned about working with other people?" she answered "That all the people are not so collaborative". Finally she rated the workshop with 4 stars and explained "Because I learned a lot of things but we had to be more collaborative as a team". Also one of the two boys from the same team mentioned that "There are many types of people" in the question "what have you learned about working with other people?".

42214 is a boy in a team with 3 other girls. Even though his team achieved their goal successfully and quick he has a very negative opinion about the way they collaborated. In the post questionnaire he answered "I strongly agree" in the Likert question "working in a team was difficult" and "neither agree neither disagree" in the Likert question "working in a team was fun". Moreover on the open question "What have you learned about yourself?" he answered that "I cannot be in a team with many members" and on the question "What have you learned about working with other people" he said "It is hard".

Finally with respect to collaboration between teams the examples vary as there were both cases that students from different teams exchanged their ideas and helped each other and other cases that they were very competitive and didn't want to share their ideas or artefacts with others. It is worth mentioning that in the first case that teams exchanged ideas, it seemed that this process fostered students' communicational skills and acted as a type of reflection because they had to explain their work to others.

One example from the first case where students exchanged ideas between teams is the following

Child 3: We also exchanged opinions with other teams

Interviewer: Oh how did this happen?

Child 3: For example they wanted something from us, to ask as, and we asked them something else in return. Like taking and giving.

While an example of the second case comes from a group of younger students of a primary school who blame a team member for letting the other teams steal their idea.

I: Did you took any ideas from the others?

C3: No. They took from us

I: Oh they took from you and if I remember well someone explained to them…

C4(sound a little frustrated): Yes because C1 showed them how to program the robot and they did the same with us

I: This is not something bad. It is a good thing.

9.11.8 What works for whom and in what circumstances?

From this years' data analysis a quite interesting result has emerged with respect to this question. Unlike last year, this year's Greek workshops included in their activity plans the element of competition. Three of the workshops implemented activities in which students participated with their robots in a small competition. The types of schools were one high school, one middle school and one primary school. In all of the three competitions the winner was the robot that would complete the task successfully and faster than the others.

One of the positive outcomes from these competitive activities was that they fostered collaboration within each teams. The fact that students knew from the beginning that their robot will participate in a competition motivated them to be actively engaged in the whole process of the workshop. Moreover most of the teams when they achieved the basic task they tried to make improvements and modifications to their robot until the last minute so that it will become faster and more efficient than before. However it prevented collaboration between different teams and led to incidents of strong fights between teams about 'stealing' ideas or other similar causes.

Something very interesting that emerged about the competition element was that it seemed to have quite a positive effect for students at the ages of 14-16 especially when they had previous experience with robotics. On the other hand it didn't work well for the younger students in the primary school who also didn't have any experience with robotics. In this workshop, at the first session each team was asked to build and program a formula car robot which would participate in a race competition. Students did a first "test" race with their robots and then they had time to make improvements for the final race. At the second session they didn't do any competition and were asked to build a safe swing that will move and stop when it detects something in front of it. As emerged from the analysis, the teams whose cars came last in the race developed a very negative attitude towards robotics and STEM. This was evident both by their reduced interest and enthusiasm during the second session and also by their answers at the post-questionnaires. More precisely 3 students gave only one star to the workshop at the post-questionnaire and their explanations were "Because I can so!", "I didn't learn anything" and "It wasn't so interesting and it was boring and because I can so!". However by looking at the videos all of these kids were actively engaged during the first session, they had a great collaboration and they seemed to be excited and to have a lot of fun. But this was the team who finished last on both races and after that they seemed quite disappointed and maybe frustrated with the result and with the fact that they didn't managed to improve their car.

From the above results it seems that the competition activity within a class context may work under some circumstances and foster students' interest in STEM but it may also have the opposite results. One early assumption we can make is that the students' previous experience is an important factor to this. Competitive robotics activities may not work well for kids with no other previous experience with robotics and probably should not be the first type of robotic activity the students are involved in. Next year, in order to study this in the specific workshop we will swap the activities round so that students get familiarised with robotics through the safe swing activity and then we will implement the competition activity.

Another important factor can be the age as competition in younger ages can be more intense and have different results than in older students. This also needs to be studied by including competition activities in primary school workshops.

9.12 APPENDIX L: COUNTRY ANLAYSIS – MALTA

9.12.1 Students' interest in workshop's activities

In general, the data analysis on elementary schools revealed that most of the students found the workshop activities interesting with a small rate of 6.85% to state that they were bored during the procedure. Additionally information found on the post questionnaire concerning the total rating of the workshop seem to agree with that notion as the lowest average students marked was that of 4.36 out of 5 stars, while the highest reached 4.96 out of 5 stars. On the other hand, there were significantly more students who argued that they got bored in the middle schools' workshops. Specifically, a total rate of 24% (51/211) answered on the post questionnaire either that they got bored (Likert question) or they commented that they found some of the activities boring. Moreover the workshops rate is quite low related to the elementary schools as 4 out of 7 middle schools have a rate below 4 stars with the lowest being 3.65. The reasons of students' low rating are mainly three as they emerged from their explanations: They got bored, they found the activities quite hard, they didn’t like the way of teaching. Below are presented some of the students’ ratings of the workshop together with their explanations that confirm the above outcome.

1.5 stars: “*I found it to be extremely boring and I don't like how it was presented*” (girl, 13 yrs. Verdala 1)

3 stars: “*It was really fun and it was something new. At the end it was repetitive”* (girl, 11yrs. CAT1)

3 stars: “I *was bored at times and I believe the exercise were a bit difficult and confusing. Sometimes I think they weren't explained quite well from the tutors. But I did have fun with the robot*”. (girl 12 yrs., ST.FRA 3)

An interesting outcome that emerged from the video data and from the post questionnaire is that many students lost their interest and excitement at the activities with the graphs. At some point of the 3rd phase of the workshop students are asked to stop working with the robot and transform the numerical data they collected into mathematical graphs (puzzle 6) and to find the probability for the generation of a random number (puzzle 7). Both these two puzzles are done on their worksheet without any interaction with the robot or the code. We can see in the videos many students complaining about that part and trying to use their robot during the exercises. Moreover some of them mention it on the post-questionnaire at their rating. For example a girl from ST Fr 1 workshop says gives 4.5 stars and says “*I really enjoyed my time but nothing is perfect so 4.5 not 4 stars. But you could do this by spending more time with robots rather than the graph*“ . Similarly a girl from another workshop (St Fr 3) rates the workshop with 4 stars and explains “*Sometimes I was bored and I didn't understand why we had to do a bar graph. I liked dash and I liked working with him*.**”.** Finally a boy from Verdala B gave 3 stars because “It was a fun experience but I would've liked to learn more about the actual code**”**. From these answers combined with the video observations we can clearly see that students prefer the hands-on experience with robot from the typical exercises on paper. In fact if this activities interrupt their flow of experimentation and engagement with the robotic artefact, they can affect quite negatively their overall workshop experience. It is notable that this activities were not present in the activity plan for the elementary schools, in which as we described before, there was a biggest satisfaction of the students.

We have to consider this outcome for the design of next years’ activity plans in which we should probably redesign or limit activities like the two above, which prevent students from interacting with their robotic artefact.

9.12.2 Students’ interest in STEM education

The data analysis revealed cases of students from all the workshops who expressed their excitement about STEM education. The evidence include both boys and girls all the age groups (9-14) who demonstrate increased interest about STEM activities and robotics through their answers in post-questionnaires and interviews. A large number of students argued that they found the activities fun and enjoyable and expressed a desire to be involved with robotics in the future. Some of them mentioned how much they liked the way they learned through robotics and make a connection to school subjects. For instance a 12 years old boy says on the post-questionnaire “*I found it fun and interesting and I would like to learn in this way at school*”. Similarly 11 years old girls admits that “*I have learned that technology is an important subject*” and a 12 years old girl from another workshop says “*It was fun! I really enjoyed it, I hope to have more activities like this one!*” and an

There were also cases of students who claim that they discovered a new interest related to robotics or to more specific STEM fields like programming. Below are some related answers from the post-questionnaire question “What have you learned about yourself?”

“*I have learned that I like robotics*”(52084 girl 13)

“*I like robots!*” (52082 girl 12)

“*I am interested in programming*” (520244 girl 12)

In addition to that, many of the students who expressed their interest about STEM mentioned also their intention or desire to be involved with a similar activity in the future. For instance a 11 years old girl on the question “What have you learned about yourself?” answers “That I like technology and programming” and then she rated the workshop with 5 stars because “*This was fun and I liked programming robots and **I would like to continue studying about robots***”. Another girl also says “*It was very interesting, I would like to do it again*” .

9.12.3 Students’ interest in STEM careers

Through the data analysis there was also evidence of students expressing interest in STEM related careers. This included both their intention to do a STEM related job in the future but also the realization of the importance of STEM fields for their future job. However this evidence was present mostly in younger students of elementary schools and not that much in middle schools.

One example where students demonstrate their interest for a STEM career are two student of the focus group of an Elementary school (attard class 2) who argue during their interview:

S1. Well I would like to study robotics in the future

S2. Even me I would like to study it...maybe in the future I will invent something that will help us be better

[...]

S1. I would like to invent and I try to program them

I: Ok

S2. I would like to go to university, study so that I will be able to become a scientist and be able to work with robots like you

Moreover a student from AL-1-10-NicholasA says during the interview that “*Maths is a subject that will help you in life to get a job and Science is good to know because it’s very interesting I think it will help many children...if they want to become a Scientist they should really work hard follow their dreams and improve what they trying to do*”. From his answer we can see that he makes a connection of maths and science to STEM careers.

Finally there were 8 cases of students from all the workshops who changed their job preference to a STEM related one. This was analyzed by comparing the students’ answer on the question “In the future what job would you like to do?” of the pre and post questionnaire. For example a 10 years old girl from workshop AL-1-10-NicholasA changed from Tennis Player to Programmer while a 12 years old girl from AL-2-10-FRAc changed her answer from “Accountant” to “Engineer/Accountant”. From the 10 students who changed their answer, 6 were from elementary school students while only 3 of them were from middle schools.

9.12.4 Gender Stereotypes Held

By analysing the data we came across with some interviews where the students depicted the scientist as male inclining the existence of gender stereotype. In most of the cases the interviewer intervened asking the students why they are imagining a scientist as a male with some of the students answering that it could be possibly be a female too and some others admitting that the idea of a man scientist pumped in their mind more easily.

For instance at the following interview of AL-1-11-NicholasB the participants are both girls. However they use the male gender when referring to the scientist so the tutor interrupts them and asks them why they used 'he' instead of 'she'.

Tutor: Ok, you mentioned the word he

S1. I'm sorry about that

Tutor: No it's ok no it's not about sorry it's fine. Do you feel that sometimes we associate scientists with a he or a with a she?

S1. It can be a he or she but to me you know when you said scientists I pictured a man with crazy hair

S2.Even me I think scientist as a man even though I know that my mom is a scientist but however every time I think of a Scientist….boom is a man

Annalise: Ok so that's a very clear example that scientists can actually be woman. I for starter I'm a Scientist

S1. Like Marie Antoinette the first woman scientist

At the above interview part we can see the two girls reproducing the stereotypes from the media about scientist. S1 refers to the scientist as " *a man with crazy hair* " while S2 says she always thinking of a man even though her mom is actually a scientist. However after the tutor's intervention S1 immediately mentions Marie Antoinette as an example of a female scientist that came to her mind.

Another interesting quote regarding gender stereotypes is a girl from AL-1-7-DorothyA workshop whose answers on the post questionnaire question "What have you learned about yourself" is "I learned about myself that robot are not for boys but for girls too" and at the next question argues that "I learnt how to program a robot". This girl clearly breaks the gender stereotype about robots being more suitable for boys than for girls. However, apart from that girl there was no other so clear evidence in the data of breaking similar gender stereotypes.

9.12.5 Study of real-world societal problems

In the activity plan of the middle schools there were some activities that were designed in a way that students had to project their observations about the real world in order to further understand and solve the problem.

After their implementation the tutor started a discussion on how students' solutions are applicable in a realistic context. Such an activity included the proper programming of Dash in order to work as a traffic light. In the discussion that followed in some of the workshops, students linked their inefficient or wrong implementations with continuous traffic jam on the streets releasing in that way the importance of the proper condition on the loop statements. Another discussion with real world application was the concept of variable. Tutor linked the the ability of a variable to take multiple values with the way social media personalize the names of students, taking in that way whatever name value is needed for each one of them. In the same way students had to program dash in a way that could produce multiple random numbers with the use of a variable.

9.12.6 Demonstrate Learner Engagement

From the analysis of the data emerged that students were engaged and developed new knowledge mainly on the fields of technology and programming. Little evidence of learning was related to maths and there was no evidence about engineering, physics or other STEM fields. This was probably due to the lack of construction that Malta's workshops had. The main focus of the activities both in Elementary schools and in Middle schools was in programming the Dash robot and in understanding how robots interact with the world. In middle schools there were also some activities related to mathematical concepts like charts and possibilities. However the answers of the students on the post-questionnaires and in the interviews don't reflect development of new mathematical knowledge by them.

On the other hand, there were many students who mention that they learned new things about programming and about robots in general. For instance a 10 years old boy claims that "In this lesson I learned how to program things" while a 12 year old girl from another workshop agues that "I have learned using coding to control the robot". Other students mentioned more specific concepts that they've learnt like for example a 13 years old boy who says "I learnt about variables and functions" and an 11 years old who answered "I learned that there are some specific words when talking to robot like: if, else, until". Student's learning about programming is also evident from their answers to the interviews. At the following answer of a 10 years old girl from AL-1-10-NicholasA workshop we can clearly see her engagement with programming.

> *"Overall these 2 days I had a lot of fun programming robots, I've learned how robots work and I've also learned they don't have any feelings cause before I used to think they do. I also learned that there are many different types of robots, I figured out how to program them and it's quite hard at first it's quite hard but then you will get used to it and will be very fun "*

Her teammate, a boy 11 years old, mentions in the interview after a while

"*I learned that STEM means Science, Technology, Engineering and Maths. I think those are four very important things if you want to work with robotics you know if you want to become engineer it's very important to know how to use those four subjects and about the programming it's challenging but not very much not a lot*"

Apart from programming the robots, many children also mention that they gained new knowledge about what a robot is, of what it consists and how it works. Some representatives answers on the question of the post-questionnaire "what have you learned about robots" are the following:

> "*I learned that the robot have senses, that are not intelligent like us*" (boy, 10 years old)
>
> *"I have learned that robots have sensors" (girl, 11 years old)*

“*I have learnt that for something to be a robot it has to move and sense things*” (boy 12 years old)

“*I learned the differences between a robot and a machine*” (girl, 12 years old)

“I learned that they (robots) do what you want, when you want it. They also have their own source of energy, they move and they have intelligence” (girl, 12 years old)

Finally many students from different workshops on the question “what have you learned about robots” answered that robots are not clever by themselves but you can make them smart with programming. For example student 52049, a 13 years old girl says “I learned that robots are stupid but if you program them they aren't” and a 12 years old boy 12 (52076) that “They are stupid and you have to teach them” Similar answers were also given by younger students such as “*If you don't programme them they are idiots*” (11 yrs. girl) and “t*hey are dumb by themselves but smart with programmer*” (boy, 9 yrs.). This is an interesting statement regarding the perception of robots by the students, which was not mentioned so often by students of other countries’ workshops and probably was a result of the way the activities were held.

9.12.7 Changing and Sustaining Attitudes to STEM

With respect to student’s attitudes to STEM there were some cases were students changed their attitude positively to one or more STEM fields. This change was demonstrated either by expressing increased interest than before or by realizing they are more capable than they thought before.

For instance the two students of the focus group of AL-1-8-AugustineA workshop admit in the interview to have changed their attitude towards STEM subjects:

S2: “That I can do things because before I did robotics I couldn’t believe that I could do programming...I said that I’m not good at robotics and technology and now I’m sure of myself that I can do programming”.

S1: “I discovered that I like robotics a lot and I’ve started like Science...also that Maths are involved in almost everything”

This positive turn in their attitude is also clear when they are asked whether this workshop has changed their view about science and their career:

Tutor: These 2 days workshops have they changed your view about Science about your career about your interest

S2. Yes I was interested because I hated Science but now after we did these I loved it so much especially the robotics...that’s all I think

In AL-2-1-CAT workshop there was a 12 years old boy who had a negative opinion about maths as on the pre-questionnaire answered that he strongly disagreed on the question “I like maths” and said that maths is the subject he likes the least because “it is hard”. He also argues that maths lessons are boring. After the workshop he agrees with the statement “I think I am good at maths” and he argues that “I learned that I like technology”. This case can be considered as a positive change of attitude to maths due to the enhancement of his self-efficacy through the activities.

Another example comes from the 2nd workshop that was organized at the same school (AL-2-2-CAT). There was a 12 years old girl who argues in the pre-questionnaire that IT and Science are among the subjects she likes the least. At the post questionnaire seems to have changed her attitude to programming and IT but not to science. On the question “what have you learned about yourself” says that “I have learnt that I am good at programing” and she agrees on the statement “I would like to learn more about programming”. However on the rating of the workshops she gives 5 stars and explains “I liked it a lot but the science not so much”.

An interesting case is the workshop AL-2-7-JOS which had only girls participants aged 11-12 years old and the majority of them (14 out of 25) had a negative attitude to one or more STEM related subjects (science, math, IT, technology). We analyzed the answers of these girls to the post-questionnaires to see if there was any change in their attitude. From those who answered the post-questionnaire there were 6 who changed positively their opinion about to the STEM subject.

One example is girl 520173 who says on the pre-questionnaire that her least favorite subject is IT because "I am not good with computers". On the post-questionnaire she strongly agrees that working with robots was interesting and fun, that working with robots helped her learn about technology. In addition on the question "what have you learned about yourself?" answers that "I have learned that coding isn't so boring" and on the question "What have you learned about robots?" she answers "How interesting they are". Finally she agrees with the statements "I would like to learn more about programming" and "I would like to use robots to learn new things in the future". Another example is girl 520174 who said in the pre-questionnaire that maths is her least favorite subject because "I don't understand and have problems with solving". On the post-questionnaire she said that "That I can do anything if I believe in myself" and she agreed with the statements "I would like to learn maths in robotics workshops like this one" and "I would like to do more activities like this one". Something also very interesting is the explanation for her rating (3 stars) which was "I would like to build a robot too". This girl expresses her interest and intention to be involved in similar activities but also desire to engage in construction, something that was missing from this workshop.

The other girls who changed their attitude also expressed their desire to participate in similar activities and in some of their answers we observe increase of their self-efficacy such as "*I learned that I'm capable of doing things I don't know*", "*That I am good at coding*" and "*That I am intelligent*".

9.12.8 Increase in self-efficacy

In Malta's workshops there were many cases of students who increased their self-efficacy about STEM subjects or seemed to have learnt intrarelational (how well they know themselves) and interpersonal skills. Most of them seem to have become more confident for their capabilities in a specific field (i.e. in maths or in programming) and also to have discovered new skills they have. The following quotes are answers on the post-questionnaire from students of all the workshops that demonstrate the increase of their self-efficacy related to STEM fields.

51234 I have learned that I am good at technology (girl 11 yrs)

51235 I have learned that I am good at programming robots

51222 That I am good at solving problems

52080 That I'm not bad at working with robots (girl 12)

52097 I'm a little good at Maths (girl 13)

51232 That I am good at science (boy 10 yrs)

In addition below are some selected quotes in which students seem to have realize more general things about themselves, like skills or abilities they may have .

"That I am capable of doing everything I set my mind too" ((boy, 9 yrs)

"That I can do anything if I use my mind" 51178

"I can understand lots of things" 51175

"I have good ideas" (boy 12 yrs.)

"That I get into things quickly" 52092 girl 12

"That I'm capable of more stuff" 520160 g 11

" I have learned that I am clever" 520216 g 11

"That I can be useful and creative" 520232 girl 11

"I learned that I can do things that I didn't know I can" 520248 g 11

The students of elementary schools also mentioned this in their interviews. For example a student from AL-1-10-NicholasA says:

" *I discovered that I'm a hard worker and I won't give up that easily and many people should be like that they should keep on trying until they succeed*"

Moreover there were students who seem to have discovered things for themselves that they want to improve like a 10 years old boy who admits "*I have learned that I need to work harder*" and a 12 years old girl on the question what have you learned about yourself says " *That I should work with other people a little more (I did a lot of the work on my own)*".

However there were some cases of students who seem to develop a negative idea about their abilities in STEM fields. For example in AL-2-4-VER workshop with participants of age 12-14 they were noticed four cases of students to whom workshop had negative effect on change of attitude towards Technology. On the post questionnaire these students state the following on the question "What have you learned about yourself ?":

(520113, boy) : "That I am not a good programmer"

(520111, girl) : "I learned that science isn't really my thing"

(520101, boy) : "That I am not that good in programming"

(520110, boy) : "Nothing more than I already knew"

While these answers reveal lack of confidence or disappointment of their performance considering programming and science it is interesting that the same students are rating the workshop as relatively interesting and fun, implying that possibly a better implementation would maybe have more positive results.

(520113, boy) : "It's very fun and interesting but sometimes it gets boring"

(520111, girl) : "It was extremely fun and I enjoyed myself"

(520101, boy) : "This project was super fun and interesting"

(520110, boy) : "Its better than classes"

9.12.9 Connecting STEM to society

It is an interesting fact studying the collected data how students took a further step into connecting the robotics with real world situations and society, both as a useful mean for people in the future and as part of present reality. A 10 years old girl fromAL-1-12-StFrancesMsidaA states that "I learned that robots are good use for sick people so they can check if there is a cancer or whatever in your body". Other students also agree with the usefulness of robots for people with the following comments :

*Robot is not intelligent and robot can help the people (*51204)

I had fun I learned how to program robots that will be helpful in the future (girl, 10 yrs, AL-1-7-DorothyA)

that they are helpful to people (520147 girl 11 yrs.)

that they are everywhere around us (520162 girl 11 yrs.)

That they exist and are not going to be in the future because we already have robots (52059 boy 11yrs.)

they can help people and me too **(***5072 girl 12 yrs.)*

It is fun and interesting. Robots can be very helpful!! (520184 girl 12 yrs)

9.12.10 Engagement in creativity

In the workshop held on Verdala International school and attended by students of both genders aged between 11-14 years old we came across with an example on how STEM helped students develop creativity. During an activity students had to treat robot like it was their student and freely decide what they would like to teach it. Then, they should implement a solution compatible with their idea. Focus group combined all the commands that they had learned up to this point and came along with a creative idea which very proud showed also to the camera. "make dash greet, say "hello", then dance, then say "ta-da", walk a square distance, then greet again by saying "bye". They also implemented correctly all the steps of their idea. The concept of focus group revealed creativity while they came along with an unexpected solution and extension of the activity while some other groups prefered easier ideas like make the robot walk some distance. Nevertheless, the majority of groups came along with rather composite ideas (make robot avoid obstacles or make robot talk and turn) which each one presented in front of the whole class. It was interesting how depending on the complexity and how impressive the implementation looked the students were applauding with more or less enthusiasm their co-students. It is also important to mention that while students were explaining their idea to the tutor and the tutor repeated the steps they wanted Dash to make the tutor announced some steps in wrong order. Instantly the students corrected the teacher in a way that showed that they had fully understand the importance of the right order and accuracy of commands on the structure of a program.

9.12.11 Engagement in collaborative work

Regarding collaboration, in all workshops students worked in small groups of 2-3 persons. In most of the workshops the groups were usually mixed gendered. However some of the schools had same gender classes so there were only same gender groups. Within their group students had to work together with one shared tablet in order to program a Dash robot. Sometimes they distributed roles regarding the control of tablet and robot which switched during the activities.

The roles distribution was evident in the videos and in the interviews. For example the two students below describe to the interviewer how they distributed roles in their team

> *S1. We both decided...we thought that for example I will go get the robot and I will start with the robot like switching it on and he will start programming it. then in the next app we switched and we kept on switching, that's how we went along*
>
> *S2. Even in puzzles we switched, we took it in turns*

At the following part from an interview an 11 years old boy from an elementary school describes to the tutor that they started with roles but then they worked together.

"*sometimes I had the tablet...first we started to have roles like me on the tablet and her on the questions when they got harder we did a group and we start helping each other in one question using the robot together and so on*"

In some cases the collaboration seemed to be very fruitful and effective. Students discussed and exchanged ideas and used the tablet equally. In the questionnaires they mentioned that collaboration was fun and interesting and helped them to achieve their goals in the workshop. For example a 12 years old girl rates the workshop with 5 stars because "*It was a great experience…working with others was fun!*" or another girl mentions "*Working with other people is fun and with teamwork we solved everything!*". In addition there was a 12 years old girl in AL-2-1-CAT workshop who answers on the question "What have you learned about yourself?" "*I learnt that I work better in a team than alone*" and she also adds on the question "What have you learned about working with other people?" "*That is really good because they help you when you need, they encourage you when you need, they give ideas.*" Finally from the elementary schools 51245 mentions that *"I learned that if I work in a team I will have more friends*" and also that "*I learned that in a team there will be masterpieces*".

Evidence of effective collaboration was also present at the interviews of the elementary schools like for example at the following one of AL-1-10-NicholasA

> *I. And you? What did you discover about yourself*
>
> *S1: I discovered is that being together with another person with working together it's much more better than like doing it by yourself because if for example if you have a difficulty like always ask the other person and try to figure out it together*

Finally a very effective collaboration was evident at the focus group of AL-1-11-NicholasB which was a group with two female participants. During their interview they mention:

S1: When we had a problem we tried various ways to figure it out and couldn't think of anything else we called for help

[...]

S2: At first I was thinking maybe if I was alone I would be able to keep playing with the robot but then there were some things that I couldn't understand and Emma could help me

Annalise: So the fact that you have work in a team you saw that it was a positive thing. It actually answer the next question so how did you learn? How did you learn these things? S1:We learned by working together and conversating

S2: Yes like for example if she doesn't know something and I know it I tell it to her...I dont keep it for myself

In the above part of the interview we can see a positive change of S1 view regarding collaboration as she admits that in the beginning she would prefer to work alone but then she realized the importance of collaboration in the difficult parts.

Moreover some students' answers on the questionnaire show not only to have a good collaboration but also to have developed collaborative strategies and skills and to have recognized values for a good collaboration. Some of these values and skills are shown at the following answers of questionnaires:

"I have learned that sometimes you just have to listen to other ideas and see which is the best one". (girl 13 yrs)

"That if we have ideas we must feel free to share them" (girl 12 yrs.)

"That we have to respect and listen to each other opinion" (girl 11 yrs AL-2-10-FRAc)

"I learned that sometimes not everything I do is right" (girl 12 yrs AL-2-10-FRAc)

"That we have to treat people equally" (girl 12 yrs AL-2-10-FRAc)

"To be encouraging" (girl 11 yrs AL-2-10-FRAc)

" I have learned that we have to include all ideas with other people" (girl 10 yrs AL-1-7-DorothyA)

"You have to share" (boy 10 yrs. AL-1-8-AugustineA)

"That I have to be patient and listen to other opinions" (girl AL-1-11-NicholasB)

However the data analysis revealed that in every workshop there was at least one case of problematic collaboration. In most of these cases the fact that students had to share a tablet in order to be involved in the activities made it more difficult for the students to collaborate effectively. Moreover the lack of a construction part made it hard to distribute roles in the activities as all members had to be involved in programming simultaneously. In some workshops the collaboration problems were more common than in others and in some case the difficulties were so intense that seemed to affect the whole experience of the students.

More precisely at the middle schools were emerged 15 cases of groups who had problems with their collaboration. 5 of them were mixed gender groups 7 of them had only female members and 3 of them only male members. This outcome doesn't demonstrate a difference between same gender and mixed gender teams something evident in other countries' workshops. What was evident from the post questionnaires is that in few cases all students of the team mention they experienced a bad collaboration but in most of them it is mentioned only by some of the team members.

One example of the first case is a team of two boys from AL-2-2-CAT who they both strongly agree with the statements "working in a team was difficult" and that "I worked on my own". On the question "what have you learned about working with others" 52058 answers " It was better alone" and 52059 "it can be really annoying". Something interesting is that despite they both agree that "I did the most of the work", 52058 strongly agrees on the statement "I was able to choose what I wanted to do" while 52059 strongly disagrees.

As mentioned before, in the majority of the cases, the difficulties in collaboration wasn't mentioned by all of the team members. This fact indicates that something considered as a problem by one student may not be realized by another. For instance in verdala 2 there was a team with one boy and one girl where the girls agrees that working in a team was difficult and she mentions that "Some teams don't function together" on the question "what have you learned about working with others?". On the contrary the boy doesn't mention any problem and he agrees that working in a team was interesting and fun.

Another interesting case is a group with two girls and one boy from AL-2-1-CAT where both girls accuse the boy on the post questionnaire by saying that "Some people (52018) are annoying". However the comparison of the answers of the boy and the girls to other questions reveals that the boy worked harder in the activities than the girls. More precisely the boy agrees on the statements " I feel that other people did not listen to me" and "I did most of the work" while the 2 girls disagree on the same statements.

In the elementary schools were emerged 12 cases of groups who had difficulties in their collaboration. In these cases 5 of those groups were of mixed gender. It is interesting also to mention that 7 of those groups had 3 members while the rest consisted of 2 members. That observation is possible to suggest that 3 member groups may have an extra difficulty in taking turns with the robot as a student (boy,10) states in his post questionnaire "*It's a problem especially my group with selfish people and 3 people*". Another interesting observation that emerged from analysis is that from the total of 12 cases only in 3 of them all the team members reported a problematic collaboration. In rest of them the problems that were reported belonged just to one student from the team.

In the post questionnaires that were answered by the students of the workshop in Elementary School AL-1-8-AugustineA, there are students who note difficult parts of collaboration. Boy 51194 for example argues that "collaboration slows you down" and 51172 that "collaboration isn't that easy". There was one participate, 51178, whom answers about teamwork show there were problems concerning team's collaboration, as he claims that working in team was neither interesting nor fun and notes "I hate working in team".

There were also some incidents in other elementary schools like AL-1-12-StFrancesMsidaA where students appeared to have difficulties in collaboration. In some cases the problems appeared to be more intense and in some others resolvable in a way that seemed not to influence in a great scale the students' experience of the workshop. In St.Francis participated students of both gender aged between 9-11 years old. A 10 year old boy argues that working with other people was a "so and so" situation while in the general rating of the workshop comments "I had lots of fun but some people did everything trying to leave me out", inclining maybe leadership by one of the rest team members. Another 10 year old girl answers on the question "What did you learn about working with other people?" that "It is very difficult" and on general rating of the workshop "I didn't really like with who I was and they were fighting but the rest was very fun". It is important to mention that both of the students were in the same team that consisted of 3 members. The third member states that "I worked my best I didn't work on my own". Similar comments were noticed also in other 3 member groups on the same school with one student (girl, 10) stating that she learnt nothing about working with other groups because she didn't work with her friends. The other boy of the same age stated about collaboration "It's a problem especially my group with selfish people and 3 people" while the last member found commented "I learned that working with others is interesting".

Other less intense comments that revealed difficulty in collaboration but probably resolvable as they were compared with the answers of the rest members within the group were:

Q: "What have you learned about working with other people?"

A: Boy, 10 "I learned that it is so hard"

A: Boy, 10 "I have leant that it was very annoying difficult"

A: Boy, 10 "That they are always fooling around"

Another reason we consider these comments reveal less tension in collaboration is that the rest of their answers on the questionnaire do not add further information on the topic.

9.13 APPENDIX M: COUNTRY ANALYSIS – AUSTRIA

9.13.1 Learner engagement

Some students were engaged during the workshops. They liked creating and programming a robot. The exercises in the workshops made it possible to get fast results. In addition, the students were engaged by touching and seeing a robot. Therefore, there were two parts to the learner engagement, firstly the exercises involving working on the robot and secondly the first contacts with the robot through viewing and touching.

An example from Interview_TUW_02022017 shows that students engaged with the design and explanations of the workshops. It shows that they preferred detailed descriptions and autonomous work.

Interviewer: "Could you tell me how you liked the workshop?"

12119: "I think it is really cool that we could program ourselves, and also that it has been described very well how to do that and yeah."

12123: "I liked it too and it was very good described what we had to do."

The workshops combined STEM subjects and robotics with an emotional bond. Students showed a positive reaction in STEM subjects (science and mathematics) and robotics to the workshops, saying “it was cool”, “that is cool” and “it can be cool”.

From Interview_TUW_01022017:

Interviewer: “What was the most interesting thing?”

12128: “For me the second part, which has been right now.”

12126: “Yes, in regie-group it was also cool”

From Interview_TUW_260117:

Interviewer: What did you do today?

12036: “We did program robots and build lego.”

Interviewer: “What else? You did built lego and program robots and what was the reason for all of this?”

12063: “That it is fun”

12073: “Lego was cool”

Interviewer: “After yesterday and today did you learn anything?”

12036: “I did learn that robots can be very cool.”

From Post-Questionnaire_TUW_02022017

12123: “I liked the workshop and I have learned new things.” 12123 would like more activities like this.

12101: “It was fun and really interesting.” 12101 wants to learn more about programming.

From Post-Questionnaire_TUW_010217

Q18: “*What you are learning about yourself?”*

12125: “I am interested in science.”

12132: “After the workshop I like programming more than before.”

12133: “I like robots“

Q19: “*What have you learned about working with other people?”*

12125: “It was very funny.”

12132: “It is hard.”

12133: “It's fun.”

Q20: “*What have you learned about robots?”*

12125: “How I can program it and how I wrap everything and make a story out of it.”

12132: “They are complicated.”

12133: “Not very easy to program.”

Q25: “Why do you like the workshop?”

12125: “we had a lot of fun.”

12129: “I have learned a lot and it was funny.”

12135: “It was very funny, I have learned a lot of new things regarding computers.”

12139: “We had a lot of fun.”

12143: “It was very cool, better then school.”

12144: “It were better than school and we had a lot of fun.”

12145: "I had a lot of fun with this workshop."

A subcategory of the learner engagement criterion is the interest of the students in the workshops. The students had different interests and activities. Some of them were interested in programming a robot or in using technology, mathematics or independent learning in order to define their tasks themselves.

From Interview_PRIA_031016

Interviewer: "Now you said what was the most difficult, uh, observed from a different angle, what was the most interesting thing about these days?"

32011: "Also ähm to learn how to program, everything (from front to back)."

32001: "Yes uh the most interesting thing you know how to program well. Yes I liked the programming, the naming, the teaching, simply the function."

From Interview_PRIA_090117

Interviewer: "Ok, what was the most interesting part of your workshop in your sight? So which task or rather the building, the programming."

32110: "Progamming."

Interviewer: "Ok"

32106: "I also liked the programming and later the programming with its own accessories, because you could do what you like."

From Interview_PRIA_200117

Interviewer: "What was the most interesting thing for you, both in building and programming, or was programming more interesting or building?"

32128: "Programming was more interesting to me."

32127: "For me, building was more interesting."

Interviewer: "And for you programming was more interesting."

32128: "Yes."

From Interview_PRIA_031016

Interviewer: "It interests you more than you thought or less than you thought?"

32001: "Yes, I'm more interested than I thought. It was more fun than I thought. I knew () yes. Although it was quite new, I thought it was somehow like math, but it was not because you could build it yourself. You can program yourself, you can be creative, you can build something yourself, you can design it yourself. And it is not everything given but you can try to be creative and yes I like doing something which is not predetermined."

Interviewer: "And (Name 32011) how do you see that?"

32011: "Yes the same way. I do not just, yes that is also so, just as she says that one always with math that one can do almost nothing itself and one does only make prescribed things. There is only one solution for everything."

32001: "With robots, you can find several different solutions, you can build differently, you can program differently, you can do various things, everything possible with the robots. And I like that very much, that you can have much more, different solutions because it gives you a certain freedom that you simply do not have to do exactly what is prescribed but only that you should get the given as a result. There are many different solutions and you can really do what you want."

The students had different experiences in the workshops. One told about his or her experiences and how these experiences involved engagement with STEM and robotics. Below is a selected extract from Interview_TUW_02022017, which shows what students learned through the workshops.

Interviewer: "Do you think you learned something today?"

12119: "Yes, definitely."

Interviewer: "Ok, and, do you think now different about engineering etc.?"

12119: "Hm. not really a different one but I understand now how much work it is to create a game or something like this."

12123: "Yeah."

There some more results found in the Questionnaires.

From Post-Questionaire_TUW_23022017

12085 used knowledge of technology by working with robots. 12085 learned about herself, that she is able to program a robot.

From Post-Questionaire_TUW _02022017

12122 would like to learn more about programming and understand how robots can be used to solve important problems.

12101 would like to try more challenges like this. 12101 want to learn more about programming. Comment: "It was fun and really interesting."

From Post-Questionaire_TUW_01022017

Q18: "What you are learning about yourself?"

12124: "I'm better in working with computers."

12125: "I'm interested in science."

12126: "I like that sort of thinking different and it was nice to see how things like that are done."

12129: "I'm interested in programming and testing."

12131: "Maybe it would be nice to execute a job in science in the future."

12133: "I like robots."

The students learned through the workshops about their subjective perceptions in STEM. They were able to verify their subjective perception through the workshops. Below are some examples where students tell how difficult the activities of the workshops were.

From Post-Questionaire_TUW_01022017

Q20: "What have you learned about robots?"

12125: "How I can programme it."

12126: "How they work and how i can programme them."

12132: "They are complicated."

12133: "Not very easy to program."

From Interview_PRIA_20170123

Interviewer: "What about you? Has your opinion changed during the workshop?"

32109: "Yes, now I know it is very difficult and you must also () work and not just a code and that is it and yes."

9.13.2 Changing & sustaining attitudes to STEM

The survey reveals how some students changed their views regarding STEM or robotics as a result of the workshops. Such a change occurred regarding both positive and negative attitudes to STEM. Sometimes the attitudes did not change. The analysis process must first look at the results of the pre-questionnaires and then compare them with the results of the post-questionnaires.

From Pre-Questionaire_TUW_23022017

12086 (Q12) would like a job in the future with sports.

From Post-Questionaire_TUW_23022017

12086 (Q12) changed his attitude from sport to science.

From Post-Questionaire_TUW_02022017

12101 (Q21_2) is now more interested to study science in the future.
12101 (Q18) learned that he/she like programming and (Q20) that robots are cool.

12098 After the workshop he understand how important is (Q21_9) math and (Q21_10) science. 12098 (Q21_15) would like to learn math in robotic workshops like this.

From Post-Questionaire_TUW_01022017

Q18: "What you are learning about yourself?"

12131: "Maybe it would be nice to execute a job in science in the future."

12132: "After the workshop I like programming more than before."

From Interview_PRIA_100117

Interviewer: "You too. Has the workshop changed your mind about it? Are you less interested in this now, or perhaps you are even more interested in technology?"

32081: "More."

Interviewer: "Because you now see how to program something?"

32081: "More."

32080: "More."

Interviewer: "Do you think this workshop will help other children so that they are more interested in how things work?"

32080: "Yes."

Interviewer: "And why?"

32081: "Because the children can learn from it."

From Interview_PRIA_031016

Interviewer: "And to what extent have you believed in these weeks where the robotics course was changing your mind about how interesting science, technology, mathematics can be?"

32011: "I do not know about the same as before, for me nothing has changed much."

32001: "Not with me either. Mathematics is still not a favorite subject and technology still interests me. A lot has not changed."

Interviewer: "And you both believe these weeks have changed with the robotic workshop, uhm, your opinion a bit, what you want to do as after school?"

32011: "No for me not."

32001: "No, I still do not know exactly what I want to do, so I stay in school because it is very general here and it is not exactly a branch. So I can really do everything afterwards and I will (also come through)."

32011: "So I still want to do the same as before, so something with veterinary medicine so probably."

9.13.3 Connecting STEM to society

Most of the results concerning this topic were found in the post-questionnaires. There are some examples that show that students connect STEM or robotics to society.

From Post-Questionaire_PRIA_051216

Q18: What have you learned about yourself?

32050: "I have learnt how important science is in everyday life."

Q20: What have you learned about robots?

32052: "That robots can help the world."

32054: "That they are very complicated. They are also important for humans."

From Post-Questionaire_PRIA_100117

Q20: "What have you learned about working with robots?"

32081: "That robots can help older people."

From Post-Questionaire_PRIA_150517

Q20: "What have you learned about working with robots?"

32276: "That robots can simplify your life."

From Post-Questionaire_PRIA_221216

Q18:" What have you learned about yourself?"

32067: "That people seriously need robots."

From Post-Questionaire_PRIA_300117

Q20: "What have you learned about robots?"

32156: "They help humans."

From Post-Questionaire_PRIA_310117

Q20: "What have you learned about robots?"

32174: "They are used very often to help/substitute humans. They have become an important part."

32177: "That they simplify our everyday life."

9.13.4 Creativity

The criterion of creativity includes problem solving and designing a robot as a kind of art in the workshops. The videos show students revealing their creative ideas and constructions.

From Video_TUW_06032017_Observation1_00127

At the minute 26:13 the student 12008 takes, his pencil case and put it in front of the robots to get a reaction from the robot. He tried to activate the sensors.

This shows a creative problem solving.

From Video_TUW_23022017_Langegasse_3b

Minutes 13:16–13:30: The group in the first row on the right-hand side expands the exercise on their own and develops a special solution for their problem. They build a ramp with carton plates so that the *robot has to drive upwards and downwards. With this construction, they can test the angle sensor of the robot.*

Minutes 05:40–10:54: The group in the first row on the left-hand side experiments with the robot. They want to know which objects the robot can slide on the table. What is the reaction of the robot? How do the sensors function? In this situation, all the members of the team stay around the table and watch the action.

In the next extracts, students talk about their opportunities concerning being creative during the workshops.

From Interview_PRIA_031016

Interviewer: "And now for yourself, have you come closer to an answer on what interests you in the field of technology?"

32001: "Yes."

Interviewer: "It interests you more than you thought or less than you thought?"

32001: "Yes, I'm more interested than I thought. It was more fun than I thought. I knew () yes. Although it was quite new, I thought it was somehow like math, but it was not because you could build it yourself. You can program yourself, you can be creative, you can build something yourself, you can design it yourself. And it is not everything given but you can try to be creative and yes I like doing something which is not predetermined."

From Interview_PRIA_200117

Interviewer: "For you, building was more interesting?"

32127: "Yes, because you could choose how to build it."

Interviewer: "Ok, so you could decide for yourself and be creative."

32127: "Yes Yes Yes."

From Post-Questionaire_PRIA_051216

Q18: "What have you learned about yourself?"

32046: "That I can show my creative side mostly while designing. I found it really cool."

32053: "That I'm not very creative. A bit, but not very much."

From Post-Questionaire_PRIA_150517

Q18: "What have you learned about yourself?"

32286: "That I'm very creative."

From Post-Questionaire_PRIA_300117

Q18:" What have you learned about yourself?"

32150: "That I'm good at improvising."

9.13.5 Collaborative working

In every workshop, students worked in groups of two or three members. Collaborative working was seen. One category of collaborative working was revealed in common organising and planning. In Interview_PRIA_031016, students talk about their organising and planning.

Interviewer: "Then I have the question, who has done what during this time?"

32001: "We split it up."

32011: "So we both have together."

32001: "We have assembled, programmed together, we have always changed, that we also understand what makes."

32011: "We did everything else together."

Interviewer: "Um and who has decided what you are going to do next or what tasks you will be working on?"

32001: "We just talked and then have.."

32011: "..decided together ()"

Interviewer: "This means, none of you has worked more in direction and took care after that?"

32011: "No we did it together and."

Interviewer: "Mhm, um. Now I have some questions about learning. Um. What do you think you would say you learned during this?"

32011: "Yeah, we've learned how to program it, how to do it, and how to do it together that the robot really does what you want, yeah."

There are other interviews in which the interviewer and students talk about organising and planning their tasks and activities.

From Interview_PRIA_090117

Interviewer: "Okay, did you do it all at the same time, or did you split the work up, who did what?"

32106:"We actually split as well as actually, one has programmed the robot, which was me. He was responsible for the parts to build and <32110 Name> was responsible for collecting the parts or assembling them with <32109 Name>."

From Interview_PRIA_100117

Interviewer: "Together? And who has decided what you will do?"

32081: "We decided together, we asked so, you want to do that you want to do that."

From Interview_PRIA_20170127

Interviewer: "Did you split the work or did you do it all together or did you say that one is building and the other one is programming or have you switched? How did you split it up?"

32127: "We've switched."

Interviewer: "So one [has programmed and one built and vice versa."

32127: "Yes Yes."

Collaborative working needs good communication and discussion. Interview_PRIA_200117 shows students talking about finding a compromise as a normal situation.

Interviewer: "Ok, I just wanted to ask about that. So you have been trying to learn how to co-ordinate and make decisions for the robot, how to build it and how to program it? Have you tried this or has one said we [make it like this or have you tried together to find a solution?"

32128: "No."

32127: "We had no problems, so we did everything together."

32128: "So we said our own opinion and then we found a compromise."

The students had a respectful communication with each other. In Post-questionnaire_PRIA_310117, students speak about their learning while working with other people. They say that they learned during the workshops to listen to each other.

Q19: "What have you learned about working with other people?"

32178: "That you have to listen to the others, maybe they know it better."

32172: "Listen to others."

32180: "It was fun and we listened to each other when we had ideas."

Collaborative working includes helping others. Sometimes a student of one group supported a student in another group. They took help, gave support and asked for help. This is shown by Video_TUW_06032017_00126.

Minutes 6:40-07:00: 12004 says to 12013, he is sitting in another group: "You have to push here." 12013 replies: "That does not function by us." After this conversation, the boy allow the girl to control the robot.

Minutes 17:22-18:40: 12020 goes to the group (12022, 12003) to support them. She shows them, how to control the robot.

From Video_TUW_06032017_00125:

At the minute 15:45: Group 3 asks the group 2: "How did you do this?"

At the minute 16:05: 12012 says to the group 3 "Push the middle button very long."

From Interview_TUW_260117:

Interviewer: “Yeah, for you too? What has been the most interesting thing?”

12036: “Mine, so it was that I could say () and that I could help.”

The groups were usually led by one student. Sometimes another student took the position of leader during the activities of a group. The next case shows a female taking the position of leader and finding a compromise with her group member. They changed their roles during the working process. This is shown by Video_TUW_06032017_134.

Minutes 01:30-6:45: Children sit around and observe the robot. 12013 leaves the group with one robot in hand to programme it again. Other students (12005, 12001, 12004) follow him. 12013 (a male) tries to programme the robot on the computer. 02:38: 12004 (a female) takes the leading role and takes the mouse to programme the robot. 12013 says: "I am making that." 12004 says: "No, you are making it wrong. I am making it." Then she gives the role back to 12013. While 12013 is programming, she says: "No!! (little brake) No!! (brake) No!!" She puts her face in her hands. 12013: "Why not?" 12008: "I will say it to you." She explains to him the function of the robot. 12013 tries it again. 12008 helps him again. 06:45: They find a compromise and solve the problem through collaborative working.

Several post-questionnaires show different attitudes to collaborative working. There are different opinions in the same group.

From Post-Questionaire_PRIA_02022017:

Q19: "What have you learned about working with other people?"

32210: "Together you are more efficient, help with problems, more fun than alone."

31150: "Teams never work."

From Post-Questionaire_PRIA_051216:

Q18: "What have you learned about yourself?"

32044: "That working in a team and helping each other is important. And that it's more fun than I thought."

Q19: "What have you learned about working with other people?"

32049: "That by working together, something amazing can be formed."

32050: "It can be fun, but can also be the opposite."

From Post-Questionaire_PRIA_090117:

Q18: "What have you learned about yourself?"

32106: "I am able to do it better without a team."

From Post-Questionaire_PRIA_100117:

Q18: "What have you learned about yourself?"

32084: "I learned that I have fun working in a team."

From Post-Questionaire_PRIA_200117:

Q18: "What have you learned about yourself?"

32121: "I learned about myself, that with a team you can realize the funniest and best idea."

Q19: "What have you learned about working with other people?"

32118: "It is difficult."

From Post-Questionaire_PRIA_201216:

Q18: "What have you learned about yourself?"

32292: "That I am good in helping others."

From Post-Questionaire_PRIA_270117:

Q19:" What have you learned about working with other people?"

32132: "That it's sometimes difficult but still funny."

From Post-Questionaire_PRIA_300117:

Q19:" What have you learned about working with other people?"

32154: "That solving a problem is easier with the help of some others."

32156: “A project can be finished quicker this way.”

32158: ”That you don't have to do everything on your own but you can also split the work.”

32160: ”That some people help you and others only do nonsense.”

9.14 APPENDIX N: QUESTIONNAIRE ANALYSIS (PROJECT LEVEL)

9.14.1 Prequestionnaire Analysis: General

This section uses the whole answers provided by the participants who answered the prequestionnaire. A total of 1424 were obtained for the prequestionnaire.

9.14.1.1 LANGUAGES

In this subsection is reported the languages spoken at home by the participants. In the following tables the total corresponds to the total number of participants who answered the prequestionnaire. Unfortunately, there is no way to know if the participants did not answer or do not speak the language. Table 8 reports the number of participants who speak English at home. As it could be seen more than 50% of the participants from AL speak English at home. Most of CU participants speak English at home.. Table 10 reports the top 9 of the languages spoken at home. As it could be seen, French is the number one language, with 28 participants who spoke it at home. Second is Turkish and third Serbian. PRIA is the partner with the biggest number of participants who speak Turkish and Serbian at home.

Table 8 Prequestionnaire Analysis: General. Languages spoken at home. Number of participants who speak English at home

	Do you speak English at home?		
Partner	**No or No Answer**	**Yes**	**Total**
AL	174	228	402
CU	7	96	103
ESI	321	25	346
PRIA	243	28	271
TU Wien	169	13	182
UoA	120	0	120
Total	**1034**	**390**	**1424**

Table 9 Prequestionnaire Analysis: General. Languages spoken at home. Top 9 of other languages spoken at home per partner.

Partner	French	Turkish	Serbian	Russian	Italian	Romanian	Croatian	Polish	Bosnian	Total
AL	5	3	1	4	10	1		1		402
CU	3									103
ESI			1	6						346
PRIA		20	15	2		8	7	2	3	271
TU Wien	20	3	5	6	3	2	3	7	4	182
UoA				1						120
Total	**28**	**26**	**22**	**19**	**13**	**11**	**10**	**10**	**7**	**1424**

9.14.1.2 CAREER PREFERENCES – PREQUESTIONNAIRE

The number total of participants who answered the question "*what job would you like to do?*" is 1317. Table 11 presents the number of participants that wrote a STEM career. As it could be observed, PRIA is the partner with the biggest number of participants interested in STEM careers. On the other hand, CU is the partner with the lowest number of participants who are interested on it. As it could be observed in Table 12, there is significant difference in the number of participants per gender. As it could be seen, a big number of male in comparison to female who would like to study a STEM career. As it could be observed in Figure 4 and Table 13, the biggest number of participants is found at the age of 10. There is also possible to observe that most of the participants are distributed from 9 until 17 years old. As it could be observed in Table 14 and Figure 5, there is a difference between gender at the age of 9, 10, 12, and 15. From the ages of 9 until 17, there are more male interested in STEM that female.

Table 10 Prequestionnaire Analysis: General. Career preferences – Prequestionnaire. Number of participants who answered the question "What job would you like to do?" and the ones who wrote a STEM career per partner.

Partner	Number of Participants who wrote a STEM career	Total
AL	57	399
CU	9	94
ESI	56	297
PRIA	82	240
TU Wien	19	168
UoA	34	119
Total	**257**	**1317**

Table 11 Prequestionnaire Analysis: General. Career preferences – Prequestionnaire. Number of participants who answered the question "What job would you like to do?" and the ones who wrote a STEM career per partner and gender.

	Number of Participants who wrote a STEM career		Total Number of Participants	
Partner	Male	Female	Male	Female
AL	27	30	146	253
CU	1	8	43	51
ESI	45	11	156	141
PRIA	69	13	152	87
TU Wien	15	4	81	87
UoA	21	12	70	48
Total	**178**	**78**	**648**	**667**

Table 12 Prequestionnaire Analysis: General. Career preferences – Prequestionnaire. Number of participants who answered the question "What job would you like to do?" and the ones who wrote a STEM career per partner and age.

	Number of Participants who wrote a STEM career															Total Number of Participants														
Partner	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**Total**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**Total**
AL				2	25	12	14	4							**57**				9	164	108	93	24	1						**399**
CU					1	7									**8**			5	11	11	21	42								**90**
ESI			1	18	24	6	5								**54**			16	99	139	16	22								**292**
PRIA			4			4	14	13	5	6	14	12	6	3	**81**		7	22	4	13	17	50	45	10	9	20	23	9	4	**233**
TU Wien	2	5		6	2			1		3					**19**	23	25	14	24	13	2		16	26	21	2	1	1		**168**
UoA					1	3	6	4	4	12	4				**34**					3	21	13	20	27	27	7				**118**
Total	**2**	**5**	**5**	**26**	**53**	**32**	**39**	**22**	**9**	**21**	**18**	**12**	**6**	**3**	**253**	**23**	**32**	**57**	**147**	**343**	**185**	**220**	**105**	**64**	**57**	**29**	**24**	**10**	**4**	**1300**

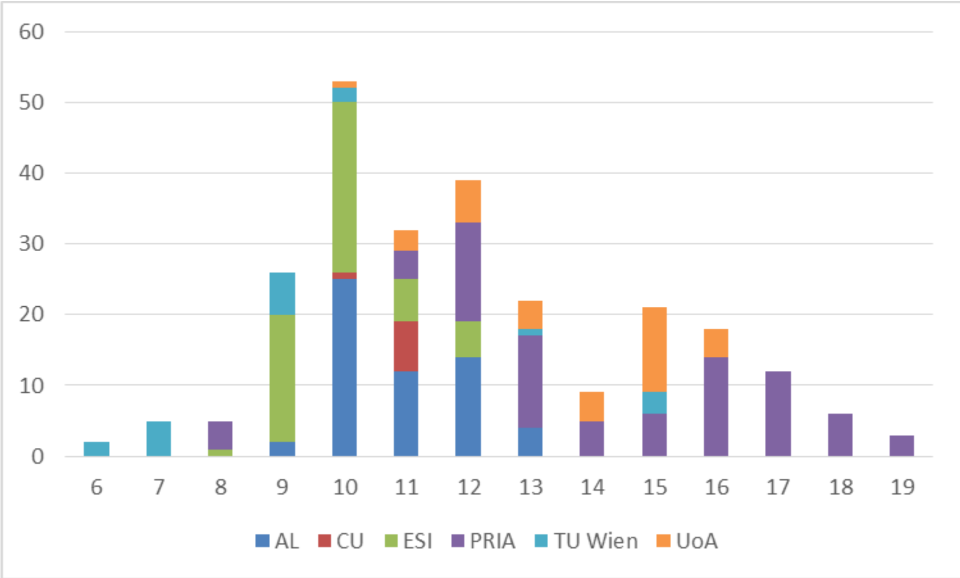


Figure 11 Prequestionnaire Analysis: General. Career preferences – Prequestionnaire. Number of participants who answered the question "What job would you like to do?" and the ones who wrote a STEM career per partner and age.

Table 13 Prequestionnaire Analysis: General. Career preferences – Prequestionnaire. Number of participants who answered the question "What job would you like to do?" and the ones who wrote a STEM career per partner, gender and age.

	Number of Participants who wrote a STEM career																									
	6	7		8		9		10		11		12		13		14		15		16		17		18	19	
Partner	**M**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**M**	**Total**
AL						2		19	6		12	6	8		4											57
CU									1	1	6															8

ESI				1		14	4	20	4	4	2	4	1												54
PRIA					4					3	1	13	1	11	2	5		5	1	12	2	10	2	6	3	81
TU Wien	2	4	1			4	2	2							1			3								19
UoA									1	2	1	5	1	2	2	2	2	7	5	3						33
Total	**2**	**4**	**1**	**1**	**4**	**20**	**6**	**41**	**12**	**10**	**22**	**28**	**11**	**13**	**9**	**7**	**2**	**15**	**6**	**15**	**2**	**10**	**2**	**6**	**3**	**252**

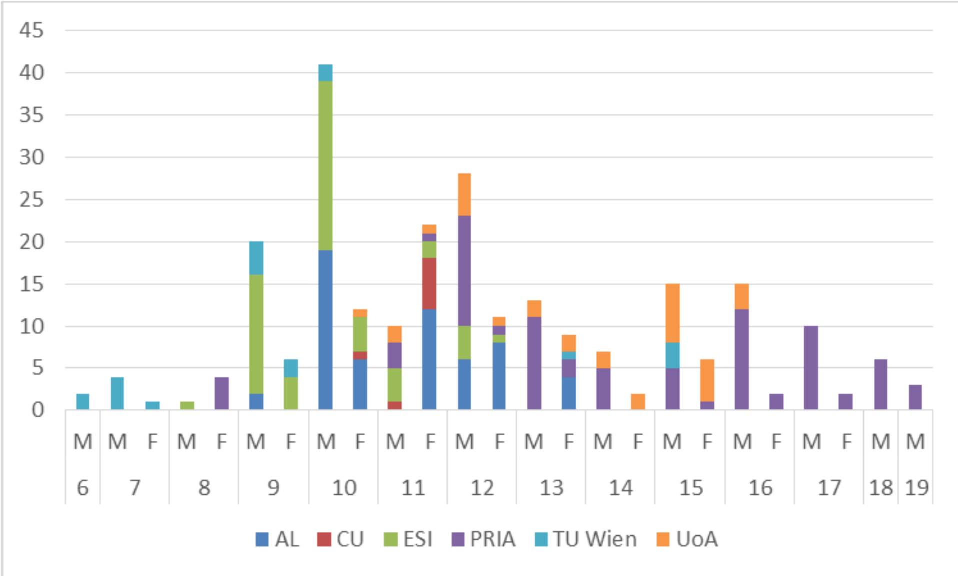


Figure 12 Prequestionnaire Analysis: General. Career preferences – Prequestionnaire. Number of participants who answered the question "What job would you like to do?" and the ones who wrote a STEM career per partner, gender and age

9.14.1.3 PREVIOUS EXPERIENCE WITH ROBOTICS – HAVE YOU EVER CREATED A ROBOT BEFORE?

The total number of participants who answered this question was 1403 out of 1424. Table 15 reports the number of participants who have created a robot and those who not. It could be observed that a vast majority of participants from ESI have created a robot before. A significant number from the rest of the partners, an exception of CU, have created a robot before. As it could be observed in Table 16, there are more male participants from ESI, PRIA and UoA than female who have created a robot before. Female participants from the rest of the participants are in the lead but the difference in small in comparison to the ration in the other partners. As it could be seen in Table 17, school is the place where most participants have created a robot and home with less. Regarding the number of participants per place and partner, it could be observed in Figure 6 that most of the participants from ESI have done it in their school. As it could be observed in Table 18, the biggest number of participants with previous experience at the age of 10. It is also possible to observe that in all ages there are at least two participants with previous experience. As it could be observed in Table 19 and Figure 7, the number of male participants who have created a robot before is greater than the female participants in the age range 6 to 12 and 15 to 19. In the ages 13 and 14 the number of female is slightly bigger than male participants.

Table 14 Prequestionnaire Analysis: General. Previous experience with robotics – have you ever created a robot before? Number of participants per partner.

Partner	No Answered	No	Yes	Total
AL	6	301	95	402
CU	2	89	12	103
ESI	6	136	204	346
PRIA	4	183	84	271
TU Wien	1	120	61	182
UoA	2	62	56	120
Total	**21**	**891**	**512**	**1424**

Table 15 Prequestionnaire Analysis: General. Previous experience with robotics – have you ever created a robot before? Number of participants per partner and gender.

	No		Yes			Total	
Partner	M	F	M	F	Gender was not provided	M	F
AL	103	198	42	53		145	251
CU	39	50	5	7		44	57
ESI	59	77	123	81		182	158
PRIA	111	72	61	22	1	172	94
TU Wien	63	57	24	37		87	94

UoA	27	35	43	12	1	70	47
Total	**402**	**489**	**298**	**212**	**2**	**700**	**701**

Table 16 Prequestionnaire Analysis: General. Previous experience with robotics – have you ever created a robot before? Number of participants who have created a robot before per place and partner

Partner	**School**	**Club/Workshop**	**Home**
AL	22	44	33
CU	10	0	5
ESI	160	43	30
PRIA	45	18	21
TU Wien	16	32	18
UoA	23	18	14
Total	**276**	**155**	**121**

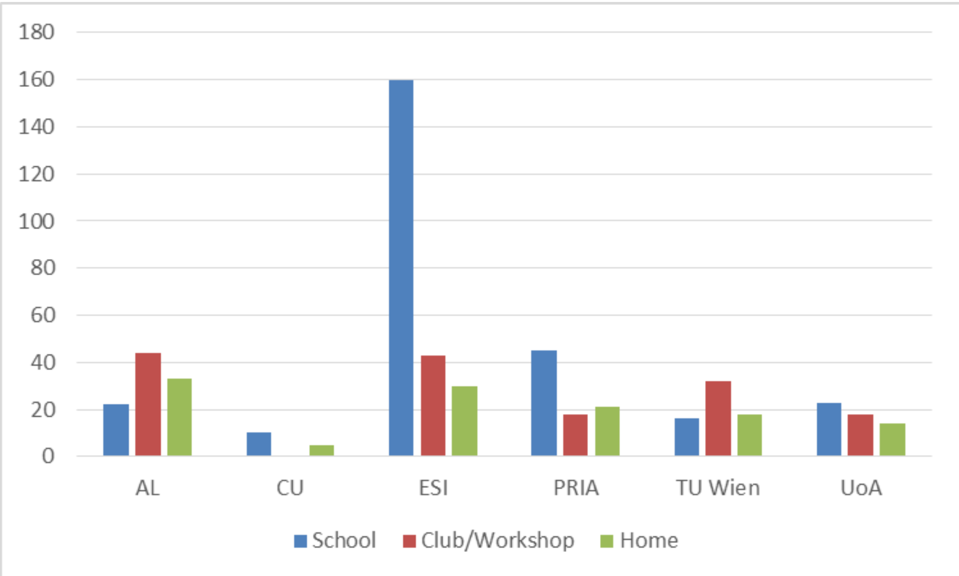


Figure 13 Prequestionnaire Analysis: General. Previous experience with robotics – have you ever created a robot before? Number of participants who have created a robot before per place and partner

Table 17 Prequestionnaire Analysis: General. Previous experience with robotics – have you ever created a robot before? Number of participants per partner and age.

	no														yes															
Partner	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**NA**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**NA**	**Total**
AL				7	126	84	68	16										2	37	24	23	8	1							396
CU			4	9	8	23	42							3			1	2	3	1	3								2	101
ESI			14	81	9	12	17							3			6	38	138	6	11								5	340
PRIA		7	19	3	13	9	44	48	9	8	12	4	1	6		1	4	1	1	7	8	4	1	1	14	28	9	4	1	267
TU Wien	21	20	8	16	11	2		7	14	18		2	1		2	6	6	7	3			10	16	9	2					181
UoA					2	15	7	11	13	14										5	6	9	14	14	7				1	118
Total	**21**	**27**	**45**	**116**	**169**	**145**	**178**	**82**	**36**	**40**	**12**	**6**	**2**	**12**	**2**	**7**	**17**	**50**	**182**	**43**	**51**	**31**	**32**	**24**	**23**	**28**	**9**	**4**	**9**	**1403**

Table 18 Prequestionnaire Analysis: General. Previous experience with robotics – have you ever created a robot before? Number of participants who answered "yes" per partner, gender and age

	yes																													
	6		**7**		**8**		**9**		**10**		**11**		**12**			**13**		**14**		**15**		**16**			**17**		**18**	**19**	**NA**	
Partner	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**NA**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**NA**	**M**	**F**	**M**	**M**	**M**	**F**
AL							1	1	23	14	2	22	12	11		3	5	1												
CU					1		1	1	2	1		1		3															1	1
ESI					5	1	27	11	73	65	4	2	10	1															4	1
PRIA				1	4		1			1		7	3	4	1	4		1			1	12	2		22	6	9	4	1	

TU Wien	1	1	4	2	1	5	3	4	2	1						1	9	3	13	8	1	1	1							
UoA											5		6			6	3	11	3	10	4	5	1	1						1
Total	**1**	**1**	**4**	**3**	**11**	**6**	**33**	**17**	**100**	**82**	**11**	**32**	**31**	**19**	**1**	**14**	**17**	**16**	**16**	**18**	**6**	**18**	**4**	**1**	**22**	**6**	**9**	**4**	**6**	**3**

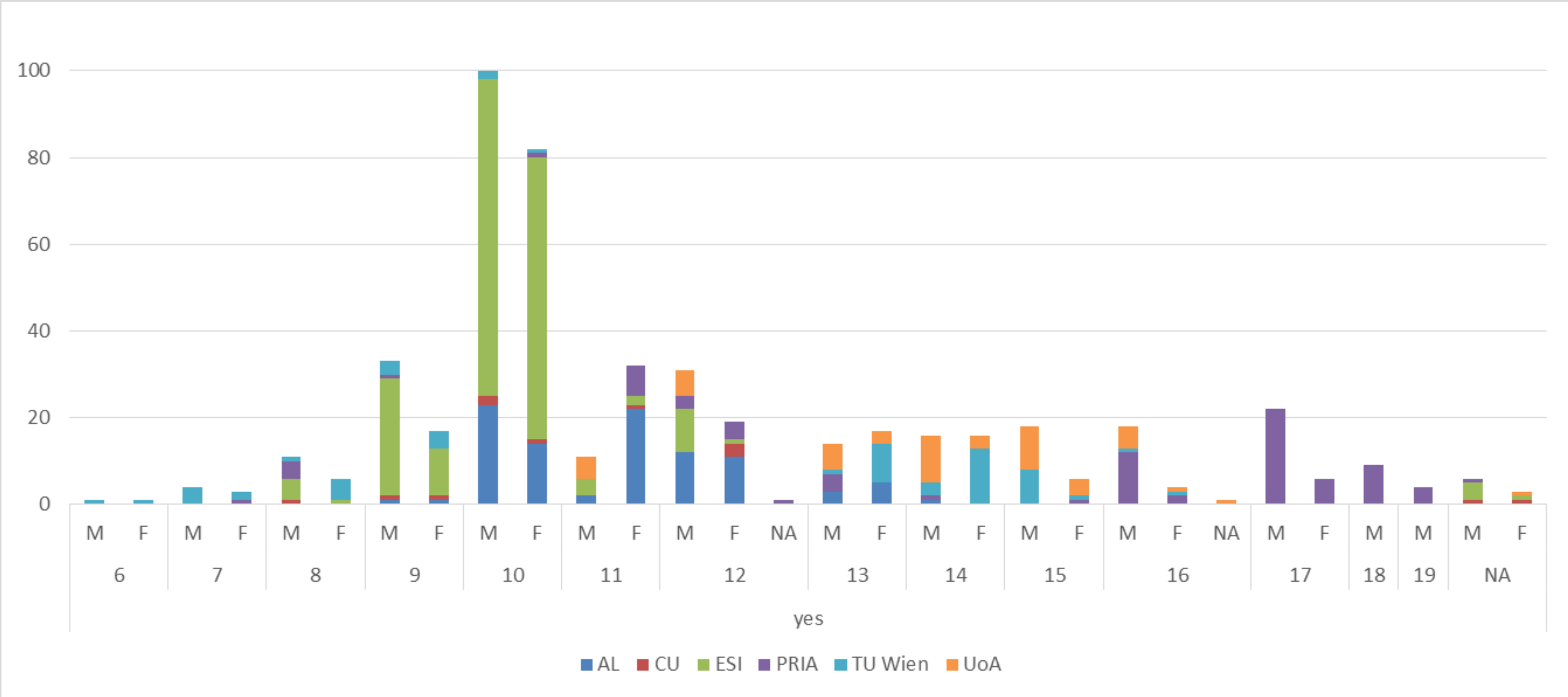


Figure 14 Prequestionnaire Analysis: General. Previous experience with robotics – have you ever created a robot before? Number of participants who answered “yes“ per partner, gender and age.

9.14.1.4 PREVIOUS EXPERIENCE IN PROGRAMMING – HAVE YOU EVER DONE ANY PROGRAMMING BEFORE?

The total number of participants who answered this question was 1389 out of 1424. Table 20 reports the number of participants who have programmed and those who not. It could be observed that a majority of the participants have had an experience in programming. Also, it is possible to observe that 68% of UoA's, 58% of ESI's and CU's, and 51% of AL's have a previous experience. As it could be observed in Table 21, there are more male participants than female participants with previous experience in programming. Also, it is possible observed that female participants from AL, CU and TU Wien with previous experience are more than male participants. As it could be observed in Table 22, the place where most participants have programmed is at school. As it could be observed in Figure 8, participants from almost all partners have mainly programmed at school. The only exception is TU Wien, where participants have mainly programmed at Club/Workshop. As it could be seen in Table 23, the biggest number of participants with previous experience could be found at the age 10. Also, ages 11 and 12 have a significant number of participants. It is important to observe that there are at least 4 participants in all the ages. As it could be observed in Table 24 and Figure 9, the number of male participants per age is bigger in almost all the ages. The main exceptions are at age of 11 and 12.

Table 19 Prequestionnaire Analysis: General. Previous experience in programming – Have you ever done any programming before? Number of participants per partner.

Partner	No Answered	No	Yes	Total
AL	9	185	208	402
CU	6	37	60	103
ESI	10	131	205	346
PRIA	7	137	127	271
TU Wien	2	97	83	182
UoA	1	37	82	120
Total	**35**	**624**	**765**	**1424**

Table 20 Prequestionnaire Analysis: General. Previous experience in programming – Have you ever done any programming before? Number of participants per partner and gender.

	No		Yes			Total	
Partner	M	F	M	F	No Answered	M	F
AL	63	122	84	124		147	246
CU	16	21	25	35		41	56
ESI	55	76	126	79		181	155
PRIA	73	64	96	30	1	169	94
TU Wien	52	45	34	49		86	84
UoA	21	16	50	31	1	71	47

Total	**280**	**344**	**415**	**348**	**2**	**695**	**692**

Table 21 Prequestionnaire Analysis: General. Previous experience in programming – Have you ever done any programming before? Number of participants who have programmed before per place and partner

Partner	School	Club/Workshop	Home
AL	142	36	39
CU	48	0	8
ESI	140	49	35
PRIA	80	14	26
TU Wien	29	40	18
UoA	51	19	11
Total	**490**	**158**	**137**

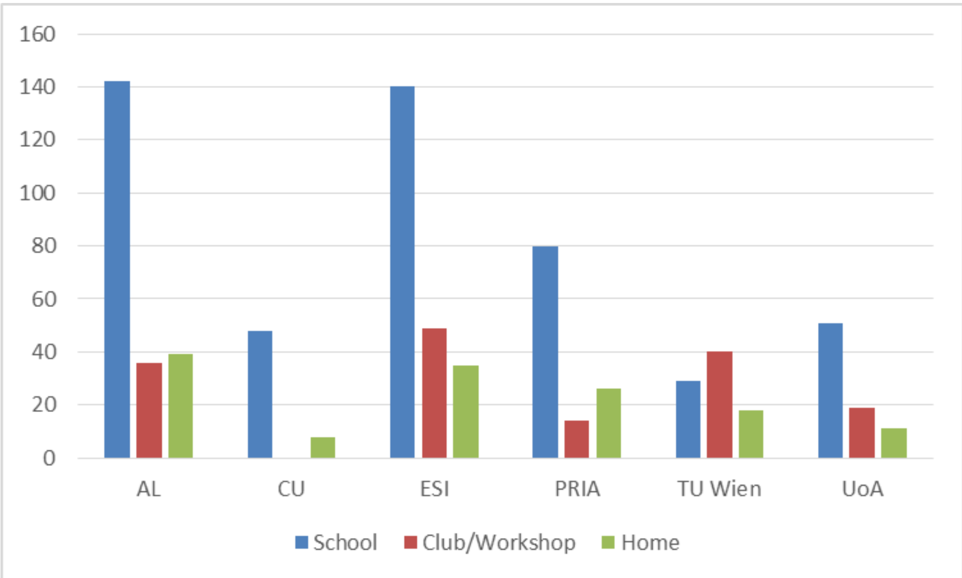


Figure 15 Prequestionnaire Analysis: General. Previous experience in programming – Have you ever done any programming before? Number of participants who have programmed before per place and partner.

Table 22 Prequestionnaire Analysis: General. Previous experience in programming – Have you ever done any programming before? Number of participants per partner and age.

Partner	no													yes														
	6	7	8	9	10	11	12	13	14	15	16	17	NA	6	7	8	9	10	11	12	13	14	15	16	17	18	19	NA
AL				6	90	43	37	9									3	73	63	53	15	1						
CU			1	8	4	9	15									4	5	5	13	30								3
ESI			14	73	14	10	17						3			6	42	133	8	11								5
PRIA		4	11	2	13	11	39	39	6	5		1	6		3	12	2	1	6	12	11	4	4	26	31	10	4	1
TU Wien	15	11	12	18	11	2		7	8	12	1			8	15	2	5	3			10	22	14	1	2	1		
UoA					2	8	6	12	5	3	1							1	12	7	8	22	25	6				1
Total	**15**	**15**	**38**	**107**	**134**	**83**	**114**	**67**	**19**	**20**	**2**	**1**	**9**	**8**	**18**	**24**	**57**	**216**	**102**	**113**	**44**	**49**	**43**	**33**	**33**	**11**	**4**	**10**

Table 23 Prequestionnaire Analysis: General. Previous experience in programming – Have you ever done any programming before? Number of participants who answered "yes" per partner, gender and age

Partner	yes																													
	6		7		8		9		10		11		12			13		14		15		16			17		18	19	NA	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	NA	M	F	M	F	M	F	M	F	NA	M	F	M	M	M	F
AL							2	1	46	27	7	56	20	33		8	7	1												
CU					1	3	3	2	2	3	4	9	12	18															3	
ESI					5	1	31	11	74	59	4	4	8	3															4	1
PRIA			2	1	8	4	2			1		6	7	4	1	8	3	4		3	1	22	4		25	6	10	4	1	

TU Wien	1	7	7	8		2	3	2	1	2						2	8	7	15	10	4	1			1	1	1			
UoA										1	8	4	6	1		4	4	15	7	13	12	4	1	1						1
Total	**1**	**7**	**9**	**9**	**14**	**10**	**41**	**16**	**123**	**93**	**23**	**79**	**53**	**59**	**1**	**22**	**22**	**27**	**22**	**26**	**17**	**27**	**5**	**1**	**26**	**7**	**11**	**4**	**8**	**2**

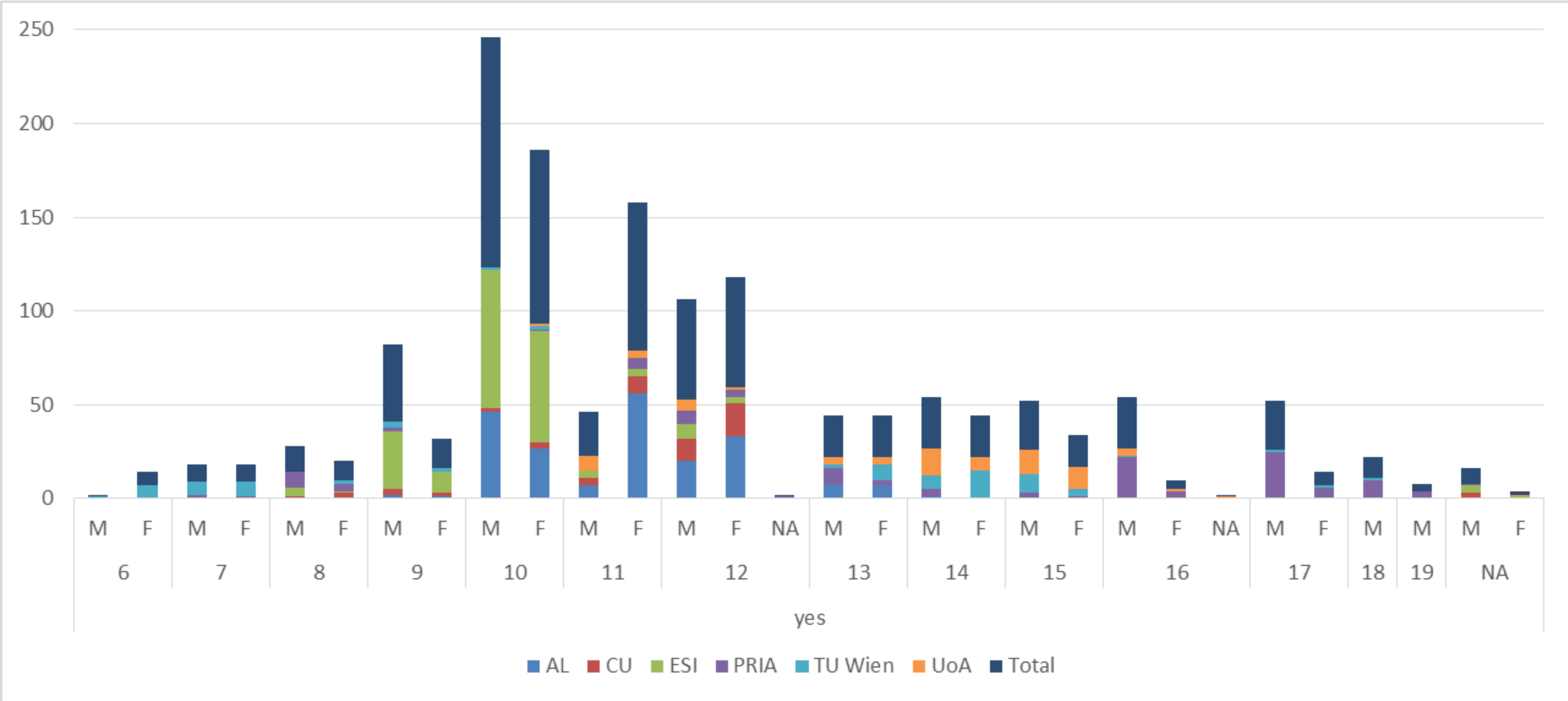


Figure 16 Prequestionnaire Analysis: General. Previous experience in programming – Have you ever done any programming before? Number of participants who answered “yes“ per partner, gender and age.

9.14.1.5 CONCLUSIONS

Most of the participants from CU and a majority of participants from AL speak English at home. In the rest of the partners the number is below 10%, with a special case in UoA, where there are no participants who speak English at home. French is the most talked language besides the local and English. It is followed by Turkish and Serbian.

The number of participants who wrote a STEM career are 257. To check the list of answers that were considered as STEM, please look in general comments. There is a big difference in the number of male and female participants at project level. The only case in which female participants are more than male participants is in AL. Looking at age, there is a big peak at age of 10, with significant number at age of 9, 11 and 12. Moreover, at all ages there is at least two participants who are interested in a STEM career. Analysing also per gender, it is possible to observe that in most of the ages male participants are more than female participants. The exceptions are at age of 11, where female participants are the double of male participants.

ESI is the partner with the biggest number of participants who have created a robot before. Almost a 30% of participants from all the project have a previous experience in robotics. The number of male participants from ESI, PRIA and UoA is bigger than female participants. Female participants are more in AL, CU and TU Wien than male participants. School is the place where more participants have worked in robotics. ESI is the partner with the biggest number of participants who have done robotics at school.

A majority of participants have a previous experience in programming. ESI and ESI are the partners with the biggest numbers of participants. The number of female participants from AL, CU and TU Wien is bigger than the number of males with previous experience, the appositive is in the other partners. School is the place where most of the participants have programmed. The only exception is TU Wien, where a majority of participants have programmed in a Club/Workshop. The number of male participants is bigger in almost all the ages. The exceptions are at age of 11 and 12, where are more female than male participants.

9.14.2 Prequestionnaire Analysis: Likert scale

9.14.2.1 I LIKE USING COMPUTERS

Table 25 reports the frequencies for the question I like using computers and Table 26 reports the descriptive statistics. As it could be observed, most of the participants from AL, CU, ESI, PRIA and UoA strongly agree and agree with the statement. Although a majority of participants from TU Wien strongly agree and agree, there is almost 20% of TU Wien participants who are neutral. As it could be observed in Table 27 and Table 28, there is not considerable differences between genders all the partners. The main difference between genders is found in TU Wien and UoA, where male participants tend to strongly agree while female participants tend to be divided between strongly agree and agree. As it could be observed in Table 29 and Table 30, there is not considerable difference between age group per partner. As it could be seen in Table 31 and Table 32, the main difference between genders per age group is the distribution between agree and strongly agree.

Table 24 Prequestionnaire Analysis: Likert scale. I like using computers per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	5	2	21	117	252	397
CU	1	1	7	27	66	102
ESI	4	2	7	76	248	337
PRIA	3	3	14	58	190	268
TU Wien	2	8	31	51	86	178
UoA	1	1	7	40	69	118
Total	**16**	**17**	**87**	**369**	**911**	**1400**

Table 25 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like using computers per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	5	4.53	5	5
CU	1	4	5	4.53	5	5
ESI	1	4	5	4.67	5	5
PRIA	1	4	5	4.60	5	5
TU Wien	1	4	4	4.19	5	5
UoA	1	4	5	4.48	5	5

Table 26 Prequestionnaire Analysis: Likert scale. I like using computers per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	4	2	17	90	138	251
AL	M	1	0	4	27	114	146
CU	F	1	0	6	21	29	57
CU	M	0	1	1	6	37	45
ESI	F	2	1	6	42	106	157
ESI	M	2	1	1	34	142	180
PRIA	F	1	0	10	35	50	96
PRIA	M	2	3	4	22	140	171
TU Wien	F	1	5	14	33	39	92
TU Wien	M	1	3	17	18	47	86
UoA	F	0	1	6	19	21	47
UoA	M	1	0	1	21	47	70
Total		**16**	**17**	**87**	**368**	**910**	**1398**

Table 27 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like using computers per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	4	5	4.42	5	5
AL	M	1	5	5	4.73	5	5
CU	F	1	4	5	4.35	5	5
CU	M	2	5	5	4.76	5	5
ESI	F	1	4	5	4.59	5	5
ESI	M	1	5	5	4.74	5	5
PRIA	F	1	4	5	4.39	5	5
PRIA	M	1	5	5	4.73	5	5
TU Wien	F	1	4	4	4.13	5	5
TU Wien	M	1	4	5	4.24	5	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	F	2	4	4	4.28	5	5
UoA	M	1	4	5	4.61	5	5

Table 28 Prequestionnaire Analysis: Likert scale. I like using computers per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	2	0	7	38	122	169
AL	(10,14]	3	2	14	79	130	228
CU	(6,10]	1	0	2	7	18	28
CU	(10,14]	0	1	5	20	43	69
ESI	(6,10]	4	2	6	56	222	290
ESI	(10,14]	0	0	1	18	20	39
PRIA	(6,10]	2	1	4	6	34	47
PRIA	(10,14]	1	1	5	44	82	133
PRIA	(14,18]	0	1	5	8	63	77
TU Wien	(6,10]	2	5	13	19	36	75
TU Wien	(10,14]	0	3	3	17	25	48
TU Wien	(14,18]	0	0	8	12	12	32
UoA	(6,10]	0	0	0	2	1	3
UoA	(10,14]	1	1	5	24	50	81
UoA	(14,18]	0	0	2	14	17	33
Total		**16**	**17**	**80**	**364**	**875**	**1352**

Table 29 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like using computers per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	4.00	5	4.64	5.0	5
AL	(10,14]	1	4.00	5	4.45	5.0	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
CU	(6,10]	1	4.00	5	4.46	5.0	5
CU	(10,14]	2	4.00	5	4.52	5.0	5
ESI	(6,10]	1	5.00	5	4.69	5.0	5
ESI	(10,14]	3	4.00	5	4.49	5.0	5
PRIA	(6,10]	1	4.00	5	4.47	5.0	5
PRIA	(10,14]	1	4.00	5	4.54	5.0	5
PRIA	(14,18]	2	5.00	5	4.73	5.0	5
TU Wien	(6,10]	1	3.00	4	4.09	5.0	5
TU Wien	(10,14]	2	4.00	5	4.33	5.0	5
TU Wien	(14,18]	3	3.75	4	4.12	5.0	5
UoA	(6,10]	4	4.00	4	4.33	4.5	5
UoA	(10,14]	1	4.00	5	4.49	5.0	5
UoA	(14,18]	3	4.00	5	4.45	5.0	5

Table 30 Prequestionnaire Analysis: Likert scale. I like using computers per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	1	0	4	24	40	69
AL	(6,10]	M	1	0	3	14	82	100
AL	(10,14]	F	3	2	13	66	98	182
AL	(10,14]	M	0	0	1	13	32	46
CU	(6,10]	F	1	0	1	4	10	16
CU	(6,10]	M	0	0	1	3	8	12
CU	(10,14]	F	0	0	5	17	18	40
CU	(10,14]	M	0	1	0	3	25	29
ESI	(6,10]	F	2	1	5	34	99	141
ESI	(6,10]	M	2	1	1	22	123	149
ESI	(10,14]	F	0	0	1	7	5	13

Partner	Age Group	Gender	1	2	3	4	5	Total
ESI	(10,14]	M	0	0	0	11	15	26
PRIA	(6,10]	F	1	0	4	5	14	24
PRIA	(6,10]	M	1	1	0	1	20	23
PRIA	(10,14]	F	0	0	4	28	27	59
PRIA	(10,14]	M	1	1	1	15	55	73
PRIA	(14,18]	F	0	0	2	2	8	12
PRIA	(14,18]	M	0	1	3	6	55	65
TU Wien	(6,10]	F	1	3	3	11	18	36
TU Wien	(6,10]	M	1	2	10	8	18	39
TU Wien	(10,14]	F	0	2	3	14	12	31
TU Wien	(10,14]	M	0	1	0	3	13	17
TU Wien	(14,18]	F	0	0	5	6	0	11
TU Wien	(14,18]	M	0	0	3	6	12	21
UoA	(6,10]	F	0	0	0	2	1	3
UoA	(10,14]	F	0	1	5	9	14	29
UoA	(10,14]	M	1	0	0	15	36	52
UoA	(14,18]	F	0	0	1	8	5	14
UoA	(14,18]	M	0	0	1	6	11	18
Total			**16**	**17**	**80**	**363**	**874**	**1350**

Table 31 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like using computers per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	4	5.0	4.48	5.0	5
AL	M	(6,10]	1	5	5.0	4.76	5.0	5
AL	F	(10,14]	1	4	5.0	4.40	5.0	5
AL	M	(10,14]	3	4	5.0	4.67	5.0	5
CU	F	(6,10]	1	4	5.0	4.38	5.0	5

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
CU	M	(6,10]	3	4	5.0	4.58	5.0	5
CU	F	(10,14]	3	4	4.0	4.32	5.0	5
CU	M	(10,14]	2	5	5.0	4.79	5.0	5
ESI	F	(6,10]	1	4	5.0	4.61	5.0	5
ESI	M	(6,10]	1	5	5.0	4.77	5.0	5
ESI	F	(10,14]	3	4	4.0	4.31	5.0	5
ESI	M	(10,14]	4	4	5.0	4.58	5.0	5
PRIA	F	(6,10]	1	4	5.0	4.29	5.0	5
PRIA	M	(6,10]	1	5	5.0	4.65	5.0	5
PRIA	F	(10,14]	3	4	4.0	4.39	5.0	5
PRIA	M	(10,14]	1	5	5.0	4.67	5.0	5
PRIA	F	(14,18]	3	4	5.0	4.50	5.0	5
PRIA	M	(14,18]	2	5	5.0	4.77	5.0	5
TU Wien	F	(6,10]	1	4	4.5	4.17	5.0	5
TU Wien	M	(6,10]	1	3	4.0	4.03	5.0	5
TU Wien	F	(10,14]	2	4	4.0	4.16	5.0	5
TU Wien	M	(10,14]	2	5	5.0	4.65	5.0	5
TU Wien	F	(14,18]	3	3	4.0	3.55	4.0	4
TU Wien	M	(14,18]	3	4	5.0	4.43	5.0	5
UoA	F	(6,10]	4	4	4.0	4.33	4.5	5
UoA	F	(10,14]	2	4	4.0	4.24	5.0	5
UoA	M	(10,14]	1	4	5.0	4.63	5.0	5
UoA	F	(14,18]	3	4	4.0	4.29	5.0	5
UoA	M	(14,18]	3	4	5.0	4.56	5.0	5

9.14.2.2 I KNOW A LOT ABOUT ROBOTS

Table 33 reports the frequencies for the question I know a lot about robots and Table 34 reports the descriptive statistics. As it could be observed a majority of the participants are neutral, disagree and strongly disagree with the statement. There is a 37% of participants who answered neutral. As it could be observed in Table 35 and Table 36, there is difference between gender in ESI, PRIA, AL and UoA. Male participants tend to agree and strongly more than female participants, who tend to disagree and strongly disagree. As it could be observed in Table 37 and Table 38, there is difference between group ages in PRIA. Young group ages tend to disagree more than old groups. The youngest age group (7-10) is mainly divided between strongly disagree and neutral. The next age group (11-14) tend to select more neutral than the rest of options, and finally the age group 15-18 tend to agree and strongly agree. As it could be observed in Table 39 and Table 40, there is difference between genders per age group in AL, ESI and PRIA. Male participants in the age group 7-10 from AL tend to agree and strongly agree, with a significant number in neutral. Female participants tend to be neutral, with a strong tendency towards disagree. The main difference between genders from ESI's age group 6-10 is that male participants are mainly distributed between neutral and strongly agree, while female participants are mainly distributed between disagree and agree with a peak in neutral. Male participants from PRIA in the age group 7-10 mainly selected the neutral option, while female participants are mainly neutral with a tendency towards disagree and strongly disagree. PRIA's genders in the age group 15-18 differ mainly because male participants are mainly distributed between neutral and strongly agree, with a peak in neutral. On the other hand, female participants are almost evenly distributed between disagree and strongly agree.

Table 32 Prequestionnaire Analysis: Likert scale. I know a lot about robots per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	40	119	148	67	21	395
CU	15	44	28	9	5	101
ESI	26	56	118	86	49	335
PRIA	31	40	125	33	38	267
TU Wien	39	61	54	17	7	178
UoA	7	30	46	22	14	119
Total	**158**	**350**	**519**	**234**	**134**	**1395**

Table 33 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I know a lot about robots per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	2	3	2.77	3	5
CU	1	2	2	2.46	3	5
ESI	1	3	3	3.23	4	5
PRIA	1	2	3	3.03	4	5

Partner	Min	1 Q	Median	Average	3 Q	Max
TU Wien	1	2	2	2.39	3	5
UoA	1	2	3	3.05	4	5

Table 34 Prequestionnaire Analysis: Likert scale. I know a lot about robots per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	28	88	100	26	7	249
AL	M	12	31	48	41	14	146
CU	F	15	21	15	5	0	56
CU	M	0	23	13	4	5	45
ESI	F	15	35	63	35	8	156
ESI	M	11	21	55	51	41	179
PRIA	F	18	18	45	5	9	95
PRIA	M	13	22	80	28	28	171
TU Wien	F	20	37	27	6	3	93
TU Wien	M	19	24	27	11	4	85
UoA	F	4	18	19	5	1	47
UoA	M	3	12	26	17	13	71
Total		**158**	**350**	**518**	**234**	**133**	**1393**

Table 35 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I know a lot about robots per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	2	3	2.58	3	5
AL	M	1	2	3	3.10	4	5
CU	F	1	1	2	2.18	3	4
CU	M	2	2	2	2.80	3	5
ESI	F	1	2	3	2.91	4	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
ESI	M	1	3	4	3.50	4	5
PRIA	F	1	2	3	2.67	3	5
PRIA	M	1	3	3	3.21	4	5
TU Wien	F	1	2	2	2.30	3	5
TU Wien	M	1	2	2	2.49	3	5
UoA	F	1	2	3	2.60	3	5
UoA	M	1	3	3	3.35	4	5

Table 36 Prequestionnaire Analysis: Likert scale. I know a lot about robots per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	17	36	59	43	14	169
AL	(10,14]	23	83	89	24	7	226
CU	(6,10]	5	11	4	2	5	27
CU	(10,14]	10	28	24	7	0	69
ESI	(6,10]	23	45	99	76	45	288
ESI	(10,14]	3	10	15	9	2	39
PRIA	(6,10]	15	8	10	4	11	48
PRIA	(10,14]	14	22	81	9	5	131
PRIA	(14,18]	1	9	30	20	17	77
TU Wien	(6,10]	15	23	22	11	5	76
TU Wien	(10,14]	9	20	17	1	0	47
TU Wien	(14,18]	8	9	12	3	0	32
UoA	(6,10]	0	2	1	0	0	3
UoA	(10,14]	5	20	29	17	10	81
UoA	(14,18]	2	8	15	5	4	34
Total		**150**	**334**	**507**	**231**	**125**	**1347**

Table 37 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I know a lot about robots per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	2.00	3.0	3.01	4.00	5
AL	(10,14]	1	2.00	3.0	2.60	3.00	5
CU	(6,10]	1	2.00	2.0	2.67	3.50	5
CU	(10,14]	1	2.00	2.0	2.41	3.00	4
ESI	(6,10]	1	3.00	3.0	3.26	4.00	5
ESI	(10,14]	1	2.00	3.0	2.92	4.00	5
PRIA	(6,10]	1	1.00	3.0	2.75	4.00	5
PRIA	(10,14]	1	2.00	3.0	2.76	3.00	5
PRIA	(14,18]	1	3.00	3.0	3.56	4.00	5
TU Wien	(6,10]	1	2.00	2.5	2.58	3.00	5
TU Wien	(10,14]	1	2.00	2.0	2.21	3.00	4
TU Wien	(14,18]	1	1.75	2.0	2.31	3.00	4
UoA	(6,10]	2	2.00	2.0	2.33	2.50	3
UoA	(10,14]	1	2.00	3.0	3.09	4.00	5
UoA	(14,18]	1	2.00	3.0	3.03	3.75	5

Table 38 Prequestionnaire Analysis: Likert scale. I know a lot about robots per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	9	18	29	10	3	69
AL	(6,10]	M	8	18	30	33	11	100
AL	(10,14]	F	19	70	71	16	4	180
AL	(10,14]	M	4	13	18	8	3	46
CU	(6,10]	F	5	6	2	2	0	15
CU	(6,10]	M	0	5	2	0	5	12
CU	(10,14]	F	10	14	13	3	0	40
CU	(10,14]	M	0	14	11	4	0	29

Partner	Age Group	Gender	1	2	3	4	5	Total
ESI	(6,10]	F	14	30	57	31	8	140
ESI	(6,10]	M	9	15	42	45	37	148
ESI	(10,14]	F	1	4	4	4	0	13
ESI	(10,14]	M	2	6	11	5	2	26
PRIA	(6,10]	F	8	7	4	1	4	24
PRIA	(6,10]	M	7	1	6	3	7	24
PRIA	(10,14]	F	10	10	35	2	1	58
PRIA	(10,14]	M	4	12	46	7	3	72
PRIA	(14,18]	F	0	1	5	2	4	12
PRIA	(14,18]	M	1	8	25	18	13	65
TU Wien	(6,10]	F	7	13	11	4	1	36
TU Wien	(6,10]	M	8	10	11	7	4	40
TU Wien	(10,14]	F	6	14	12	0	0	32
TU Wien	(10,14]	M	3	6	5	1	0	15
TU Wien	(14,18]	F	5	3	3	0	0	11
TU Wien	(14,18]	M	3	6	9	3	0	21
UoA	(6,10]	F	0	2	1	0	0	3
UoA	(10,14]	F	2	12	11	3	1	29
UoA	(10,14]	M	3	8	18	14	9	52
UoA	(14,18]	F	2	4	6	2	0	14
UoA	(14,18]	M	0	4	8	3	4	19
Total			**150**	**334**	**506**	**231**	**124**	**1345**

Table 39 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I know a lot about robots per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	2.00	3.0	2.71	3.00	5
AL	M	(6,10]	1	2.00	3.0	3.21	4.00	5

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(10,14]	1	2.00	3.0	2.53	3.00	5
AL	M	(10,14]	1	2.00	3.0	2.85	3.00	5
CU	F	(6,10]	1	1.00	2.0	2.07	2.50	4
CU	M	(6,10]	2	2.00	3.0	3.42	5.00	5
CU	F	(10,14]	1	1.75	2.0	2.22	3.00	4
CU	M	(10,14]	2	2.00	3.0	2.66	3.00	4
ESI	F	(6,10]	1	2.00	3.0	2.92	4.00	5
ESI	M	(6,10]	1	3.00	4.0	3.58	4.25	5
ESI	F	(10,14]	1	2.00	3.0	2.85	4.00	4
ESI	M	(10,14]	1	2.00	3.0	2.96	3.75	5
PRIA	F	(6,10]	1	1.00	2.0	2.42	3.00	5
PRIA	M	(6,10]	1	1.00	3.0	3.08	5.00	5
PRIA	F	(10,14]	1	2.00	3.0	2.55	3.00	5
PRIA	M	(10,14]	1	3.00	3.0	2.90	3.00	5
PRIA	F	(14,18]	2	3.00	3.5	3.75	5.00	5
PRIA	M	(14,18]	1	3.00	3.0	3.52	4.00	5
TU Wien	F	(6,10]	1	2.00	2.0	2.42	3.00	5
TU Wien	M	(6,10]	1	2.00	3.0	2.72	4.00	5
TU Wien	F	(10,14]	1	2.00	2.0	2.19	3.00	3
TU Wien	M	(10,14]	1	2.00	2.0	2.27	3.00	4
TU Wien	F	(14,18]	1	1.00	2.0	1.82	2.50	3
TU Wien	M	(14,18]	1	2.00	3.0	2.57	3.00	4
UoA	F	(6,10]	2	2.00	2.0	2.33	2.50	3
UoA	F	(10,14]	1	2.00	3.0	2.62	3.00	5
UoA	M	(10,14]	1	3.00	3.0	3.35	4.00	5
UoA	F	(14,18]	1	2.00	3.0	2.57	3.00	4
UoA	M	(14,18]	2	3.00	3.0	3.37	4.00	5

9.14.2.3 I LEARN BEST WITH OTHER PEOPLE

Table 41 reports the frequencies for the question I learn best with other people and Table 42 reports the descriptive statistics. As it could be observed, a majority of participants from all partner agree and strongly agree with the statement "*I learn best with other people*", with the lowest percentage in TU Wien (61%). The biggest percentage of participants who disagree and strongly disagree with the statement is found in PRIA (20%). As it could be seen in Table 43 and Table 44, there is no considerable difference between genders per partner. As it could be observed in Table 45 and Table 46, there is a difference between age group in TU Wien. The group age 7-10 is mainly distributed between agree and strongly agree. Almost half of participants from age group 11-14 agree with the statements, with significant number in neutral and disagree. Participants from age group 14-18 are mainly divided between agree and disagree. As it could be observed in Table 47 and Table 48, there is difference between genders per age group. A majority of female participants from AL's age group 10-14 agree with the statement, with also significant number in strongly agree. On the other hand, male participants are almost evenly distributed between neutral and strongly agree. The difference between genders in CU's age group 7-10 is that female participants are only distributed between agree and strongly agree, while a vast majority of male participants agree with the statement. Female participants in PRIA's age group 11-14 are mainly distributed between neutral and strongly agree, with a tendency to increase the number of participants as it goes from neutral to strongly agree. Male participants are mainly distributed between neutral and strongly agree, with a peak in agree and slightly tendency towards neutral. A majority of female participants from TU Wien's age 10-14 selected agree, and they were distributed only between disagree and agree. Male participants are almost evenly distributed between all the options. Female participants from UoA's age 15-18 are only distributed between disagree and agree. Most of male participants selected agree and strongly agree.

Table 40 Prequestionnaire Analysis: Likert scale. I learn best with other people per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	14	20	61	160	140	395
CU	1	5	18	35	42	101
ESI	13	9	30	81	197	330
PRIA	13	13	63	90	90	269
TU Wien	9	28	26	57	42	162
UoA	2	7	27	45	38	119
Total	**52**	**82**	**225**	**468**	**549**	**1376**

Table 41 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I learn best with other people per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	4	3.99	5	5
CU	1	4	4	4.11	5	5

Partner	Min	1 Q	Median	Average	3 Q	Max
ESI	1	4	5	4.33	5	5
PRIA	1	3	4	3.86	5	5
TU Wien	1	3	4	3.59	5	5
UoA	1	3	4	3.92	5	5

Table 42 Prequestionnaire Analysis: Likert scale. I learn best with other people per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	5	12	34	120	79	250
AL	M	9	8	27	40	61	145
CU	F	0	4	10	18	24	56
CU	M	1	1	8	17	18	45
ESI	F	6	6	17	43	82	154
ESI	M	7	3	13	38	115	176
PRIA	F	3	3	24	25	40	95
PRIA	M	9	10	39	65	50	173
TU Wien	F	4	12	16	33	21	86
TU Wien	M	5	16	10	24	21	76
UoA	F	1	4	12	23	7	47
UoA	M	1	3	15	21	31	71
Total		**51**	**82**	**225**	**467**	**549**	**1374**

Table 43 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I learn best with other people per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	4.00	4	4.02	5	5
AL	M	1	3.00	4	3.94	5	5
CU	F	2	3.75	4	4.11	5	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
CU	M	1	4.00	4	4.11	5	5
ESI	F	1	4.00	5	4.23	5	5
ESI	M	1	4.00	5	4.43	5	5
PRIA	F	1	3.00	4	4.01	5	5
PRIA	M	1	3.00	4	3.79	5	5
TU Wien	F	1	3.00	4	3.64	4	5
TU Wien	M	1	2.00	4	3.53	5	5
UoA	F	1	3.00	4	3.66	4	5
UoA	M	1	3.00	4	4.10	5	5

Table 44 Prequestionnaire Analysis: Likert scale. I learn best with other people per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	8	7	20	51	82	168
AL	(10,14]	6	13	41	109	58	227
CU	(6,10]	1	0	1	14	11	27
CU	(10,14]	0	5	17	19	28	69
ESI	(6,10]	9	7	26	72	171	285
ESI	(10,14]	3	1	3	7	23	37
PRIA	(6,10]	4	0	6	8	30	48
PRIA	(10,14]	4	11	34	43	42	134
PRIA	(14,18]	5	1	22	35	13	76
TU Wien	(6,10]	5	5	10	17	33	70
TU Wien	(10,14]	2	10	11	23	1	47
TU Wien	(14,18]	0	13	5	12	2	32
UoA	(6,10]	0	0	1	1	1	3
UoA	(10,14]	1	4	18	29	29	81
UoA	(14,18]	1	2	8	15	8	34

Partner	Age Group	1	2	3	4	5	Total
Total		**49**	**79**	**223**	**455**	**532**	**1338**

Table 45 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I learn best with other people per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	4.0	4	4.14	5.0	5
AL	(10,14]	1	3.0	4	3.88	5.0	5
CU	(6,10]	1	4.0	4	4.26	5.0	5
CU	(10,14]	2	3.0	4	4.01	5.0	5
ESI	(6,10]	1	4.0	5	4.36	5.0	5
ESI	(10,14]	1	4.0	5	4.24	5.0	5
PRIA	(6,10]	1	4.0	5	4.25	5.0	5
PRIA	(10,14]	1	3.0	4	3.81	5.0	5
PRIA	(14,18]	1	3.0	4	3.66	4.0	5
TU Wien	(6,10]	1	3.0	4	3.97	5.0	5
TU Wien	(10,14]	1	2.5	4	3.23	4.0	5
TU Wien	(14,18]	2	2.0	3	3.09	4.0	5
UoA	(6,10]	3	3.5	4	4.00	4.5	5
UoA	(10,14]	1	3.0	4	4.00	5.0	5
UoA	(14,18]	1	3.0	4	3.79	4.0	5

Table 46 Prequestionnaire Analysis: Likert scale. I learn best with other people per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	2	2	6	26	33	69
AL	(6,10]	M	6	5	14	25	49	99
AL	(10,14]	F	3	10	28	94	46	181
AL	(10,14]	M	3	3	13	15	12	46

Partner	**Age Group**	**Gender**	**1**	**2**	**3**	**4**	**5**	**Total**
CU	(6,10]	F	0	0	0	7	8	15
CU	(6,10]	M	1	0	1	7	3	12
CU	(10,14]	F	0	4	10	10	16	40
CU	(10,14]	M	0	1	7	9	12	29
ESI	(6,10]	F	6	4	15	39	75	139
ESI	(6,10]	M	3	3	11	33	96	146
ESI	(10,14]	F	0	1	1	3	7	12
ESI	(10,14]	M	3	0	2	4	16	25
PRIA	(6,10]	F	1	0	5	2	15	23
PRIA	(6,10]	M	3	0	1	6	15	25
PRIA	(10,14]	F	1	3	14	18	23	59
PRIA	(10,14]	M	2	8	20	25	19	74
PRIA	(14,18]	F	1	0	5	4	2	12
PRIA	(14,18]	M	4	1	17	31	11	64
TU Wien	(6,10]	F	3	2	5	9	16	35
TU Wien	(6,10]	M	2	3	5	8	17	35
TU Wien	(10,14]	F	0	6	8	18	0	32
TU Wien	(10,14]	M	2	4	3	5	1	15
TU Wien	(14,18]	F	0	4	3	3	1	11
TU Wien	(14,18]	M	0	9	2	9	1	21
UoA	(6,10]	F	0	0	1	1	1	3
UoA	(10,14]	F	1	1	5	16	6	29
UoA	(10,14]	M	0	3	13	13	23	52
UoA	(14,18]	F	0	2	6	6	0	14
UoA	(14,18]	M	1	0	2	8	8	19
Total			**48**	**79**	**223**	**454**	**532**	**1336**

Table 47 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I learn best with other people per partner, age partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	4.0	4.0	4.25	5.00	5
AL	M	(6,10]	1	3.5	4.0	4.07	5.00	5
AL	F	(10,14]	1	4.0	4.0	3.94	5.00	5
AL	M	(10,14]	1	3.0	4.0	3.65	4.75	5
CU	F	(6,10]	4	4.0	5.0	4.53	5.00	5
CU	M	(6,10]	1	4.0	4.0	3.92	4.25	5
CU	F	(10,14]	2	3.0	4.0	3.95	5.00	5
CU	M	(10,14]	2	3.0	4.0	4.10	5.00	5
ESI	F	(6,10]	1	4.0	5.0	4.24	5.00	5
ESI	M	(6,10]	1	4.0	5.0	4.48	5.00	5
ESI	F	(10,14]	2	4.0	5.0	4.33	5.00	5
ESI	M	(10,14]	1	4.0	5.0	4.20	5.00	5
PRIA	F	(6,10]	1	3.5	5.0	4.30	5.00	5
PRIA	M	(6,10]	1	4.0	5.0	4.20	5.00	5
PRIA	F	(10,14]	1	3.0	4.0	4.00	5.00	5
PRIA	M	(10,14]	1	3.0	4.0	3.69	4.75	5
PRIA	F	(14,18]	1	3.0	3.5	3.50	4.00	5
PRIA	M	(14,18]	1	3.0	4.0	3.69	4.00	5
TU Wien	F	(6,10]	1	3.0	4.0	3.94	5.00	5
TU Wien	M	(6,10]	1	3.0	4.0	4.00	5.00	5
TU Wien	F	(10,14]	2	3.0	4.0	3.38	4.00	4
TU Wien	M	(10,14]	1	2.0	3.0	2.93	4.00	5
TU Wien	F	(14,18]	2	2.0	3.0	3.09	4.00	5
TU Wien	M	(14,18]	2	2.0	3.0	3.10	4.00	5
UoA	F	(6,10]	3	3.5	4.0	4.00	4.50	5
UoA	F	(10,14]	1	4.0	4.0	3.86	4.00	5

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
UoA	M	(10,14]	2	3.0	4.0	4.08	5.00	5
UoA	F	(14,18]	2	3.0	3.0	3.29	4.00	4
UoA	M	(14,18]	1	4.0	4.0	4.16	5.00	5

9.14.2.4 I LIKE SCIENCE

Table 49 reports the frequencies for the question I like science and Table 50 reports the descriptive statistics. As it could be observed, a majority of participants from all partners agree and strongly agree with the statement "*I like science",* with the lowest percentage in CU (57%), which also has the biggest percentage of neutral answers (27%). The biggest percentage of participants who disagree and strongly disagree with the statement is found in PRIA (20%). The majority of participants from ESI selected strongly agree. As it could be observed in Table 51 and Table 52, there is a difference between genders in ESI. Female participants are mainly distributed between neutral and strongly agree, which is the same for male participants. The main difference is that male participants tend to selected more strongly agree than females, who tend to moves slightly towards neutral. As it could be seen in Table 53 and Table 54, there are difference between age groups per partner in AL, ESI, PRIA and TU Wien. The age group 7-11 from AL have a strong tendency to select strongly agree than the age group 11-14. A majority of the participants from the first age group (7-10) selected strongly agree, while the majority of participants in the second one (11-14) are divided between agree and strongly agree. The age group 7-11 from CU is mainly distributed between neutral and strongly agree, with same number of participants in neutral and agree, and the biggest number in strongly agree. The age group 11-14 from CU is mainly distributed between neutral and strongly agree, but the biggest number of participants is found in agree. Also the number of participants who selected disagree and strongly disagree is low in comparison the number in the rest of the options. A majority of the participants from ESI's age group 7-10 selected strongly agree, with 83% of participants between agree and strongly agree. The age group 11-14 is mainly distributed between agree and strongly agree. The age group 7-10 from PRIA has an interesting distribution of answers. The biggest number of participants is found in strongly agree (n=28) but the second is found in strongly disagree (n=10). The age group 11-14 is distributed between disagree and strongly agree, with a peak in agree. The options disagree and strongly agree have almost the same number of participants. There is a difference between the age group 7-10 with the groups 11-14 and 15-18 in TU Wien. A majority of the participants from the age group 7-10 selected strongly agree, with same number of participants in neutral and agree. In the other two groups, the biggest number of participants is found in agree. As it could be seen in Table 55 and Table 56, there is a difference between gender per age group in AL, CU and TU Wien. The biggest number of female participants in AL's age group 11-14 selected strongly agree, with 28% of participants selected agree. Male participants selected mainly agree, with 21% in strongly agree. Both genders in CU's age group 11-14 are mainly distributed between neutral and strongly agree. The difference is that there are no male participants in the options disagree and strongly agree, and that the peak in male participants is found in agree while the one in female participants in strongly agree. Female participants from TU Wien's age group 15-18 mainly selected disagree and strongly disagree, while male participants mainly selected agree and strongly agree.

Table 48 Prequestionnaire Analysis: Likert scale. I like science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	18	24	50	122	181	395

Partner	1	2	3	4	5	Total
CU	11	5	27	28	30	101
ESI	7	4	51	100	172	334
PRIA	18	36	51	81	82	268
TU Wien	8	14	35	50	72	179
UoA	2	4	16	43	53	118
Total	**64**	**87**	**230**	**424**	**590**	**1395**

Table 49 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	4	4.07	5	5
CU	1	3	4	3.60	5	5
ESI	1	4	5	4.28	5	5
PRIA	1	3	4	3.65	5	5
TU Wien	1	3	4	3.92	5	5
UoA	1	4	4	4.19	5	5

Table 50 Prequestionnaire Analysis: Likert scale. I like science per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	12	14	33	74	117	250
AL	M	6	10	17	48	64	145
CU	F	8	5	12	12	20	57
CU	M	3	0	15	16	10	44
ESI	F	1	3	28	48	74	154
ESI	M	6	1	23	52	98	180
PRIA	F	6	13	20	28	28	95
PRIA	M	12	23	31	53	53	172
TU Wien	F	4	10	19	29	30	92

Partner	Gender	1	2	3	4	5	Total
TU Wien	M	4	4	16	21	42	87
UoA	F	1	2	4	18	22	47
UoA	M	1	2	12	25	30	70
Total	Total	64	87	230	424	588	1393

Table 51 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like science per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	4	4	4.08	5	5
AL	M	1	4	4	4.06	5	5
CU	F	1	3	4	3.54	5	5
CU	M	1	3	4	3.68	4	5
ESI	F	1	4	4	4.24	5	5
ESI	M	1	4	5	4.31	5	5
PRIA	F	1	3	4	3.62	5	5
PRIA	M	1	3	4	3.65	5	5
TU Wien	F	1	3	4	3.77	5	5
TU Wien	M	1	3	4	4.07	5	5
UoA	F	1	4	4	4.23	5	5
UoA	M	1	4	4	4.16	5	5

Table 52 Prequestionnaire Analysis: Likert scale. I like science per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	3	7	14	53	91	168
AL	(10,14]	15	17	36	69	90	227
CU	(6,10]	4	2	6	6	9	27
CU	(10,14]	6	3	18	22	20	69
ESI	(6,10]	6	3	39	88	152	288

Partner	Age Group	1	2	3	4	5	Total
ESI	(10,14]	1	1	7	11	18	38
PRIA	(6,10]	10	4	5	2	28	49
PRIA	(10,14]	5	25	29	48	24	131
PRIA	(14,18]	3	7	17	29	21	77
TU Wien	(6,10]	1	1	14	14	46	76
TU Wien	(10,14]	3	7	11	18	9	48
TU Wien	(14,18]	3	5	4	14	6	32
UoA	(6,10]	0	0	1	1	1	3
UoA	(10,14]	2	3	9	30	36	80
UoA	(14,18]	0	1	6	12	15	34
Total		**62**	**86**	**216**	**417**	**566**	**1347**

Table 53 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like science per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	4.00	5	4.32	5.0	5
AL	(10,14]	1	3.00	4	3.89	5.0	5
CU	(6,10]	1	3.00	4	3.52	5.0	5
CU	(10,14]	1	3.00	4	3.68	5.0	5
ESI	(6,10]	1	4.00	5	4.31	5.0	5
ESI	(10,14]	1	4.00	4	4.16	5.0	5
PRIA	(6,10]	1	2.00	5	3.69	5.0	5
PRIA	(10,14]	1	3.00	4	3.47	4.0	5
PRIA	(14,18]	1	3.00	4	3.75	5.0	5
TU Wien	(6,10]	1	4.00	5	4.36	5.0	5
TU Wien	(10,14]	1	3.00	4	3.48	4.0	5
TU Wien	(14,18]	1	2.75	4	3.47	4.0	5
UoA	(6,10]	3	3.50	4	4.00	4.5	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
UoA	(10,14]	1	4.00	4	4.19	5.0	5
UoA	(14,18]	2	4.00	4	4.21	5.0	5

Table 54 Prequestionnaire Analysis: Likert scale. I like science per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	1	4	5	22	37	69
AL	(6,10]	M	2	3	9	31	54	99
AL	(10,14]	F	11	10	28	52	80	181
AL	(10,14]	M	4	7	8	17	10	46
CU	(6,10]	F	2	2	4	2	6	16
CU	(6,10]	M	2	0	2	4	3	11
CU	(10,14]	F	6	3	8	10	13	40
CU	(10,14]	M	0	0	10	12	7	29
ESI	(6,10]	F	1	2	23	45	68	139
ESI	(6,10]	M	5	1	16	43	84	149
ESI	(10,14]	F	0	1	3	3	5	12
ESI	(10,14]	M	1	0	4	8	13	26
PRIA	(6,10]	F	2	2	3	2	15	24
PRIA	(6,10]	M	8	2	2	0	13	25
PRIA	(10,14]	F	4	10	15	21	8	58
PRIA	(10,14]	M	1	15	14	27	15	72
PRIA	(14,18]	F	0	1	2	5	4	12
PRIA	(14,18]	M	3	6	15	24	17	65
TU Wien	(6,10]	F	1	0	7	10	18	36
TU Wien	(6,10]	M	0	1	7	4	28	40
TU Wien	(10,14]	F	1	5	8	12	5	31
TU Wien	(10,14]	M	2	2	3	6	4	17

Partner	Age Group	Gender	1	2	3	4	5	Total
TU Wien	(14,18]	F	2	4	1	3	1	11
TU Wien	(14,18]	M	1	1	3	11	5	21
UoA	(6,10]	F	0	0	1	1	1	3
UoA	(10,14]	F	1	1	0	14	13	29
UoA	(10,14]	M	1	2	9	16	23	51
UoA	(14,18]	F	0	1	3	3	7	14
UoA	(14,18]	M	0	0	3	9	7	19
Total			**62**	**86**	**216**	**417**	**564**	**1345**

Table 55 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like science per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	4.00	5.0	4.30	5.0	5
AL	M	(6,10]	1	4.00	5.0	4.33	5.0	5
AL	F	(10,14]	1	3.00	4.0	3.99	5.0	5
AL	M	(10,14]	1	3.00	4.0	3.48	4.0	5
CU	F	(6,10]	1	2.75	3.5	3.50	5.0	5
CU	M	(6,10]	1	3.00	4.0	3.55	4.5	5
CU	F	(10,14]	1	3.00	4.0	3.52	5.0	5
CU	M	(10,14]	3	3.00	4.0	3.90	4.0	5
ESI	F	(6,10]	1	4.00	4.0	4.27	5.0	5
ESI	M	(6,10]	1	4.00	5.0	4.34	5.0	5
ESI	F	(10,14]	2	3.00	4.0	4.00	5.0	5
ESI	M	(10,14]	1	4.00	4.5	4.23	5.0	5
PRIA	F	(6,10]	1	3.00	5.0	4.08	5.0	5
PRIA	M	(6,10]	1	1.00	5.0	3.32	5.0	5
PRIA	F	(10,14]	1	3.00	3.5	3.33	4.0	5
PRIA	M	(10,14]	1	3.00	4.0	3.56	4.0	5

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
PRIA	F	(14,18]	2	3.75	4.0	4.00	5.0	5
PRIA	M	(14,18]	1	3.00	4.0	3.71	5.0	5
TU Wien	F	(6,10]	1	4.00	4.5	4.22	5.0	5
TU Wien	M	(6,10]	2	4.00	5.0	4.47	5.0	5
TU Wien	F	(10,14]	1	3.00	4.0	3.48	4.0	5
TU Wien	M	(10,14]	1	3.00	4.0	3.47	4.0	5
TU Wien	F	(14,18]	1	2.00	2.0	2.73	4.0	5
TU Wien	M	(14,18]	1	4.00	4.0	3.86	4.0	5
UoA	F	(6,10]	3	3.50	4.0	4.00	4.5	5
UoA	F	(10,14]	1	4.00	4.0	4.28	5.0	5
UoA	M	(10,14]	1	4.00	4.0	4.14	5.0	5
UoA	F	(14,18]	2	3.25	4.5	4.14	5.0	5
UoA	M	(14,18]	3	4.00	4.0	4.21	5.0	5

9.14.2.5 I LIKE MATHS

Table 57 reports the frequencies for the question I like maths and Table 58 reports the descriptive statistics. A majority participants from UoA, PRIA, ESI, CU and AL selected strongly agree and agree. Just 48% of participants from TU Wien selected agree and strongly agree. TU Wien and PRIA are the partners with the biggest number of participants who selected neutral, 22% and 26% respectively. TU Wien and CU are the partners with the biggest number of participants who selected disagree and strongly disagree, 30% and 29% respectively. As it could be observed in Table 59 and Table 60, there is a difference between genders in AL and TU Wien. A majority of male participants from AL selected strongly agree, with very few participants in disagree and strongly disagree. 72% of female participants are distributed between agree and strongly agree and 14% in disagree and strongly disagree. The biggest number of female participants from TU Wien selected neutral, and with the same number were selected strongly disagree, agree and strongly agree. The biggest number of male participants is found in strongly agree, with almost evenly number of participants in the options strongly disagree, neutral and agree. As it could be observed in Table 61 and Table 62, there is difference between age groups in AL, CU, PRIA and TU Wien. 61% of AL's age group 7-10 selected strongly agree and some selected disagree and strongly disagree. 44% of the age group 11-14 selected strongly agree, with a 30% in agree. The percentage of participants from the age group 11-14 (13.15%) who selected disagree and strongly disagree is almost the double than the age group 7-10 (7.14%). 57.6% of CU's age group 7-10 selected strongly agree. Rest of the participants are almost evenly distributes between the other options. The other age group (11-14) has three different tendencies. The strongest one is that 40% of participants selected strongly agree. The second is that 17% selected disagree and 16% selected neutral. PRIA's age group 7-10 mainly selected strongly agree. The age group 11-14 has the biggest number of participants in the option neutral, with a tendency towards agree. The last age group (15-18) is mainly distributed between neutral and strongly agree, with a tendency to increase as it goes to strongly agree. TU Wien's age group 7-10 has the particularity that 35% selected strongly agree, 20% agree and 22% strongly disagree. The age group 11-14 has the biggest numbers in disagree and neutral, with similar amount of participants in the other options. The last age group (15-18) has a peak in agree, followed by neutral and almost same amount of participants in the rest of options. As it could be observed in Table 63 and Table 64, there is a difference between gender per age group in CU (11-14), PRIA (7-10), and TU Wien (7-10 and 15-18).

Table 56 Prequestionnaire Analysis: Likert scale. I like maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	**1**	**2**	**3**	**4**	**5**	**Total**
AL	22	20	50	101	203	396
CU	13	16	13	15	43	100
ESI	26	8	34	67	199	334
PRIA	28	20	70	60	91	269
TU Wien	34	20	39	38	49	180
UoA	2	7	10	33	67	119
Total	**125**	**91**	**216**	**314**	**652**	**1398**

Table 57 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	**Min**	**1 Q**	**Median**	**Average**	**3 Q**	**Max**
AL	1	4	5	4.12	5	5
CU	1	2	4	3.59	5	5
ESI	1	4	5	4.21	5	5
PRIA	1	3	4	3.62	5	5
TU Wien	1	2	3	3.27	5	5
UoA	1	4	5	4.31	5	5

Table 58 Prequestionnaire Analysis: Likert scale. I like maths per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	**Gender**	**1**	**2**	**3**	**4**	**5**	**Total**
AL	F	18	18	32	75	108	251
AL	M	4	2	18	26	95	145
CU	F	9	8	6	9	24	56

Partner	Gender	1	2	3	4	5	Total
CU	M	4	8	7	6	19	44
ESI	F	14	3	22	30	85	154
ESI	M	12	5	12	37	114	180
PRIA	F	10	6	29	21	29	95
PRIA	M	17	14	41	39	62	173
TU Wien	F	19	14	22	19	19	93
TU Wien	M	15	6	17	19	30	87
UoA	F	2	6	3	10	26	47
UoA	M	0	1	7	23	40	71
Total		**124**	**91**	**216**	**314**	**651**	**1396**

Table 59 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like maths per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	3.00	4	3.94	5	5
AL	M	1	4.00	5	4.42	5	5
CU	F	1	2.00	4	3.55	5	5
CU	M	1	2.00	4	3.64	5	5
ESI	F	1	3.25	5	4.10	5	5
ESI	M	1	4.00	5	4.31	5	5
PRIA	F	1	3.00	4	3.56	5	5
PRIA	M	1	3.00	4	3.66	5	5
TU Wien	F	1	2.00	3	3.05	4	5
TU Wien	M	1	3.00	4	3.49	5	5
UoA	F	1	4.00	5	4.11	5	5
UoA	M	2	4.00	5	4.44	5	5

Table 60 Prequestionnaire Analysis: Likert scale. I like maths per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	8	4	20	33	103	168
AL	(10,14]	14	16	30	68	100	228
CU	(6,10]	3	1	2	5	15	26
CU	(10,14]	9	12	11	9	28	69
ESI	(6,10]	24	6	30	56	172	288
ESI	(10,14]	1	2	2	10	23	38
PRIA	(6,10]	5	1	2	3	38	49
PRIA	(10,14]	18	11	46	37	20	132
PRIA	(14,18]	4	8	21	18	26	77
TU Wien	(6,10]	17	3	14	16	27	77
TU Wien	(10,14]	7	13	14	9	6	49
TU Wien	(14,18]	5	4	8	11	4	32
UoA	(6,10]	0	0	0	1	2	3
UoA	(10,14]	1	3	8	20	49	81
UoA	(14,18]	1	4	2	12	15	34
Total		**117**	**88**	**210**	**308**	**628**	**1351**

Table 61 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like maths per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	4.0	5	4.30	5	5
AL	(10,14]	1	3.0	4	3.98	5	5
CU	(6,10]	1	4.0	5	4.08	5	5
CU	(10,14]	1	2.0	4	3.51	5	5
ESI	(6,10]	1	4.0	5	4.20	5	5
ESI	(10,14]	1	4.0	5	4.37	5	5
PRIA	(6,10]	1	5.0	5	4.39	5	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
PRIA	(10,14]	1	3.0	3	3.23	4	5
PRIA	(14,18]	1	3.0	4	3.70	5	5
TU Wien	(6,10]	1	2.0	4	3.43	5	5
TU Wien	(10,14]	1	2.0	3	2.88	4	5
TU Wien	(14,18]	1	2.0	3	3.16	4	5
UoA	(6,10]	4	4.5	5	4.67	5	5
UoA	(10,14]	1	4.0	5	4.40	5	5
UoA	(14,18]	1	4.0	4	4.06	5	5

Table 62 Prequestionnaire Analysis: Likert scale. I like maths per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	6	2	10	19	32	69
AL	(6,10]	M	2	2	10	14	71	99
AL	(10,14]	F	12	16	22	56	76	182
AL	(10,14]	M	2	0	8	12	24	46
CU	(6,10]	F	0	1	1	4	9	15
CU	(6,10]	M	3	0	1	1	6	11
CU	(10,14]	F	9	7	5	4	15	40
CU	(10,14]	M	0	5	6	5	13	29
ESI	(6,10]	F	13	2	22	26	76	139
ESI	(6,10]	M	11	4	8	30	96	149
ESI	(10,14]	F	0	1	0	4	7	12
ESI	(10,14]	M	1	1	2	6	16	26
PRIA	(6,10]	F	3	1	2	2	16	24
PRIA	(6,10]	M	2	0	0	1	22	25
PRIA	(10,14]	F	7	4	24	15	8	58
PRIA	(10,14]	M	10	7	22	22	12	73

Partner	Age Group	Gender	1	2	3	4	5	Total
PRIA	(14,18]	F	0	1	3	3	5	12
PRIA	(14,18]	M	4	7	18	15	21	65
TU Wien	(6,10]	F	10	1	8	10	8	37
TU Wien	(6,10]	M	7	2	6	6	19	40
TU Wien	(10,14]	F	4	10	9	5	4	32
TU Wien	(10,14]	M	3	3	5	4	2	17
TU Wien	(14,18]	F	2	3	2	4	0	11
TU Wien	(14,18]	M	3	1	6	7	4	21
UoA	(6,10]	F	0	0	0	1	2	3
UoA	(10,14]	F	1	3	2	6	17	29
UoA	(10,14]	M	0	0	6	14	32	52
UoA	(14,18]	F	1	3	1	3	6	14
UoA	(14,18]	M	0	1	1	9	8	19
Total			**116**	**88**	**210**	**308**	**627**	**1349**

Table 63 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like maths per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	3.00	4	4.00	5	5
AL	M	(6,10]	1	4.00	5	4.52	5	5
AL	F	(10,14]	1	3.00	4	3.92	5	5
AL	M	(10,14]	1	4.00	5	4.22	5	5
CU	F	(6,10]	2	4.00	5	4.40	5	5
CU	M	(6,10]	1	2.00	5	3.64	5	5
CU	F	(10,14]	1	2.00	3	3.22	5	5
CU	M	(10,14]	2	3.00	4	3.90	5	5
ESI	F	(6,10]	1	3.00	5	4.08	5	5
ESI	M	(6,10]	1	4.00	5	4.32	5	5

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
ESI	F	(10,14]	2	4.00	5	4.42	5	5
ESI	M	(10,14]	1	4.00	5	4.35	5	5
PRIA	F	(6,10]	1	3.75	5	4.12	5	5
PRIA	M	(6,10]	1	5.00	5	4.64	5	5
PRIA	F	(10,14]	1	3.00	3	3.22	4	5
PRIA	M	(10,14]	1	3.00	3	3.26	4	5
PRIA	F	(14,18]	2	3.00	4	4.00	5	5
PRIA	M	(14,18]	1	3.00	4	3.65	5	5
TU Wien	F	(6,10]	1	1.00	3	3.14	4	5
TU Wien	M	(6,10]	1	3.00	4	3.70	5	5
TU Wien	F	(10,14]	1	2.00	3	2.84	4	5
TU Wien	M	(10,14]	1	2.00	3	2.94	4	5
TU Wien	F	(14,18]	1	2.00	3	2.73	4	4
TU Wien	M	(14,18]	1	3.00	4	3.38	4	5
UoA	F	(6,10]	4	4.50	5	4.67	5	5
UoA	F	(10,14]	1	4.00	5	4.21	5	5
UoA	M	(10,14]	3	4.00	5	4.50	5	5
UoA	F	(14,18]	1	2.25	4	3.71	5	5
UoA	M	(14,18]	2	4.00	4	4.26	5	5

9.14.2.6 I LIKE WORKING ON MY OWN

Table 65 reports the frequencies for the question I like working on my own and Table 66 reports the descriptive statistics. ESI is the partner with the biggest number of participants that selected disagree and strongly disagree (51%), followed by TU Wien (38%) and AL (33%). The partner with the biggest number of participants who selected neutral is UoA (41%) and the one with the lowest is ESI (22%). The partner with the biggest number of participants who selected agree and strongly agree is PRIA (43%) and the lowest ESI (27%). As it could be observed in Table 67 and Table 68, there is difference between genders in CU and ESI. As it could be seen in Table 69 and Table 70, there is difference between age groups in CU, ESI, PRIA and UoA. As it could be observed in Table 71 and Table 72, there is difference between genders per age group in CU (7-10 and 11-14), ESI (11-14), PRIA (7-10, and 11-14), TU Wien (7-11), and UoA (11-14 and 15-18).

Table 64 Prequestionnaire Analysis: Likert scale. I like working on my own per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	67	64	127	72	66	396
CU	23	9	30	21	19	102
ESI	114	53	74	35	54	330
PRIA	41	30	82	58	56	267
TU Wien	15	39	40	38	9	141
UoA	11	22	48	22	15	118
Total	**271**	**217**	**401**	**246**	**219**	**1354**

Table 65 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like working on my own per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	2	3	3.02	4	5
CU	1	2	3	3.04	4	5
ESI	1	1	2	2.58	4	5
PRIA	1	2	3	3.22	4	5
TU Wien	1	2	3	2.91	4	5
UoA	1	2	3	3.07	4	5

Table 66 Prequestionnaire Analysis: Likert scale. I like working on my own per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	37	49	93	40	32	251
AL	M	30	15	34	32	34	145
CU	F	10	4	16	18	10	58
CU	M	13	5	14	3	9	44
ESI	F	56	29	33	14	21	153

Partner	Gender	1	2	3	4	5	Total
ESI	M	58	24	41	21	33	177
PRIA	F	20	15	21	18	19	93
PRIA	M	20	15	61	40	37	173
TU Wien	F	5	23	22	19	3	72
TU Wien	M	10	16	18	19	6	69
UoA	F	2	8	18	12	7	47
UoA	M	9	14	29	10	8	70
Total		**270**	**217**	**400**	**246**	**219**	**1352**

Table 67 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like working on my own per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	2	3	2.92	4.00	5
AL	M	1	2	3	3.17	4.00	5
CU	F	1	3	3	3.24	4.00	5
CU	M	1	1	3	2.77	4.00	5
ESI	F	1	1	2	2.44	3.00	5
ESI	M	1	1	3	2.70	4.00	5
PRIA	F	1	2	3	3.01	4.00	5
PRIA	M	1	3	3	3.34	4.00	5
TU Wien	F	1	2	3	2.89	4.00	5
TU Wien	M	1	2	3	2.93	4.00	5
UoA	F	1	3	3	3.30	4.00	5
UoA	M	1	2	3	2.91	3.75	5

Table 68 Prequestionnaire Analysis: Likert scale. I like working on my own per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	30	32	44	33	29	168
AL	(10,14]	37	32	83	39	37	228
CU	(6,10]	6	3	2	8	9	28
CU	(10,14]	13	6	28	13	9	69
ESI	(6,10]	104	47	63	24	46	284
ESI	(10,14]	8	5	10	9	6	38
PRIA	(6,10]	10	2	4	2	30	48
PRIA	(10,14]	25	18	42	30	16	131
PRIA	(14,18]	3	10	33	24	7	77
TU Wien	(6,10]	9	18	16	11	3	57
TU Wien	(10,14]	3	15	11	18	2	49
TU Wien	(14,18]	2	6	13	8	2	31
UoA	(6,10]	1	1	1	0	0	3
UoA	(10,14]	8	14	32	18	8	80
UoA	(14,18]	2	7	15	3	7	34
Total		**261**	**216**	**397**	**240**	**211**	**1325**

Table 69 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like working on my own per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	2.00	3	2.99	4.0	5
AL	(10,14]	1	2.00	3	3.03	4.0	5
CU	(6,10]	1	2.00	4	3.39	5.0	5
CU	(10,14]	1	2.00	3	2.99	4.0	5
ESI	(6,10]	1	1.00	2	2.51	3.0	5
ESI	(10,14]	1	2.00	3	3.00	4.0	5
PRIA	(6,10]	1	2.75	5	3.83	5.0	5
PRIA	(10,14]	1	2.00	3	2.95	4.0	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
PRIA	(14,18]	1	3.00	3	3.29	4.0	5
TU Wien	(6,10]	1	2.00	3	2.67	3.0	5
TU Wien	(10,14]	1	2.00	3	3.02	4.0	5
TU Wien	(14,18]	1	2.50	3	3.06	4.0	5
UoA	(6,10]	1	1.50	2	2.00	2.5	3
UoA	(10,14]	1	2.00	3	3.05	4.0	5
UoA	(14,18]	1	2.25	3	3.18	4.0	5

Table 70 Prequestionnaire Analysis: Likert scale. I like working on my own per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	12	21	21	11	4	69
AL	(6,10]	M	18	11	23	22	25	99
AL	(10,14]	F	25	28	72	29	28	182
AL	(10,14]	M	12	4	11	10	9	46
CU	(6,10]	F	3	2	0	6	6	17
CU	(6,10]	M	3	1	2	2	3	11
CU	(10,14]	F	7	2	16	12	3	40
CU	(10,14]	M	6	4	12	1	6	29
ESI	(6,10]	F	52	25	28	12	21	138
ESI	(6,10]	M	52	22	35	12	25	146
ESI	(10,14]	F	4	3	4	1	0	12
ESI	(10,14]	M	4	2	6	8	6	26
PRIA	(6,10]	F	7	1	3	1	11	23
PRIA	(6,10]	M	3	1	1	1	19	25
PRIA	(10,14]	F	12	12	14	12	7	57
PRIA	(10,14]	M	12	6	28	18	9	73
PRIA	(14,18]	F	1	2	4	4	1	12

Partner	Age Group	Gender	1	2	3	4	5	Total
PRIA	(14,18]	M	2	8	29	20	6	65
TU Wien	(6,10]	F	1	11	10	5	1	28
TU Wien	(6,10]	M	8	7	6	6	2	29
TU Wien	(10,14]	F	2	11	7	11	1	32
TU Wien	(10,14]	M	1	4	4	7	1	17
TU Wien	(14,18]	F	1	1	5	3	1	11
TU Wien	(14,18]	M	1	5	8	5	1	20
UoA	(6,10]	F	1	1	1	0	0	3
UoA	(10,14]	F	1	6	11	8	3	29
UoA	(10,14]	M	7	8	21	10	5	51
UoA	(14,18]	F	0	1	6	3	4	14
UoA	(14,18]	M	2	6	8	0	3	19
Total			**260**	**216**	**396**	**240**	**211**	**1323**

Table 71 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like working on my own per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	2.00	3.0	2.62	3.00	5
AL	M	(6,10]	1	2.00	3.0	3.25	4.50	5
AL	F	(10,14]	1	2.00	3.0	3.04	4.00	5
AL	M	(10,14]	1	1.25	3.0	3.00	4.00	5
CU	F	(6,10]	1	2.00	4.0	3.59	5.00	5
CU	M	(6,10]	1	1.50	3.0	3.09	4.50	5
CU	F	(10,14]	1	3.00	3.0	3.05	4.00	5
CU	M	(10,14]	1	2.00	3.0	2.90	3.00	5
ESI	F	(6,10]	1	1.00	2.0	2.46	3.00	5
ESI	M	(6,10]	1	1.00	2.0	2.56	3.75	5
ESI	F	(10,14]	1	1.00	2.0	2.17	3.00	4

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
ESI	M	(10,14]	1	3.00	4.0	3.38	4.00	5
PRIA	F	(6,10]	1	1.00	4.0	3.35	5.00	5
PRIA	M	(6,10]	1	5.00	5.0	4.28	5.00	5
PRIA	F	(10,14]	1	2.00	3.0	2.82	4.00	5
PRIA	M	(10,14]	1	3.00	3.0	3.08	4.00	5
PRIA	F	(14,18]	1	2.75	3.0	3.17	4.00	5
PRIA	M	(14,18]	1	3.00	3.0	3.31	4.00	5
TU Wien	F	(6,10]	1	2.00	3.0	2.79	3.00	5
TU Wien	M	(6,10]	1	1.00	2.0	2.55	4.00	5
TU Wien	F	(10,14]	1	2.00	3.0	2.94	4.00	5
TU Wien	M	(10,14]	1	2.00	3.0	3.18	4.00	5
TU Wien	F	(14,18]	1	3.00	3.0	3.18	4.00	5
TU Wien	M	(14,18]	1	2.00	3.0	3.00	4.00	5
UoA	F	(6,10]	1	1.50	2.0	2.00	2.50	3
UoA	F	(10,14]	1	3.00	3.0	3.21	4.00	5
UoA	M	(10,14]	1	2.00	3.0	2.96	4.00	5
UoA	F	(14,18]	2	3.00	3.5	3.71	4.75	5
UoA	M	(14,18]	1	2.00	3.0	2.79	3.00	5

9.14.2.7 I LIKE WORKING IN TEAMS

Table 73 reports the frequencies for the question I like working in teams and Table 74 reports the descriptive statistics. UoA is the partner with the lowest percentage with 70% and ESI with the biggest (91%). UoA is the partner with the biggest number of participants who selected neutral (26%), the rest of partners have a percentage lower than 12%. All partners have a percentage of participants who disagree and strongly disagree lower than 8%. As it could be seen in Table 75 and Table 76, there is no difference between genders in all partners. As it could be observed in Table 77 and Table 78, there is difference between age group in AL, PRIA, TU Wien and UoA. As it could be observed in Table 79 and Table 80, there is difference in gender per age group in UoA (15-18).

Table 72 Prequestionnaire Analysis: Likert scale. I like working in teams per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	9	7	39	119	223	397
CU	2	6	11	35	47	101
ESI	3	2	10	55	268	338
PRIA	5	5	35	81	143	269
TU Wien	2	9	18	49	83	161
UoA	1	4	31	41	42	119
Total	**22**	**33**	**144**	**380**	**806**	**1385**

Table 73 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like working in teams per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	5	4.36	5	5
CU	1	4	4	4.18	5	5
ESI	1	5	5	4.72	5	5
PRIA	1	4	5	4.31	5	5
TU Wien	1	4	5	4.25	5	5
UoA	1	3	4	4.00	5	5

Table 74 Prequestionnaire Analysis: Likert scale. I like working in teams per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total

Partner	Gender	1	2	3	4	5	Total
AL	F	4	3	29	80	135	251
AL	M	5	4	10	39	88	146
CU	F	1	6	4	18	27	56
CU	M	1	0	7	17	20	45
ESI	F	1	0	4	29	122	156
ESI	M	2	2	6	26	146	182
PRIA	F	3	0	8	23	62	96
PRIA	M	2	5	27	58	80	172
TU Wien	F	2	5	9	23	46	85
TU Wien	M	0	4	9	26	37	76
UoA	F	0	2	17	14	14	47
UoA	M	1	2	14	26	28	71
Total		**22**	**33**	**144**	**379**	**805**	**1383**

Table 75 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like working in teams per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	4	5	4.35	5	5
AL	M	1	4	5	4.38	5	5
CU	F	1	4	4	4.14	5	5
CU	M	1	4	4	4.22	5	5
ESI	F	1	5	5	4.74	5	5
ESI	M	1	5	5	4.71	5	5
PRIA	F	1	4	5	4.47	5	5
PRIA	M	1	4	4	4.22	5	5
TU Wien	F	1	4	5	4.25	5	5
TU Wien	M	2	4	4	4.26	5	5
UoA	F	2	3	4	3.85	5	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	M	1	4	4	4.10	5	5

Table 76 Prequestionnaire Analysis: Likert scale. I like working in teams per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	1	3	3	34	128	169
AL	(10,14]	8	4	36	85	95	228
CU	(6,10]	2	0	1	10	14	27
CU	(10,14]	0	6	10	21	32	69
ESI	(6,10]	2	2	9	36	242	291
ESI	(10,14]	1	0	1	15	22	39
PRIA	(6,10]	3	0	3	3	40	49
PRIA	(10,14]	2	2	14	41	74	133
PRIA	(14,18]	0	3	16	35	22	76
TU Wien	(6,10]	1	1	2	7	57	68
TU Wien	(10,14]	0	5	7	23	14	49
TU Wien	(14,18]	0	2	6	16	8	32
UoA	(6,10]	0	0	0	2	1	3
UoA	(10,14]	1	1	20	26	33	81
UoA	(14,18]	0	3	10	13	8	34
Total		**21**	**32**	**138**	**367**	**790**	**1348**

Table 77 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like working in teams per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	5.00	5	4.69	5.00	5
AL	(10,14]	1	4.00	4	4.12	5.00	5
CU	(6,10]	1	4.00	5	4.26	5.00	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
CU	(10,14]	2	4.00	4	4.14	5.00	5
ESI	(6,10]	1	5.00	5	4.77	5.00	5
ESI	(10,14]	1	4.00	5	4.46	5.00	5
PRIA	(6,10]	1	5.00	5	4.57	5.00	5
PRIA	(10,14]	1	4.00	5	4.38	5.00	5
PRIA	(14,18]	2	3.75	4	4.00	5.00	5
TU Wien	(6,10]	1	5.00	5	4.74	5.00	5
TU Wien	(10,14]	2	4.00	4	3.94	5.00	5
TU Wien	(14,18]	2	3.75	4	3.94	4.25	5
UoA	(6,10]	4	4.00	4	4.33	4.50	5
UoA	(10,14]	1	3.00	4	4.10	5.00	5
UoA	(14,18]	2	3.00	4	3.76	4.00	5

Table 78 Prequestionnaire Analysis: Likert scale. I like working in teams per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	0	0	0	9	60	69
AL	(6,10]	M	1	3	3	25	68	100
AL	(10,14]	F	4	3	29	71	75	182
AL	(10,14]	M	4	1	7	14	20	46
CU	(6,10]	F	1	0	0	7	7	15
CU	(6,10]	M	1	0	1	3	7	12
CU	(10,14]	F	0	6	4	10	20	40
CU	(10,14]	M	0	0	6	11	12	29
ESI	(6,10]	F	1	0	4	19	116	140
ESI	(6,10]	M	1	2	5	17	126	151
ESI	(10,14]	F	0	0	0	7	6	13
ESI	(10,14]	M	1	0	1	8	16	26

Partner	Age Group	Gender	1	2	3	4	5	Total
PRIA	(6,10]	F	2	0	1	1	20	24
PRIA	(6,10]	M	1	0	2	2	20	25
PRIA	(10,14]	F	1	0	5	15	38	59
PRIA	(10,14]	M	1	2	9	26	35	73
PRIA	(14,18]	F	0	0	2	7	3	12
PRIA	(14,18]	M	0	3	14	28	19	64
TU Wien	(6,10]	F	1	0	1	3	29	34
TU Wien	(6,10]	M	0	1	1	4	28	34
TU Wien	(10,14]	F	0	5	3	13	11	32
TU Wien	(10,14]	M	0	0	4	10	3	17
TU Wien	(14,18]	F	0	0	3	6	2	11
TU Wien	(14,18]	M	0	2	3	10	6	21
UoA	(6,10]	F	0	0	0	2	1	3
UoA	(10,14]	F	0	0	9	8	12	29
UoA	(10,14]	M	1	1	11	18	21	52
UoA	(14,18]	F	0	2	7	4	1	14
UoA	(14,18]	M	0	1	3	8	7	19
Total			**21**	**32**	**138**	**366**	**789**	**1346**

Table 79 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like working in teams per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	4	5.00	5.0	4.87	5.00	5
AL	M	(6,10]	1	4.00	5.0	4.56	5.00	5
AL	F	(10,14]	1	4.00	4.0	4.15	5.00	5
AL	M	(10,14]	1	3.25	4.0	3.98	5.00	5
CU	F	(6,10]	1	4.00	4.0	4.27	5.00	5
CU	M	(6,10]	1	4.00	5.0	4.25	5.00	5

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
CU	F	(10,14]	2	3.75	4.5	4.10	5.00	5
CU	M	(10,14]	3	4.00	4.0	4.21	5.00	5
ESI	F	(6,10]	1	5.00	5.0	4.78	5.00	5
ESI	M	(6,10]	1	5.00	5.0	4.75	5.00	5
ESI	F	(10,14]	4	4.00	4.0	4.46	5.00	5
ESI	M	(10,14]	1	4.00	5.0	4.46	5.00	5
PRIA	F	(6,10]	1	5.00	5.0	4.54	5.00	5
PRIA	M	(6,10]	1	5.00	5.0	4.60	5.00	5
PRIA	F	(10,14]	1	4.00	5.0	4.51	5.00	5
PRIA	M	(10,14]	1	4.00	4.0	4.26	5.00	5
PRIA	F	(14,18]	3	4.00	4.0	4.08	4.25	5
PRIA	M	(14,18]	2	3.00	4.0	3.98	5.00	5
TU Wien	F	(6,10]	1	5.00	5.0	4.74	5.00	5
TU Wien	M	(6,10]	2	5.00	5.0	4.74	5.00	5
TU Wien	F	(10,14]	2	3.75	4.0	3.94	5.00	5
TU Wien	M	(10,14]	3	4.00	4.0	3.94	4.00	5
TU Wien	F	(14,18]	3	3.50	4.0	3.91	4.00	5
TU Wien	M	(14,18]	2	4.00	4.0	3.95	5.00	5
UoA	F	(6,10]	4	4.00	4.0	4.33	4.50	5
UoA	F	(10,14]	3	3.00	4.0	4.10	5.00	5
UoA	M	(10,14]	1	3.75	4.0	4.10	5.00	5
UoA	F	(14,18]	2	3.00	3.0	3.29	4.00	5
UoA	M	(14,18]	2	4.00	4.0	4.11	5.00	5

9.14.2.8 I LIKE TRYING TO SOLVE DIFFICULT PROBLEMS

Table 81 reports the frequencies for the question I like trying to solve difficult problems and Table 82 reports the descriptive statistics. As it could be observed, TU Wien is the only partner with a lower percentage of 50% that selected agree and strongly agree. It also is the partner with the biggest number of participants who selected disagree and strongly disagree (23%). On the other hand, ESI is the one with the lowest percentage (8%). PRIA is the partner with the biggest number of participants who selected neutral (29%), followed very close by TU Wien (28%). As it could be observed in Table 83 and Table 84, there is no significant difference between genders in all partners. As it could be seen in Table 85 and Table 86, there is difference between age group in PRIA and UoA. As it could be observed in Table 87 and Table 88, there is difference between genders per age group in CU (7-10) and PRIA (7-10).

Table 80 Prequestionnaire Analysis: Likert scale. I like trying to solve difficult problems per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	26	29	90	118	133	396
CU	9	6	17	33	37	102
ESI	22	4	46	82	178	332
PRIA	12	12	78	84	83	269
TU Wien	12	20	39	35	34	140
UoA	2	6	20	46	45	119
Total	**83**	**77**	**290**	**398**	**510**	**1358**

Table 81 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like trying to solve difficult problems per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	4	3.77	5	5
CU	1	3	4	3.81	5	5
ESI	1	4	5	4.17	5	5
PRIA	1	3	4	3.80	5	5
TU Wien	1	3	3	3.42	4	5
UoA	1	4	4	4.06	5	5

Table 82 Prequestionnaire Analysis: Likert scale. I like trying to solve difficult problems per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	19	17	58	77	80	251
AL	M	7	12	32	41	53	145
CU	F	3	5	8	21	20	57
CU	M	6	1	9	12	17	45
ESI	F	13	2	23	45	72	155
ESI	M	9	2	23	37	106	177
PRIA	F	4	4	34	33	20	95
PRIA	M	8	8	44	51	62	173
TU Wien	F	3	15	19	18	16	71
TU Wien	M	9	5	20	17	18	69
UoA	F	1	3	10	17	16	47
UoA	M	1	3	10	28	29	71
Total		**83**	**77**	**290**	**397**	**509**	**1356**

Table 83 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like trying to solve difficult problems per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	3.0	4	3.73	5	5
AL	M	1	3.0	4	3.83	5	5
CU	F	1	3.0	4	3.88	5	5
CU	M	1	3.0	4	3.73	5	5
ESI	F	1	4.0	4	4.04	5	5
ESI	M	1	4.0	5	4.29	5	5
PRIA	F	1	3.0	4	3.64	4	5
PRIA	M	1	3.0	4	3.87	5	5
TU Wien	F	1	2.5	3	3.41	4	5
TU Wien	M	1	3.0	4	3.43	5	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	F	1	3.0	4	3.94	5	5
UoA	M	1	4.0	4	4.14	5	5

Table 84 Prequestionnaire Analysis: Likert scale. I like trying to solve difficult problems per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	9	10	31	56	62	168
AL	(10,14]	17	19	59	62	71	228
CU	(6,10]	3	2	2	6	15	28
CU	(10,14]	6	4	14	23	22	69
ESI	(6,10]	20	3	38	68	158	287
ESI	(10,14]	1	1	6	12	17	37
PRIA	(6,10]	6	1	6	8	28	49
PRIA	(10,14]	6	8	56	44	18	132
PRIA	(14,18]	0	3	14	28	32	77
TU Wien	(6,10]	6	5	14	13	18	56
TU Wien	(10,14]	3	10	18	11	7	49
TU Wien	(14,18]	1	5	7	11	8	32
UoA	(6,10]	0	1	1	1	0	3
UoA	(10,14]	2	5	15	31	28	81
UoA	(14,18]	0	0	4	14	16	34
Total		**80**	**77**	**285**	**388**	**500**	**1330**

Table 85 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like trying to solve difficult problems per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	3.00	4	3.90	5.00	5
AL	(10,14]	1	3.00	4	3.66	5.00	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
CU	(6,10]	1	3.75	5	4.00	5.00	5
CU	(10,14]	1	3.00	4	3.74	5.00	5
ESI	(6,10]	1	4.00	5	4.19	5.00	5
ESI	(10,14]	1	4.00	4	4.16	5.00	5
PRIA	(6,10]	1	3.00	5	4.04	5.00	5
PRIA	(10,14]	1	3.00	3	3.45	4.00	5
PRIA	(14,18]	2	4.00	4	4.16	5.00	5
TU Wien	(6,10]	1	3.00	4	3.57	5.00	5
TU Wien	(10,14]	1	2.00	3	3.18	4.00	5
TU Wien	(14,18]	1	3.00	4	3.62	4.25	5
UoA	(6,10]	2	2.50	3	3.00	3.50	4
UoA	(10,14]	1	3.00	4	3.96	5.00	5
UoA	(14,18]	3	4.00	4	4.35	5.00	5

Table 86 Prequestionnaire Analysis: Likert scale. I like trying to solve difficult problems per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	6	5	8	26	24	69
AL	(6,10]	M	3	5	23	30	38	99
AL	(10,14]	F	13	12	50	51	56	182
AL	(10,14]	M	4	7	9	11	15	46
CU	(6,10]	F	0	1	1	4	10	16
CU	(6,10]	M	3	1	1	2	5	12
CU	(10,14]	F	3	4	7	16	10	40
CU	(10,14]	M	3	0	7	7	12	29
ESI	(6,10]	F	12	2	20	40	65	139
ESI	(6,10]	M	8	1	18	28	93	148
ESI	(10,14]	F	0	0	3	4	6	13

Partner	Age Group	Gender	1	2	3	4	5	Total
ESI	(10,14]	M	1	1	3	8	11	24
PRIA	(6,10]	F	3	1	5	6	9	24
PRIA	(6,10]	M	3	0	1	2	19	25
PRIA	(10,14]	F	1	3	25	22	7	58
PRIA	(10,14]	M	5	5	31	22	10	73
PRIA	(14,18]	F	0	0	3	5	4	12
PRIA	(14,18]	M	0	3	11	23	28	65
TU Wien	(6,10]	F	1	4	6	6	10	27
TU Wien	(6,10]	M	5	1	8	7	8	29
TU Wien	(10,14]	F	1	7	12	9	3	32
TU Wien	(10,14]	M	2	3	6	2	4	17
TU Wien	(14,18]	F	0	4	1	3	3	11
TU Wien	(14,18]	M	1	1	6	8	5	21
UoA	(6,10]	F	0	1	1	1	0	3
UoA	(10,14]	F	1	2	7	11	8	29
UoA	(10,14]	M	1	3	8	20	20	52
UoA	(14,18]	F	0	0	2	5	7	14
UoA	(14,18]	M	0	0	2	8	9	19
Total			**80**	**77**	**285**	**387**	**499**	**1328**

Table 87 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like trying to solve difficult problems per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	3.00	4.0	3.83	5.00	5
AL	M	(6,10]	1	3.00	4.0	3.96	5.00	5
AL	F	(10,14]	1	3.00	4.0	3.69	5.00	5
AL	M	(10,14]	1	3.00	4.0	3.57	5.00	5
CU	F	(6,10]	2	4.00	5.0	4.44	5.00	5

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
CU	M	(6,10]	1	1.75	4.0	3.42	5.00	5
CU	F	(10,14]	1	3.00	4.0	3.65	4.25	5
CU	M	(10,14]	1	3.00	4.0	3.86	5.00	5
ESI	F	(6,10]	1	4.00	4.0	4.04	5.00	5
ESI	M	(6,10]	1	4.00	5.0	4.33	5.00	5
ESI	F	(10,14]	3	4.00	4.0	4.23	5.00	5
ESI	M	(10,14]	1	4.00	4.0	4.12	5.00	5
PRIA	F	(6,10]	1	3.00	4.0	3.71	5.00	5
PRIA	M	(6,10]	1	5.00	5.0	4.36	5.00	5
PRIA	F	(10,14]	1	3.00	3.5	3.53	4.00	5
PRIA	M	(10,14]	1	3.00	3.0	3.37	4.00	5
PRIA	F	(14,18]	3	3.75	4.0	4.08	5.00	5
PRIA	M	(14,18]	2	4.00	4.0	4.17	5.00	5
TU Wien	F	(6,10]	1	3.00	4.0	3.74	5.00	5
TU Wien	M	(6,10]	1	3.00	4.0	3.41	5.00	5
TU Wien	F	(10,14]	1	2.75	3.0	3.19	4.00	5
TU Wien	M	(10,14]	1	2.00	3.0	3.18	4.00	5
TU Wien	F	(14,18]	2	2.00	4.0	3.45	4.50	5
TU Wien	M	(14,18]	1	3.00	4.0	3.71	4.00	5
UoA	F	(6,10]	2	2.50	3.0	3.00	3.50	4
UoA	F	(10,14]	1	3.00	4.0	3.79	5.00	5
UoA	M	(10,14]	1	4.00	4.0	4.06	5.00	5
UoA	F	(14,18]	3	4.00	4.5	4.36	5.00	5
UoA	M	(14,18]	3	4.00	4.0	4.37	5.00	5

9.14.2.9 I NEED HELP SOLVING PROBLEMS

Table 89 reports the frequencies for the question I need help solving problems and Table 90 reports the descriptive statistics. ESI is the partner with the biggest percentage of participants who agree and strongly agree (56%) and it is with the lowest percentage who disagree and strongly disagree (16%). Nevertheless, most of the participants in the last group selected strongly disagree. UoA is the partner with the lowest percentage of participants who strongly agree and agree (25%) but it is the biggest number of participants who selected neutral (46%). TU Wien is the partner with the biggest percentage of participants who disagree and strongly disagree (37%), but most of the participants selected disagree. PRIA and AL have the same percentage of participants who disagree and strongly disagree (34%), and almost equal percentage in the other options. As it could be seen in Table 91 and Table 92, there is no significant difference between genders. As it could be observed in Table 93 and Table 94, there is difference between age groups in CU, ESI and UoA. As it could be seen in Table 95 and Table 96, there is difference between genders per age group in CU (11-14), ESI (11-14), PRIA (7-10 and 15-18) and UoA (11-14).

Table 88 Prequestionnaire Analysis: Likert scale. I need help solving problems per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	56	79	144	78	36	393
CU	7	18	38	18	16	97
ESI	38	14	95	90	97	334
PRIA	28	64	105	38	34	269
TU Wien	6	45	48	25	14	138
UoA	10	24	55	25	5	119
Total	**145**	**244**	**485**	**274**	**202**	**1350**

Table 89 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I need help solving problems per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	2	3	2.90	4.0	5
CU	1	2	3	3.19	4.0	5
ESI	1	3	4	3.58	5.0	5
PRIA	1	2	3	2.95	4.0	5
TU Wien	1	2	3	2.97	4.0	5
UoA	1	2	3	2.92	3.5	5

Table 90 Prequestionnaire Analysis: Likert scale. I need help solving problems per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	29	54	100	48	20	251
AL	M	27	25	44	30	16	142
CU	F	5	16	17	12	3	53
CU	M	2	2	21	6	13	44
ESI	F	15	7	45	45	42	154
ESI	M	23	7	50	45	55	180
PRIA	F	7	25	32	15	16	95
PRIA	M	21	39	72	23	18	173
TU Wien	F	2	19	30	10	9	70
TU Wien	M	4	26	18	15	5	68
UoA	F	3	7	24	12	1	47
UoA	M	7	17	30	13	4	71
Total		**145**	**244**	**483**	**274**	**202**	**1348**

Table 91 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I need help solving problems per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	2	3	2.90	4	5
AL	M	1	2	3	2.88	4	5
CU	F	1	2	3	2.85	4	5
CU	M	1	3	3	3.59	5	5
ESI	F	1	3	4	3.60	5	5
ESI	M	1	3	4	3.57	5	5
PRIA	F	1	2	3	3.08	4	5
PRIA	M	1	2	3	2.87	3	5
TU Wien	F	1	2	3	3.07	4	5
TU Wien	M	1	2	3	2.87	4	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	F	1	3	3	3.02	4	5
UoA	M	1	2	3	2.86	3	5

Table 92 Prequestionnaire Analysis: Likert scale. I need help solving problems per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	30	25	53	36	22	166
AL	(10,14]	26	54	91	42	14	227
CU	(6,10]	3	4	3	7	7	24
CU	(10,14]	4	14	35	7	9	69
ESI	(6,10]	32	10	79	76	90	287
ESI	(10,14]	4	2	15	12	6	39
PRIA	(6,10]	14	1	9	5	19	48
PRIA	(10,14]	5	37	56	27	9	134
PRIA	(14,18]	9	23	34	6	5	77
TU Wien	(6,10]	4	15	18	8	9	54
TU Wien	(10,14]	0	16	22	8	3	49
TU Wien	(14,18]	2	13	8	8	1	32
UoA	(6,10]	1	1	0	1	0	3
UoA	(10,14]	8	18	35	16	4	81
UoA	(14,18]	1	5	19	8	1	34
Total		**143**	**238**	**477**	**267**	**199**	**1324**

Table 93 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I need help solving problems per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	2.0	3.0	2.97	4.00	5
AL	(10,14]	1	2.0	3.0	2.84	3.00	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
CU	(6,10]	1	2.0	4.0	3.46	5.00	5
CU	(10,14]	1	2.0	3.0	3.04	3.00	5
ESI	(6,10]	1	3.0	4.0	3.63	5.00	5
ESI	(10,14]	1	3.0	3.0	3.36	4.00	5
PRIA	(6,10]	1	1.0	3.5	3.29	5.00	5
PRIA	(10,14]	1	2.0	3.0	2.99	4.00	5
PRIA	(14,18]	1	2.0	3.0	2.68	3.00	5
TU Wien	(6,10]	1	2.0	3.0	3.06	4.00	5
TU Wien	(10,14]	2	2.0	3.0	2.96	3.00	5
TU Wien	(14,18]	1	2.0	3.0	2.78	4.00	5
UoA	(6,10]	1	1.5	2.0	2.33	3.00	4
UoA	(10,14]	1	2.0	3.0	2.88	3.00	5
UoA	(14,18]	1	3.0	3.0	3.09	3.75	5

Table 94 Prequestionnaire Analysis: Likert scale. I need help solving problems per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	9	11	28	13	8	69
AL	(6,10]	M	21	14	25	23	14	97
AL	(10,14]	F	20	43	72	35	12	182
AL	(10,14]	M	6	11	19	7	2	45
CU	(6,10]	F	1	3	1	5	3	13
CU	(6,10]	M	2	1	2	2	4	11
CU	(10,14]	F	4	13	16	7	0	40
CU	(10,14]	M	0	1	19	0	9	29
ESI	(6,10]	F	15	6	40	37	40	138
ESI	(6,10]	M	17	4	39	39	50	149
ESI	(10,14]	F	0	0	4	7	2	13

Partner	Age Group	Gender	1	2	3	4	5	Total
ESI	(10,14]	M	4	2	11	5	4	26
PRIA	(6,10]	F	6	0	3	3	11	23
PRIA	(6,10]	M	8	1	6	2	8	25
PRIA	(10,14]	F	1	18	23	12	5	59
PRIA	(10,14]	M	4	19	32	15	4	74
PRIA	(14,18]	F	0	6	6	0	0	12
PRIA	(14,18]	M	9	17	28	6	5	65
TU Wien	(6,10]	F	1	6	12	3	4	26
TU Wien	(6,10]	M	3	9	6	5	5	28
TU Wien	(10,14]	F	0	9	15	5	3	32
TU Wien	(10,14]	M	0	7	7	3	0	17
TU Wien	(14,18]	F	1	4	3	2	1	11
TU Wien	(14,18]	M	1	9	5	6	0	21
UoA	(6,10]	F	1	1	0	1	0	3
UoA	(10,14]	F	1	4	18	5	1	29
UoA	(10,14]	M	7	14	17	11	3	52
UoA	(14,18]	F	1	2	5	6	0	14
UoA	(14,18]	M	0	3	13	2	1	19
Total			**143**	**238**	**475**	**267**	**199**	**1322**

Table 95 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I need help solving problems per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	2.00	3.0	3.00	4.00	5
AL	M	(6,10]	1	2.00	3.0	2.95	4.00	5
AL	F	(10,14]	1	2.00	3.0	2.87	4.00	5
AL	M	(10,14]	1	2.00	3.0	2.73	3.00	5
CU	F	(6,10]	1	2.00	4.0	3.46	4.00	5

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
CU	M	(6,10]	1	2.50	4.0	3.45	5.00	5
CU	F	(10,14]	1	2.00	3.0	2.65	3.00	4
CU	M	(10,14]	2	3.00	3.0	3.59	5.00	5
ESI	F	(6,10]	1	3.00	4.0	3.59	5.00	5
ESI	M	(6,10]	1	3.00	4.0	3.68	5.00	5
ESI	F	(10,14]	3	3.00	4.0	3.85	4.00	5
ESI	M	(10,14]	1	3.00	3.0	3.12	4.00	5
PRIA	F	(6,10]	1	2.00	4.0	3.57	5.00	5
PRIA	M	(6,10]	1	1.00	3.0	3.04	5.00	5
PRIA	F	(10,14]	1	2.00	3.0	3.03	4.00	5
PRIA	M	(10,14]	1	2.00	3.0	2.95	3.75	5
PRIA	F	(14,18]	2	2.00	2.5	2.50	3.00	3
PRIA	M	(14,18]	1	2.00	3.0	2.71	3.00	5
TU Wien	F	(6,10]	1	2.25	3.0	3.12	3.75	5
TU Wien	M	(6,10]	1	2.00	3.0	3.00	4.00	5
TU Wien	F	(10,14]	2	2.00	3.0	3.06	3.25	5
TU Wien	M	(10,14]	2	2.00	3.0	2.76	3.00	4
TU Wien	F	(14,18]	1	2.00	3.0	2.82	3.50	5
TU Wien	M	(14,18]	1	2.00	3.0	2.76	4.00	4
UoA	F	(6,10]	1	1.50	2.0	2.33	3.00	4
UoA	F	(10,14]	1	3.00	3.0	3.03	3.00	5
UoA	M	(10,14]	1	2.00	3.0	2.79	4.00	5
UoA	F	(14,18]	1	3.00	3.0	3.14	4.00	4
UoA	M	(14,18]	2	3.00	3.0	3.05	3.00	5

9.14.2.10 I AM GOOD AT SOLVING PROBLEMS

Table 97 reports the frequencies for the question I am good at solving problems and Table 98 reports the descriptive statistics. As it could be seen, CU is the partner with the biggest percentage of participants who agree and strongly agree (71%) and the only without any percentage in disagree and strongly disagree. The percentage of people from the rest of the partners who disagree and strongly disagree is below the 8% (AL). TU Wien is the partner with the biggest percentage of participants who selected neutral (43%) and PRIA the lowest (27%). As it could be seen in Table 99 and Table 100, there is no a significant difference between gender per partner. As it could be observed in Table 101 and Table 102, there is a difference between age group in AL and PRIA. As it could be seen in Table 103 and Table 104, there is difference between genders per age group in PRIA (7-10).

Table 96 Prequestionnaire Analysis: Likert scale. I am good at solving problems per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	4	13	78	82	48	225
CU	0	0	18	33	12	63
ESI	0	2	13	10	10	35
PRIA	4	12	62	110	44	232
TU Wien	2	2	33	31	9	77
UoA	0	4	32	44	18	98
Total	**10**	**33**	**236**	**310**	**141**	**730**

Table 97 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I am good at solving problems per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	4	3.70	4	5
CU	3	3	4	3.90	4	5
ESI	2	3	4	3.80	5	5
PRIA	1	3	4	3.77	4	5
TU Wien	1	3	4	3.56	4	5
UoA	2	3	4	3.78	4	5

Table 98 Prequestionnaire Analysis: Likert scale. I am good at solving problems per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	3	9	66	64	36	178
AL	M	1	4	12	18	12	47
CU	F	0	0	12	18	6	36
CU	M	0	0	6	15	6	27
ESI	F	0	1	5	3	3	12
ESI	M	0	1	8	7	7	23
PRIA	F	2	5	19	37	12	75
PRIA	M	2	7	43	73	31	156
TU Wien	F	1	1	20	13	6	41
TU Wien	M	1	1	13	18	3	36
UoA	F	0	1	16	16	4	37
UoA	M	0	3	16	27	14	60
Total		**10**	**33**	**236**	**309**	**140**	**728**

Table 99 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I am good at solving problems per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	3	4.0	3.68	4.00	5
AL	M	1	3	4.0	3.77	4.50	5
CU	F	3	3	4.0	3.83	4.00	5
CU	M	3	4	4.0	4.00	4.00	5
ESI	F	2	3	3.5	3.67	4.25	5
ESI	M	2	3	4.0	3.87	5.00	5
PRIA	F	1	3	4.0	3.69	4.00	5
PRIA	M	1	3	4.0	3.79	4.00	5
TU Wien	F	1	3	3.0	3.54	4.00	5
TU Wien	M	1	3	4.0	3.58	4.00	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	F	2	3	4.0	3.62	4.00	5
UoA	M	2	3	4.0	3.87	4.00	5

Table 100 Prequestionnaire Analysis: Likert scale. I am good at solving problems per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	0	1	0	0	0	1
AL	(10,14]	4	12	78	82	48	224
CU	(10,14]	0	0	15	33	12	60
ESI	(10,14]	0	2	12	10	10	34
PRIA	(6,10]	3	0	3	1	11	18
PRIA	(10,14]	1	9	39	66	11	126
PRIA	(14,18]	0	3	18	38	18	77
TU Wien	(10,14]	2	1	23	13	7	46
TU Wien	(14,18]	0	1	10	18	2	31
UoA	(10,14]	0	3	16	29	15	63
UoA	(14,18]	0	1	16	14	3	34
Total		**10**	**33**	**230**	**304**	**137**	**714**

Table 101 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I am good at solving problems per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	2	2.00	2.0	2.00	2	2
AL	(10,14]	1	3.00	4.0	3.71	4	5
CU	(10,14]	3	3.75	4.0	3.95	4	5
ESI	(10,14]	2	3.00	4.0	3.82	5	5
PRIA	(6,10]	1	3.00	5.0	3.94	5	5
PRIA	(10,14]	1	3.00	4.0	3.61	4	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
PRIA	(14,18]	2	3.00	4.0	3.92	4	5
TU Wien	(10,14]	1	3.00	3.0	3.48	4	5
TU Wien	(14,18]	2	3.00	4.0	3.68	4	5
UoA	(10,14]	2	3.00	4.0	3.89	4	5
UoA	(14,18]	2	3.00	3.5	3.56	4	5

Table 102 Prequestionnaire Analysis: Likert scale. I am good at solving problems per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	M	0	1	0	0	0	1
AL	(10,14]	F	3	9	66	64	36	178
AL	(10,14]	M	1	3	12	18	12	46
CU	(10,14]	F	0	0	12	18	6	36
CU	(10,14]	M	0	0	3	15	6	24
ESI	(10,14]	F	0	1	5	3	3	12
ESI	(10,14]	M	0	1	7	7	7	22
PRIA	(6,10]	F	2	0	1	0	4	7
PRIA	(6,10]	M	1	0	2	1	7	11
PRIA	(10,14]	F	0	5	15	29	6	55
PRIA	(10,14]	M	1	4	24	37	4	70
PRIA	(14,18]	F	0	0	3	7	2	12
PRIA	(14,18]	M	0	3	15	31	16	65
TU Wien	(10,14]	F	1	0	17	7	5	30
TU Wien	(10,14]	M	1	1	6	6	2	16
TU Wien	(14,18]	F	0	1	3	6	1	11
TU Wien	(14,18]	M	0	0	7	12	1	20
UoA	(10,14]	F	0	0	9	10	3	22
UoA	(10,14]	M	0	3	7	19	12	41

Partner	Age Group	Gender	1	2	3	4	5	Total
UoA	(14,18]	F	0	1	7	5	1	14
UoA	(14,18]	M	0	0	9	8	2	19
Total			**10**	**33**	**230**	**303**	**136**	**712**

Table 103 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I am good at solving problems per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	M	(6,10]	2	2.00	2.0	2.00	2.00	2
AL	F	(10,14]	1	3.00	4.0	3.68	4.00	5
AL	M	(10,14]	1	3.00	4.0	3.80	4.75	5
CU	F	(10,14]	3	3.00	4.0	3.83	4.00	5
CU	M	(10,14]	3	4.00	4.0	4.12	4.25	5
ESI	F	(10,14]	2	3.00	3.5	3.67	4.25	5
ESI	M	(10,14]	2	3.00	4.0	3.91	5.00	5
PRIA	F	(6,10]	1	2.00	5.0	3.57	5.00	5
PRIA	M	(6,10]	1	3.50	5.0	4.18	5.00	5
PRIA	F	(10,14]	2	3.00	4.0	3.65	4.00	5
PRIA	M	(10,14]	1	3.00	4.0	3.56	4.00	5
PRIA	F	(14,18]	3	3.75	4.0	3.92	4.00	5
PRIA	M	(14,18]	2	3.00	4.0	3.92	4.00	5
TU Wien	F	(10,14]	1	3.00	3.0	3.50	4.00	5
TU Wien	M	(10,14]	1	3.00	3.5	3.44	4.00	5
TU Wien	F	(14,18]	2	3.00	4.0	3.64	4.00	5
TU Wien	M	(14,18]	3	3.00	4.0	3.70	4.00	5
UoA	F	(10,14]	3	3.00	4.0	3.73	4.00	5
UoA	M	(10,14]	2	4.00	4.0	3.98	5.00	5
UoA	F	(14,18]	2	3.00	3.0	3.43	4.00	5
UoA	M	(14,18]	3	3.00	4.0	3.63	4.00	5

9.14.2.11 I WANT TO UNDERSTAND MORE ABOUT MECHANICAL THINGS

Table 105 reports the frequencies for the question I want to understand more about mechanical things and Table 106 reports the descriptive statistics. As it could be observed, all the partners, an exception of TU Wien, has more than 67% of participants who agree and strongly agree. ESI is the partner with the biggest percentage of participants who agree and strongly agree (81%) and at the same time the one with the lowest in the rest of the options. TU Wien is the partner with the lowest percentage of participants who agree and strongly agree (48%) and at the same times is the one with the biggest number in the rest of the options. As it could be seen in Table 107 and Table 108, there is difference between genders in AL, CU and TU Wien. As it could be seen in Table 109 and Table 110, there is difference between age group in PRIA. As it could be seen in Table 111 and Table 112, there is difference between gender per age group in AL (11-14), CU (11-14), TU Wien (11-14) and UoA (11-14).

Table 104 Prequestionnaire Analysis: Likert scale. I want to understand more about mechanical things per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	11	19	45	81	69	225
CU	6	0	12	18	27	63
ESI	1	0	6	14	16	37
PRIA	3	13	57	80	82	235
TU Wien	5	10	26	26	12	79
UoA	0	4	20	39	36	99
Total	**26**	**46**	**166**	**258**	**242**	**738**

Table 105 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I want to understand more about mechanical things per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	4	3.79	5	5
CU	1	3	4	3.95	5	5
ESI	1	4	4	4.19	5	5
PRIA	1	3	4	3.96	5	5
TU Wien	1	3	3	3.38	4	5
UoA	2	4	4	4.08	5	5

Table 106 Prequestionnaire Analysis: Likert scale. I want to understand more about mechanical things per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	11	18	40	62	47	178
AL	M	0	1	5	19	22	47
CU	F	6	0	3	15	12	36
CU	M	0	0	9	3	15	27
ESI	F	0	0	3	6	3	12
ESI	M	1	0	3	8	13	25
PRIA	F	1	3	26	33	13	76
PRIA	M	2	10	31	47	68	158
TU Wien	F	3	9	12	13	4	41
TU Wien	M	2	1	14	13	8	38
UoA	F	0	3	8	16	10	37
UoA	M	0	1	12	23	25	61
Total		**26**	**46**	**166**	**258**	**240**	**736**

Table 107 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I want to understand more about mechanical things per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	3.00	4	3.65	5.00	5
AL	M	2	4.00	4	4.32	5.00	5
CU	F	1	3.75	4	3.75	5.00	5
CU	M	3	3.00	5	4.22	5.00	5
ESI	F	3	3.75	4	4.00	4.25	5
ESI	M	1	4.00	5	4.28	5.00	5
PRIA	F	1	3.00	4	3.71	4.00	5
PRIA	M	1	3.00	4	4.07	5.00	5
TU Wien	F	1	2.00	3	3.15	4.00	5
TU Wien	M	1	3.00	4	3.63	4.00	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	F	2	3.00	4	3.89	5.00	5
UoA	M	2	4.00	4	4.18	5.00	5

Table 108 Prequestionnaire Analysis: Likert scale. I want to understand more about mechanical things per partner and group age. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	0	0	1	0	0	1
AL	(10,14]	11	19	44	81	69	224
CU	(10,14]	6	0	9	18	27	60
ESI	(10,14]	1	0	6	14	15	36
PRIA	(6,10]	1	1	1	0	15	18
PRIA	(10,14]	2	2	39	48	38	129
PRIA	(14,18]	0	9	16	30	22	77
TU Wien	(10,14]	4	7	13	17	6	47
TU Wien	(14,18]	1	3	13	9	6	32
UoA	(10,14]	0	1	14	25	24	64
UoA	(14,18]	0	3	6	14	11	34
Total		**26**	**45**	**162**	**256**	**233**	**722**

Table 109 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I want to understand more about mechanical things per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	3	3.00	3	3.00	3	3
AL	(10,14]	1	3.00	4	3.79	5	5
CU	(10,14]	1	3.75	4	4.00	5	5
ESI	(10,14]	1	4.00	4	4.17	5	5
PRIA	(6,10]	1	5.00	5	4.50	5	5
PRIA	(10,14]	1	3.00	4	3.91	5	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
PRIA	(14,18]	2	3.00	4	3.84	5	5
TU Wien	(10,14]	1	3.00	3	3.30	4	5
TU Wien	(14,18]	1	3.00	3	3.50	4	5
UoA	(10,14]	2	4.00	4	4.12	5	5
UoA	(14,18]	2	3.25	4	3.97	5	5

Table 110 Prequestionnaire Analysis: Likert scale. I want to understand more about mechanical things per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	M	0	0	1	0	0	1
AL	(10,14]	F	11	18	40	62	47	178
AL	(10,14]	M	0	1	4	19	22	46
CU	(10,14]	F	6	0	3	15	12	36
CU	(10,14]	M	0	0	6	3	15	24
ESI	(10,14]	F	0	0	3	6	3	12
ESI	(10,14]	M	1	0	3	8	12	24
PRIA	(6,10]	F	0	1	0	0	6	7
PRIA	(6,10]	M	1	0	1	0	9	11
PRIA	(10,14]	F	1	2	23	25	5	56
PRIA	(10,14]	M	1	0	16	23	32	72
PRIA	(14,18]	F	0	0	3	8	1	12
PRIA	(14,18]	M	0	9	13	22	21	65
TU Wien	(10,14]	F	3	6	9	10	2	30
TU Wien	(10,14]	M	1	1	4	7	4	17
TU Wien	(14,18]	F	0	3	3	3	2	11
TU Wien	(14,18]	M	1	0	10	6	4	21
UoA	(10,14]	F	0	1	6	11	4	22
UoA	(10,14]	M	0	0	8	14	20	42

Partner	Age Group	Gender	1	2	3	4	5	Total
UoA	(14,18]	F	0	2	2	5	5	14
UoA	(14,18]	M	0	1	4	9	5	19
Total			**26**	**45**	**162**	**256**	**231**	**720**

Table 111 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I want to understand more about mechanical things per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	M	(6,10]	3	3.00	3.0	3.00	3.00	3
AL	F	(10,14]	1	3.00	4.0	3.65	5.00	5
AL	M	(10,14]	2	4.00	4.0	4.35	5.00	5
CU	F	(10,14]	1	3.75	4.0	3.75	5.00	5
CU	M	(10,14]	3	3.75	5.0	4.38	5.00	5
ESI	F	(10,14]	3	3.75	4.0	4.00	4.25	5
ESI	M	(10,14]	1	4.00	4.5	4.25	5.00	5
PRIA	F	(6,10]	2	5.00	5.0	4.57	5.00	5
PRIA	M	(6,10]	1	5.00	5.0	4.45	5.00	5
PRIA	F	(10,14]	1	3.00	4.0	3.55	4.00	5
PRIA	M	(10,14]	1	4.00	4.0	4.18	5.00	5
PRIA	F	(14,18]	3	3.75	4.0	3.83	4.00	5
PRIA	M	(14,18]	2	3.00	4.0	3.85	5.00	5
TU Wien	F	(10,14]	1	2.00	3.0	3.07	4.00	5
TU Wien	M	(10,14]	1	3.00	4.0	3.71	4.00	5
TU Wien	F	(14,18]	2	2.50	3.0	3.36	4.00	5
TU Wien	M	(14,18]	1	3.00	3.0	3.57	4.00	5
UoA	F	(10,14]	2	3.00	4.0	3.82	4.00	5
UoA	M	(10,14]	3	4.00	4.0	4.29	5.00	5
UoA	F	(14,18]	2	3.25	4.0	3.93	5.00	5
UoA	M	(14,18]	2	3.50	4.0	3.95	4.50	5

9.14.2.12 I WANT TO SOLVE PROBLEMS THAT CAN HELP PEOPLE

Table 113 reports the frequencies for the question I want to solve problems that can help people and Table 114 reports the descriptive statistics. More than 76% of the participants from AL, CU, PRIA and UoA selected strongly agree and strongly agree. UoA and CU is the partner with the biggest percentage of participants who agree and strongly agree (86%). CU is the only partner with 0% of participants who selected disagree and strongly disagree. ESI is the partner with the lowest percentage of participants who agree and strongly agree (20%) and the one with the biggest percentage in disagree and strongly disagree (60%). As it could be observed in Table 115 and Table 116, there is no significant difference between genders per partner. As it could be seen in Table 117 and Table 118, there is difference between age group in AL, ESI and TU Wien. As it could be seen in Table 119 and Table 120, there is difference between genders per age group in ESI (11-14) and PRIA (7-10).

Table 112 Prequestionnaire Analysis: Likert scale. I want to solve problems that can help people per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	**1**	**2**	**3**	**4**	**5**	**Total**
AL	4	9	60	127	194	394
CU	0	0	9	18	36	63
ESI	156	47	65	32	37	337
PRIA	11	10	44	91	114	270
TU Wien	30	16	22	44	25	137
UoA	1	3	12	37	63	116
Total	**202**	**85**	**212**	**349**	**469**	**1317**

Table 113 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I want to solve problems that can help people per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	**Min**	**1 Q**	**Median**	**Average**	**3 Q**	**Max**
AL	1	4	4	4.26	5	5
CU	3	4	5	4.43	5	5
ESI	1	1	2	2.25	3	5
PRIA	1	4	4	4.06	5	5
TU Wien	1	2	4	3.13	4	5
UoA	1	4	5	4.36	5	5

Table 114 Prequestionnaire Analysis: Likert scale. I want to solve problems that can help people per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	1	2	34	79	135	251
AL	M	3	7	26	48	59	143
CU	F	0	0	3	12	21	36
CU	M	0	0	6	6	15	27
ESI	F	83	20	24	12	17	156
ESI	M	73	27	41	20	20	181
PRIA	F	3	4	14	29	46	96
PRIA	M	8	6	30	62	67	173
TU Wien	F	14	7	7	28	13	69
TU Wien	M	16	9	15	16	12	68
UoA	F	0	0	4	14	29	47
UoA	M	1	3	8	22	34	68
Total		**202**	**85**	**212**	**348**	**468**	**1315**

Table 115 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I want to solve problems that can help people per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	4.0	5.0	4.37	5	5
AL	M	1	3.5	4.0	4.07	5	5
CU	F	3	4.0	5.0	4.50	5	5
CU	M	3	4.0	5.0	4.33	5	5
ESI	F	1	1.0	1.0	2.10	3	5
ESI	M	1	1.0	2.0	2.38	3	5
PRIA	F	1	4.0	4.0	4.16	5	5
PRIA	M	1	3.0	4.0	4.01	5	5
TU Wien	F	1	2.0	4.0	3.28	4	5
TU Wien	M	1	2.0	3.0	2.99	4	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	F	3	4.0	5.0	4.53	5	5
UoA	M	1	4.0	4.5	4.25	5	5

Table 116 Prequestionnaire Analysis: Likert scale. I want to solve problems that can help people per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	4	7	35	56	64	166
AL	(10,14]	0	2	25	71	130	228
CU	(10,14]	0	0	6	18	36	60
ESI	(6,10]	149	46	58	22	15	290
ESI	(10,14]	2	0	6	10	21	39
PRIA	(6,10]	10	3	3	5	28	49
PRIA	(10,14]	1	2	25	58	47	133
PRIA	(14,18]	0	5	14	28	30	77
TU Wien	(6,10]	26	13	8	5	2	54
TU Wien	(10,14]	2	2	7	25	12	48
TU Wien	(14,18]	0	1	6	14	11	32
UoA	(6,10]	0	0	0	2	1	3
UoA	(10,14]	1	2	10	23	42	78
UoA	(14,18]	0	1	2	11	20	34
Total		**195**	**84**	**205**	**348**	**459**	**1291**

Table 117 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I want to solve problems that can help people per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	3	4	4.02	5.00	5
AL	(10,14]	2	4	5	4.44	5.00	5
CU	(10,14]	3	4	5	4.50	5.00	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
ESI	(6,10]	1	1	1	1.99	3.00	5
ESI	(10,14]	1	4	5	4.23	5.00	5
PRIA	(6,10]	1	2	5	3.78	5.00	5
PRIA	(10,14]	1	4	4	4.11	5.00	5
PRIA	(14,18]	2	4	4	4.08	5.00	5
TU Wien	(6,10]	1	1	2	1.96	3.00	5
TU Wien	(10,14]	1	4	4	3.90	4.25	5
TU Wien	(14,18]	2	4	4	4.09	5.00	5
UoA	(6,10]	4	4	4	4.33	4.50	5
UoA	(10,14]	1	4	5	4.32	5.00	5
UoA	(14,18]	2	4	5	4.47	5.00	5

Table 118 Prequestionnaire Analysis: Likert scale. I want to solve problems that can help people per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	1	0	13	26	29	69
AL	(6,10]	M	3	7	22	30	35	97
AL	(10,14]	F	0	2	21	53	106	182
AL	(10,14]	M	0	0	4	18	24	46
CU	(10,14]	F	0	0	3	12	21	36
CU	(10,14]	M	0	0	3	6	15	24
ESI	(6,10]	F	81	19	23	9	8	140
ESI	(6,10]	M	68	27	35	13	7	150
ESI	(10,14]	F	0	0	1	3	9	13
ESI	(10,14]	M	2	0	5	7	12	26
PRIA	(6,10]	F	3	1	2	2	16	24
PRIA	(6,10]	M	7	2	1	3	12	25
PRIA	(10,14]	F	0	2	9	25	23	59

Partner	Age Group	Gender	1	2	3	4	5	Total
PRIA	(10,14]	M	1	0	16	33	23	73
PRIA	(14,18]	F	0	1	3	2	6	12
PRIA	(14,18]	M	0	4	11	26	24	65
TU Wien	(6,10]	F	13	6	3	3	1	26
TU Wien	(6,10]	M	13	7	5	2	1	28
TU Wien	(10,14]	F	1	1	3	19	7	31
TU Wien	(10,14]	M	1	1	4	6	5	17
TU Wien	(14,18]	F	0	0	0	6	5	11
TU Wien	(14,18]	M	0	1	6	8	6	21
UoA	(6,10]	F	0	0	0	2	1	3
UoA	(10,14]	F	0	0	3	10	16	29
UoA	(10,14]	M	1	2	7	13	26	49
UoA	(14,18]	F	0	0	1	1	12	14
UoA	(14,18]	M	0	1	1	9	8	19
Total			**195**	**84**	**205**	**347**	**458**	**1289**

Table 119 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I want to solve problems that can help people per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	4.00	4.0	4.19	5.00	5
AL	M	(6,10]	1	3.00	4.0	3.90	5.00	5
AL	F	(10,14]	2	4.00	5.0	4.45	5.00	5
AL	M	(10,14]	3	4.00	5.0	4.43	5.00	5
CU	F	(10,14]	3	4.00	5.0	4.50	5.00	5
CU	M	(10,14]	3	4.00	5.0	4.50	5.00	5
ESI	F	(6,10]	1	1.00	1.0	1.89	3.00	5
ESI	M	(6,10]	1	1.00	2.0	2.09	3.00	5
ESI	F	(10,14]	3	4.00	5.0	4.62	5.00	5

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
ESI	M	(10,14]	1	3.25	4.0	4.04	5.00	5
PRIA	F	(6,10]	1	3.75	5.0	4.12	5.00	5
PRIA	M	(6,10]	1	1.00	4.0	3.44	5.00	5
PRIA	F	(10,14]	2	4.00	4.0	4.17	5.00	5
PRIA	M	(10,14]	1	4.00	4.0	4.05	5.00	5
PRIA	F	(14,18]	2	3.00	4.5	4.08	5.00	5
PRIA	M	(14,18]	2	4.00	4.0	4.08	5.00	5
TU Wien	F	(6,10]	1	1.00	1.5	1.96	2.75	5
TU Wien	M	(6,10]	1	1.00	2.0	1.96	3.00	5
TU Wien	F	(10,14]	1	4.00	4.0	3.97	4.00	5
TU Wien	M	(10,14]	1	3.00	4.0	3.76	5.00	5
TU Wien	F	(14,18]	4	4.00	4.0	4.45	5.00	5
TU Wien	M	(14,18]	2	3.00	4.0	3.90	5.00	5
UoA	F	(6,10]	4	4.00	4.0	4.33	4.50	5
UoA	F	(10,14]	3	4.00	5.0	4.45	5.00	5
UoA	M	(10,14]	1	4.00	5.0	4.24	5.00	5
UoA	F	(14,18]	3	5.00	5.0	4.79	5.00	5
UoA	M	(14,18]	2	4.00	4.0	4.26	5.00	5

9.14.2.13 I PREFER TASKS THAT ONLY HAVE ONE CORRECT ANSWER

Table 121 reports the frequencies for the question I prefer tasks that only have one correct answer and Table 122 reports the descriptive statistics. As it could be seen, ESI is the partner with the biggest number of participants who agree and strongly agree (81%) and at the same time the one with the lowest percentage of participants who disagree and strongly disagree (14%). Participants from TU Wien, AL, and CU are mainly distributed between neutral and strongly agree. 35%, 43% and 39% of the participants from TU Wien, CU and AL, respectively, selected neutral. 53%, 52% and 49% of the participants from TU Wien, CU and AL, respectively, selected agree and strongly agree. Participants from UoA and PRIA tend to move slightly towards disagree and strongly disagree. Just 30% and 39% of UoA and PRIA, respectively, selected strongly agree and agree. On the other hand, 32% and 25% of UoA and PRIA, respectively, selected strongly disagree and disagree. As it could be seen in Table 123 and Table 124, there is difference between genders in AL. As it could be observed in Table 125 and Table 126, there is difference between age group in AL and PRIA. As it could be observed in Table 127 and Table 128, there is difference between genders per age group in AL (11-14) and TU Wien (15-18).

Table 120 Prequestionnaire Analysis: Likert scale. I prefer tasks that only have one correct answer per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	10	17	89	71	40	227
CU	0	3	27	15	18	63
ESI	1	4	2	13	17	37
PRIA	15	43	85	49	44	236
TU Wien	2	7	28	29	13	79
UoA	7	24	37	19	10	97
Total	**35**	**98**	**268**	**196**	**142**	**739**

Table 121 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I prefer tasks that only have one correct answer per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	3	3.50	4	5
CU	2	3	4	3.76	5	5
ESI	1	4	4	4.11	5	5
PRIA	1	3	3	3.27	4	5
TU Wien	1	3	4	3.56	4	5
UoA	1	2	3	3.01	4	5

Table 122 Prequestionnaire Analysis: Likert scale. I prefer tasks that only have one correct answer per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	8	16	71	59	26	180
AL	M	2	1	18	12	14	47
CU	F	0	3	15	9	9	36
CU	M	0	0	12	6	9	27
ESI	F	0	0	2	5	5	12
ESI	M	1	4	0	8	12	25
PRIA	F	1	11	29	22	13	76
PRIA	M	14	32	55	27	31	159
TU Wien	F	2	2	12	17	8	41
TU Wien	M	0	5	16	12	5	38
UoA	F	2	9	11	10	4	36
UoA	M	5	14	26	9	6	60
Total		**35**	**97**	**267**	**196**	**142**	**737**

Table 123 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I prefer tasks that only have one correct answer per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	3	3.0	3.44	4.00	5
AL	M	1	3	4.0	3.74	5.00	5
CU	F	2	3	3.5	3.67	4.25	5
CU	M	3	3	4.0	3.89	5.00	5
ESI	F	3	4	4.0	4.25	5.00	5
ESI	M	1	4	4.0	4.04	5.00	5
PRIA	F	1	3	3.0	3.46	4.00	5
PRIA	M	1	2	3.0	3.18	4.00	5
TU Wien	F	1	3	4.0	3.66	4.00	5
TU Wien	M	2	3	3.0	3.45	4.00	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	F	1	2	3.0	3.14	4.00	5
UoA	M	1	2	3.0	2.95	3.25	5

Table 124 Prequestionnaire Analysis: Likert scale. I prefer tasks that only have one correct answer per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	0	0	0	1	0	1
AL	(10,14]	10	17	89	70	40	226
CU	(10,14]	0	3	27	12	18	60
ESI	(10,14]	1	4	2	13	16	36
PRIA	(6,10]	2	0	2	1	13	18
PRIA	(10,14]	3	22	47	37	21	130
PRIA	(14,18]	7	20	31	10	9	77
TU Wien	(10,14]	1	4	15	19	8	47
TU Wien	(14,18]	1	3	13	10	5	32
UoA	(10,14]	6	9	24	15	8	62
UoA	(14,18]	1	15	13	3	2	34
Total		**32**	**97**	**263**	**191**	**140**	**723**

Table 125 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I prefer tasks that only have one correct answer per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	4	4.00	4.0	4.00	4	4
AL	(10,14]	1	3.00	3.0	3.50	4	5
CU	(10,14]	2	3.00	3.5	3.75	5	5
ESI	(10,14]	1	4.00	4.0	4.08	5	5
PRIA	(6,10]	1	4.25	5.0	4.28	5	5
PRIA	(10,14]	1	3.00	3.0	3.39	4	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
PRIA	(14,18]	1	2.00	3.0	2.92	3	5
TU Wien	(10,14]	1	3.00	4.0	3.62	4	5
TU Wien	(14,18]	1	3.00	3.0	3.47	4	5
UoA	(10,14]	1	3.00	3.0	3.16	4	5
UoA	(14,18]	1	2.00	3.0	2.71	3	5

Table 126 Prequestionnaire Analysis: Likert scale. I prefer tasks that only have one correct answer per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	M	0	0	0	1	0	1
AL	(10,14]	F	8	16	71	59	26	180
AL	(10,14]	M	2	1	18	11	14	46
CU	(10,14]	F	0	3	15	9	9	36
CU	(10,14]	M	0	0	12	3	9	24
ESI	(10,14]	F	0	0	2	5	5	12
ESI	(10,14]	M	1	4	0	8	11	24
PRIA	(6,10]	F	0	0	2	0	5	7
PRIA	(6,10]	M	2	0	0	1	8	11
PRIA	(10,14]	F	1	8	19	21	7	56
PRIA	(10,14]	M	2	14	27	16	14	73
PRIA	(14,18]	F	0	3	7	1	1	12
PRIA	(14,18]	M	7	17	24	9	8	65
TU Wien	(10,14]	F	1	2	9	13	5	30
TU Wien	(10,14]	M	0	2	6	6	3	17
TU Wien	(14,18]	F	1	0	3	4	3	11
TU Wien	(14,18]	M	0	3	10	6	2	21
UoA	(10,14]	F	2	2	7	6	4	21
UoA	(10,14]	M	4	7	17	9	4	41

Partner	Age Group	Gender	1	2	3	4	5	Total
UoA	(14,18]	F	0	7	4	3	0	14
UoA	(14,18]	M	1	7	9	0	2	19
Total			**32**	**96**	**262**	**191**	**140**	**721**

Table 127 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I prefer tasks that only have one correct answer per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	M	(6,10]	4	4.00	4.0	4.00	4.00	4
AL	F	(10,14]	1	3.00	3.0	3.44	4.00	5
AL	M	(10,14]	1	3.00	4.0	3.74	5.00	5
CU	F	(10,14]	2	3.00	3.5	3.67	4.25	5
CU	M	(10,14]	3	3.00	3.5	3.88	5.00	5
ESI	F	(10,14]	3	4.00	4.0	4.25	5.00	5
ESI	M	(10,14]	1	4.00	4.0	4.00	5.00	5
PRIA	F	(6,10]	3	4.00	5.0	4.43	5.00	5
PRIA	M	(6,10]	1	4.50	5.0	4.18	5.00	5
PRIA	F	(10,14]	1	3.00	3.5	3.45	4.00	5
PRIA	M	(10,14]	1	3.00	3.0	3.36	4.00	5
PRIA	F	(14,18]	2	2.75	3.0	3.00	3.00	5
PRIA	M	(14,18]	1	2.00	3.0	2.91	4.00	5
TU Wien	F	(10,14]	1	3.00	4.0	3.63	4.00	5
TU Wien	M	(10,14]	2	3.00	4.0	3.59	4.00	5
TU Wien	F	(14,18]	1	3.00	4.0	3.73	4.50	5
TU Wien	M	(14,18]	2	3.00	3.0	3.33	4.00	5
UoA	F	(10,14]	1	3.00	3.0	3.38	4.00	5
UoA	M	(10,14]	1	2.00	3.0	3.05	4.00	5
UoA	F	(14,18]	2	2.00	2.5	2.71	3.00	4
UoA	M	(14,18]	1	2.00	3.0	2.74	3.00	5

9.14.2.14 I LIKE TO KEEP WORKING ON A PROJECT UNTIL IT IS PERFECT

Table 129 reports the frequencies for the question I like to keep working on a project until it is perfect and Table 130 reports the descriptive statistics. As it could be observed, a majority of participants from all the partners agree and strongly agree. Most of the partners, an exception of PRIA and TU Wien, have a percentage of participants higher than 80%, with the biggest percentage found in ESI (89%), which is also the partner with the lowest percentage who selected neutral (8%). TU Wien is the partner with the lowest percentage of participants who selected agree and strongly agree (56%) and it is the one with the biggest percentage in the rest of the options, 29% in neutral, and 15% in disagree and strongly disagree. As it could be observed in Table 131 and Table 132, there is difference between genders in AL and ESI. As it could be observed in Table 133 and Table 134, there is difference between age group in UoA. As it could be observed in Table 135 and Table 136, there is difference between genders per age group in AL (11-14), PRIA (15-18) and UoA (15-18).

Table 128 Prequestionnaire Analysis: Likert scale. I like to keep working on a project until it is perfect per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	3	7	30	66	121	227
CU	0	0	12	24	27	63
ESI	1	0	3	14	19	37
PRIA	2	9	52	90	82	235
TU Wien	2	10	23	31	13	79
UoA	0	5	13	34	47	99
Total	**8**	**31**	**133**	**259**	**309**	**740**

Table 129 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like to keep working on a project until it is perfect per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	5	4.30	5	5
CU	3	4	4	4.24	5	5
ESI	1	4	5	4.35	5	5
PRIA	1	3	4	4.03	5	5
TU Wien	1	3	4	3.54	4	5
UoA	2	4	4	4.24	5	5

Table 130 Prequestionnaire Analysis: Likert scale. I like to keep working on a project until it is perfect per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	2	4	22	47	105	180
AL	M	1	3	8	19	16	47
CU	F	0	0	6	12	18	36
CU	M	0	0	6	12	9	27
ESI	F	0	0	2	5	5	12
ESI	M	1	0	1	9	14	25
PRIA	F	0	2	18	28	28	76
PRIA	M	2	7	34	62	53	158
TU Wien	F	0	6	12	16	7	41
TU Wien	M	2	4	11	15	6	38
UoA	F	0	0	7	13	17	37
UoA	M	0	5	6	20	30	61
Total		**8**	**31**	**133**	**258**	**308**	**738**

Table 131 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like to keep working on a project until it is perfect per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	4.0	5.0	4.38	5	5
AL	M	1	3.5	4.0	3.98	5	5
CU	F	3	4.0	4.5	4.33	5	5
CU	M	3	4.0	4.0	4.11	5	5
ESI	F	3	4.0	4.0	4.25	5	5
ESI	M	1	4.0	5.0	4.40	5	5
PRIA	F	2	3.0	4.0	4.08	5	5
PRIA	M	1	3.0	4.0	3.99	5	5
TU Wien	F	2	3.0	4.0	3.59	4	5
TU Wien	M	1	3.0	4.0	3.50	4	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	F	3	4.0	4.0	4.27	5	5
UoA	M	2	4.0	4.0	4.23	5	5

Table 132 Prequestionnaire Analysis: Likert scale. I like to keep working on a project until it is perfect per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	0	0	1	0	0	1
AL	(10,14]	3	7	29	66	121	226
CU	(10,14]	0	0	12	24	24	60
ESI	(10,14]	1	0	3	13	19	36
PRIA	(6,10]	2	0	1	1	14	18
PRIA	(10,14]	0	5	32	49	43	129
PRIA	(14,18]	0	4	18	33	22	77
TU Wien	(10,14]	2	6	14	18	7	47
TU Wien	(14,18]	0	4	9	13	6	32
UoA	(10,14]	0	1	7	23	33	64
UoA	(14,18]	0	4	6	11	13	34
Total		**8**	**31**	**132**	**251**	**302**	**724**

Table 133 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like to keep working on a project until it is perfect per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	3	3	3	3.00	3	3
AL	(10,14]	1	4	5	4.31	5	5
CU	(10,14]	3	4	4	4.20	5	5
ESI	(10,14]	1	4	5	4.36	5	5
PRIA	(6,10]	1	5	5	4.39	5	5
PRIA	(10,14]	2	3	4	4.01	5	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
PRIA	(14,18]	2	3	4	3.95	5	5
TU Wien	(10,14]	1	3	4	3.47	4	5
TU Wien	(14,18]	2	3	4	3.66	4	5
UoA	(10,14]	2	4	5	4.38	5	5
UoA	(14,18]	2	3	4	3.97	5	5

Table 134 Prequestionnaire Analysis: Likert scale. I like to keep working on a project until it is perfect per partner, age group and age. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	M	0	0	1	0	0	1
AL	(10,14]	F	2	4	22	47	105	180
AL	(10,14]	M	1	3	7	19	16	46
CU	(10,14]	F	0	0	6	12	18	36
CU	(10,14]	M	0	0	6	12	6	24
ESI	(10,14]	F	0	0	2	5	5	12
ESI	(10,14]	M	1	0	1	8	14	24
PRIA	(6,10]	F	0	0	1	1	5	7
PRIA	(6,10]	M	2	0	0	0	9	11
PRIA	(10,14]	F	0	2	14	24	16	56
PRIA	(10,14]	M	0	3	18	25	26	72
PRIA	(14,18]	F	0	0	3	3	6	12
PRIA	(14,18]	M	0	4	15	30	16	65
TU Wien	(10,14]	F	0	4	10	12	4	30
TU Wien	(10,14]	M	2	2	4	6	3	17
TU Wien	(14,18]	F	0	2	2	4	3	11
TU Wien	(14,18]	M	0	2	7	9	3	21
UoA	(10,14]	F	0	0	4	8	10	22
UoA	(10,14]	M	0	1	3	15	23	42

Partner	Age Group	Gender	1	2	3	4	5	Total
UoA	(14,18]	F	0	0	3	5	6	14
UoA	(14,18]	M	0	4	3	5	7	19
Total			**8**	**31**	**132**	**250**	**301**	**722**

Table 135 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like to keep working on a project until it is perfect per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	M	(6,10]	3	3.00	3.0	3.00	3.00	3
AL	F	(10,14]	1	4.00	5.0	4.38	5.00	5
AL	M	(10,14]	1	4.00	4.0	4.00	5.00	5
CU	F	(10,14]	3	4.00	4.5	4.33	5.00	5
CU	M	(10,14]	3	3.75	4.0	4.00	4.25	5
ESI	F	(10,14]	3	4.00	4.0	4.25	5.00	5
ESI	M	(10,14]	1	4.00	5.0	4.42	5.00	5
PRIA	F	(6,10]	3	4.50	5.0	4.57	5.00	5
PRIA	M	(6,10]	1	5.00	5.0	4.27	5.00	5
PRIA	F	(10,14]	2	3.00	4.0	3.96	5.00	5
PRIA	M	(10,14]	2	3.00	4.0	4.03	5.00	5
PRIA	F	(14,18]	3	3.75	4.5	4.25	5.00	5
PRIA	M	(14,18]	2	3.00	4.0	3.89	4.00	5
TU Wien	F	(10,14]	2	3.00	4.0	3.53	4.00	5
TU Wien	M	(10,14]	1	3.00	4.0	3.35	4.00	5
TU Wien	F	(14,18]	2	3.00	4.0	3.73	4.50	5
TU Wien	M	(14,18]	2	3.00	4.0	3.62	4.00	5
UoA	F	(10,14]	3	4.00	4.0	4.27	5.00	5
UoA	M	(10,14]	2	4.00	5.0	4.43	5.00	5
UoA	F	(14,18]	3	4.00	4.0	4.21	5.00	5
UoA	M	(14,18]	2	3.00	4.0	3.79	5.00	5

9.14.2.15 I LIKE IT WHEN I CAN SOLVE PROBLEMS QUICKLY

Table 137 reports the frequencies for the question I like it when I can solve problems quickly and Table 138 reports the descriptive statistics. As it could be observed, most of the participants from all the partners strongly agree and agree. CU is the partner with the biggest percentage of participants who agree and strongly agree (90%), followed by ESI (89%), which has a biggest number of people in strongly agree than CU. CU and TU Wien are the partners with a 0% of participants in disagree and strongly disagree. UoA is the partner with the biggest percentage (9%) of participants who disagree and strongly disagree. As it could be observed in Table 139 and Table 140, there is no significant difference between genders per partner. As it could be seen in Table 141 and Table 142, there is a difference between age group in PRIA. As it could be seen in Table 143 and Table 144, there is difference between genders per age group in ESI (11-14) and PRIA (15-18).

Table 136 Prequestionnaire Analysis: Likert scale. I like it when I can solve problems quickly per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	2	9	33	61	122	227
CU	0	0	6	36	18	60
ESI	1	1	2	6	27	37
PRIA	0	3	21	90	122	236
TU Wien	0	0	12	38	29	79
UoA	4	5	16	38	35	98
Total	**7**	**18**	**90**	**269**	**353**	**737**

Table 137 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like it when I can solve problems quickly per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4.00	5	4.29	5	5
CU	3	4.00	4	4.20	5	5
ESI	1	4.00	5	4.54	5	5
PRIA	2	4.00	5	4.40	5	5
TU Wien	3	4.00	4	4.22	5	5
UoA	1	3.25	4	3.97	5	5

Table 138 Prequestionnaire Analysis: Likert scale. I like it when I can solve problems quickly per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	2	9	27	44	98	180
AL	M	0	0	6	17	24	47
CU	F	0	0	0	27	6	33
CU	M	0	0	6	9	12	27
ESI	F	1	0	2	1	8	12
ESI	M	0	1	0	5	19	25
PRIA	F	0	0	8	33	35	76
PRIA	M	0	3	13	57	86	159
TU Wien	F	0	0	6	21	14	41
TU Wien	M	0	0	6	17	15	38
UoA	F	3	2	3	14	15	37
UoA	M	1	3	12	24	20	60
Total		**7**	**18**	**89**	**269**	**352**	**735**

Table 139 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like it when I can solve problems quickly per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	4.00	5	4.26	5	5
AL	M	3	4.00	5	4.38	5	5
CU	F	4	4.00	4	4.18	4	5
CU	M	3	4.00	4	4.22	5	5
ESI	F	1	3.75	5	4.25	5	5
ESI	M	2	5.00	5	4.68	5	5
PRIA	F	3	4.00	4	4.36	5	5
PRIA	M	2	4.00	5	4.42	5	5
TU Wien	F	3	4.00	4	4.20	5	5
TU Wien	M	3	4.00	4	4.24	5	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	F	1	4.00	4	3.97	5	5
UoA	M	1	3.00	4	3.98	5	5

Table 140 Prequestionnaire Analysis: Likert scale. I like it when I can solve problems quickly per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	0	0	0	1	0	1
AL	(10,14]	2	9	33	60	122	226
CU	(10,14]	0	0	3	36	18	57
ESI	(10,14]	1	1	2	6	26	36
PRIA	(6,10]	0	0	1	1	16	18
PRIA	(10,14]	0	0	5	61	64	130
PRIA	(14,18]	0	3	14	25	35	77
TU Wien	(10,14]	0	0	5	24	18	47
TU Wien	(14,18]	0	0	7	14	11	32
UoA	(10,14]	4	5	7	26	21	63
UoA	(14,18]	0	0	9	12	13	34
Total		**7**	**18**	**86**	**266**	**344**	**721**

Table 141 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like it when I can solve problems quickly per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	4	4.00	4	4.00	4	4
AL	(10,14]	1	4.00	5	4.29	5	5
CU	(10,14]	3	4.00	4	4.26	5	5
ESI	(10,14]	1	4.00	5	4.53	5	5
PRIA	(6,10]	3	5.00	5	4.83	5	5
PRIA	(10,14]	3	4.00	4	4.45	5	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
PRIA	(14,18]	2	4.00	4	4.19	5	5
TU Wien	(10,14]	3	4.00	4	4.28	5	5
TU Wien	(14,18]	3	4.00	4	4.12	5	5
UoA	(10,14]	1	3.50	4	3.87	5	5
UoA	(14,18]	3	3.25	4	4.12	5	5

Table 142 Prequestionnaire Analysis: Likert scale. I like it when I can solve problems quickly per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	M	0	0	0	1	0	1
AL	(10,14]	F	2	9	27	44	98	180
AL	(10,14]	M	0	0	6	16	24	46
CU	(10,14]	F	0	0	0	27	6	33
CU	(10,14]	M	0	0	3	9	12	24
ESI	(10,14]	F	1	0	2	1	8	12
ESI	(10,14]	M	0	1	0	5	18	24
PRIA	(6,10]	F	0	0	1	1	5	7
PRIA	(6,10]	M	0	0	0	0	11	11
PRIA	(10,14]	F	0	0	2	28	26	56
PRIA	(10,14]	M	0	0	3	33	37	73
PRIA	(14,18]	F	0	0	5	4	3	12
PRIA	(14,18]	M	0	3	9	21	32	65
TU Wien	(10,14]	F	0	0	4	16	10	30
TU Wien	(10,14]	M	0	0	1	8	8	17
TU Wien	(14,18]	F	0	0	2	5	4	11
TU Wien	(14,18]	M	0	0	5	9	7	21
UoA	(10,14]	F	3	2	1	8	8	22
UoA	(10,14]	M	1	3	6	18	13	41
UoA	(14,18]	F	0	0	2	6	6	14

Partner	Age Group	Gender	1	2	3	4	5	Total
UoA	(14,18]	M	0	0	6	6	7	19
Total			**7**	**18**	**85**	**266**	**343**	**719**

Table 143 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like it when I can solve problems quickly per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	M	(6,10]	4	4.00	4.0	4.00	4.00	4
AL	F	(10,14]	1	4.00	5.0	4.26	5.00	5
AL	M	(10,14]	3	4.00	5.0	4.39	5.00	5
CU	F	(10,14]	4	4.00	4.0	4.18	4.00	5
CU	M	(10,14]	3	4.00	4.5	4.38	5.00	5
ESI	F	(10,14]	1	3.75	5.0	4.25	5.00	5
ESI	M	(10,14]	2	4.75	5.0	4.67	5.00	5
PRIA	F	(6,10]	3	4.50	5.0	4.57	5.00	5
PRIA	M	(6,10]	5	5.00	5.0	5.00	5.00	5
PRIA	F	(10,14]	3	4.00	4.0	4.43	5.00	5
PRIA	M	(10,14]	3	4.00	5.0	4.47	5.00	5
PRIA	F	(14,18]	3	3.00	4.0	3.83	4.25	5
PRIA	M	(14,18]	2	4.00	4.0	4.26	5.00	5
TU Wien	F	(10,14]	3	4.00	4.0	4.20	5.00	5
TU Wien	M	(10,14]	3	4.00	4.0	4.41	5.00	5
TU Wien	F	(14,18]	3	4.00	4.0	4.18	5.00	5
TU Wien	M	(14,18]	3	4.00	4.0	4.10	5.00	5
UoA	F	(10,14]	1	3.25	4.0	3.73	5.00	5
UoA	M	(10,14]	1	4.00	4.0	3.95	5.00	5
UoA	F	(14,18]	3	4.00	4.0	4.29	5.00	5
UoA	M	(14,18]	3	3.00	4.0	4.05	5.00	5

9.14.2.16 I THINK IT IS IMPORTANT TO LEARN ABOUT SCIENCE

Table 145 reports the frequencies for the question I think it is important to learn about science and Table 146 reports the descriptive statistics. More than 70% of participants from all partners selected agree and strongly agree. The partner with the biggest percentage is UoA (87%) and the one with the lowest is PRIA (70%). The percentage of participants who disagree and strongly disagree is inferior in all partners of 6%. As it could be seen in Table 147 and Table 148, there is no difference between genders per partner. As it could be seen in Table 149 and Table 150, there is difference between age group in PRIA. As it could be observed in Table 151 and Table 152, there is no significant difference between genders per age group in all partners.

Table 144 Prequestionnaire Analysis: Likert scale. I think it is important to learn about science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	2	5	28	76	116	227
CU	0	0	15	18	30	63
ESI	1	1	6	10	19	37
PRIA	4	11	55	86	80	236
TU Wien	0	1	17	40	19	77
UoA	1	1	11	42	44	99
Total	**8**	**19**	**132**	**272**	**308**	**739**

Table 145 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I think it is important to learn about science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	5	4.32	5	5
CU	3	4	4	4.24	5	5
ESI	1	4	5	4.22	5	5
PRIA	1	3	4	3.96	5	5
TU Wien	2	4	4	4.00	4	5
UoA	1	4	4	4.28	5	5

Table 146 Prequestionnaire Analysis: Likert scale. I think it is important to learn about science per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total

Partner	Gender	1	2	3	4	5	Total
AL	F	2	3	18	58	99	180
AL	M	0	2	10	18	17	47
CU	F	0	0	9	9	18	36
CU	M	0	0	6	9	12	27
ESI	F	0	1	2	4	5	12
ESI	M	1	0	4	6	14	25
PRIA	F	1	2	19	27	28	77
PRIA	M	3	9	36	59	51	158
TU Wien	F	0	1	9	21	8	39
TU Wien	M	0	0	8	19	11	38
UoA	F	1	0	2	17	17	37
UoA	M	0	1	9	25	26	61
Total		**8**	**19**	**132**	**272**	**306**	**737**

Table 147 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I think it is important to learn about science per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	4.00	5.0	4.38	5	5
AL	M	2	3.50	4.0	4.06	5	5
CU	F	3	3.75	4.5	4.25	5	5
CU	M	3	4.00	4.0	4.22	5	5
ESI	F	2	3.75	4.0	4.08	5	5
ESI	M	1	4.00	5.0	4.28	5	5
PRIA	F	1	3.00	4.0	4.03	5	5
PRIA	M	1	3.00	4.0	3.92	5	5
TU Wien	F	2	3.50	4.0	3.92	4	5
TU Wien	M	3	4.00	4.0	4.08	5	5
UoA	F	1	4.00	4.0	4.32	5	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	M	2	4.00	4.0	4.25	5	5

Table 148 Prequestionnaire Analysis: Likert scale. I think it is important to learn about science per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	0	0	1	0	0	1
AL	(10,14]	2	5	27	76	116	226
CU	(10,14]	0	0	12	18	30	60
ESI	(10,14]	1	1	6	10	18	36
PRIA	(6,10]	1	1	1	1	14	18
PRIA	(10,14]	2	5	37	54	32	130
PRIA	(14,18]	1	5	16	28	27	77
TU Wien	(10,14]	0	1	12	23	9	45
TU Wien	(14,18]	0	0	5	17	10	32
UoA	(10,14]	1	1	8	24	30	64
UoA	(14,18]	0	0	3	18	13	34
Total		**8**	**19**	**128**	**269**	**299**	**723**

Table 149 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I think it is important to learn about science per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	3	3	3.0	3.00	3	3
AL	(10,14]	1	4	5.0	4.32	5	5
CU	(10,14]	3	4	4.5	4.30	5	5
ESI	(10,14]	1	4	4.5	4.19	5	5
PRIA	(6,10]	1	5	5.0	4.44	5	5
PRIA	(10,14]	1	3	4.0	3.84	4	5
PRIA	(14,18]	1	3	4.0	3.97	5	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
TU Wien	(10,14]	2	3	4.0	3.89	4	5
TU Wien	(14,18]	3	4	4.0	4.16	5	5
UoA	(10,14]	1	4	4.0	4.27	5	5
UoA	(14,18]	3	4	4.0	4.29	5	5

Table 150 Prequestionnaire Analysis: Likert scale. I think it is important to learn about science per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	M	0	0	1	0	0	1
AL	(10,14]	F	2	3	18	58	99	180
AL	(10,14]	M	0	2	9	18	17	46
CU	(10,14]	F	0	0	9	9	18	36
CU	(10,14]	M	0	0	3	9	12	24
ESI	(10,14]	F	0	1	2	4	5	12
ESI	(10,14]	M	1	0	4	6	13	24
PRIA	(6,10]	F	0	0	1	0	6	7
PRIA	(6,10]	M	1	1	0	1	8	11
PRIA	(10,14]	F	1	1	16	24	15	57
PRIA	(10,14]	M	1	4	21	30	16	72
PRIA	(14,18]	F	0	1	2	3	6	12
PRIA	(14,18]	M	1	4	14	25	21	65
TU Wien	(10,14]	F	0	1	7	14	6	28
TU Wien	(10,14]	M	0	0	5	9	3	17
TU Wien	(14,18]	F	0	0	2	7	2	11
TU Wien	(14,18]	M	0	0	3	10	8	21
UoA	(10,14]	F	1	0	1	8	12	22
UoA	(10,14]	M	0	1	7	16	18	42
UoA	(14,18]	F	0	0	1	9	4	14
UoA	(14,18]	M	0	0	2	9	8	19

Partner	Age Group	Gender	1	2	3	4	5	Total
Total			**8**	**19**	**128**	**269**	**297**	**721**

Table 151 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I think it is important to learn about science per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	M	(6,10]	3	3.00	3.0	3.00	3.00	3
AL	F	(10,14]	1	4.00	5.0	4.38	5.00	5
AL	M	(10,14]	2	4.00	4.0	4.09	5.00	5
CU	F	(10,14]	3	3.75	4.5	4.25	5.00	5
CU	M	(10,14]	3	4.00	4.5	4.38	5.00	5
ESI	F	(10,14]	2	3.75	4.0	4.08	5.00	5
ESI	M	(10,14]	1	4.00	5.0	4.25	5.00	5
PRIA	F	(6,10]	3	5.00	5.0	4.71	5.00	5
PRIA	M	(6,10]	1	4.50	5.0	4.27	5.00	5
PRIA	F	(10,14]	1	3.00	4.0	3.89	5.00	5
PRIA	M	(10,14]	1	3.00	4.0	3.78	4.00	5
PRIA	F	(14,18]	2	3.75	4.5	4.17	5.00	5
PRIA	M	(14,18]	1	3.00	4.0	3.94	5.00	5
TU Wien	F	(10,14]	2	3.00	4.0	3.89	4.00	5
TU Wien	M	(10,14]	3	3.00	4.0	3.88	4.00	5
TU Wien	F	(14,18]	3	4.00	4.0	4.00	4.00	5
TU Wien	M	(14,18]	3	4.00	4.0	4.24	5.00	5
UoA	F	(10,14]	1	4.00	5.0	4.36	5.00	5
UoA	M	(10,14]	2	4.00	4.0	4.21	5.00	5
UoA	F	(14,18]	3	4.00	4.0	4.21	4.75	5
UoA	M	(14,18]	3	4.00	4.0	4.32	5.00	5

9.14.2.17 I LIKE LEARNING ABOUT HOW THINGS WORK

Table 153 reports the frequencies for the question I like learning about how things work and Table 154 reports the descriptive statistics. As it could be seen, more than 77% of participants from all partners selected agree and strongly agree in the statement "*I like learning about how things work"*. UoA is the partner with the biggest percentage of participants (98%) who agree and strongly agree, and with the lowest percentage who selected neutral (1%). TU Wien is the partner with the biggest percentage of participants (18%) who selected neutral, followed closed by ESI (17%). TU Wien is also the partner with the lowest percentage of participants (77%) who agree and strongly agree. As it could be seen in Table 155 and Table 156, there is no difference between genders in all partners. As it could be observed in Table 157 and Table 158, there is a difference between age group in PRIA. As it could be seen in Table 159 and Table 160, there is difference between genders per age group in TU Wien (15-18).

Table 152 Prequestionnaire Analysis: Likert scale. I like learning about how things work per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	**1**	**2**	**3**	**4**	**5**	**Total**
AL	1	6	24	81	115	227
CU	0	0	3	24	36	63
ESI	1	0	6	8	21	36
PRIA	0	2	22	94	115	233
TU Wien	0	4	14	32	28	78
UoA	0	1	1	33	64	99
Total	**2**	**13**	**70**	**272**	**379**	**736**

Table 153 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like learning about how things work per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	**Min**	**1 Q**	**Median**	**Average**	**3 Q**	**Max**
AL	1	4	5	4.33	5	5
CU	3	4	5	4.52	5	5
ESI	1	4	5	4.33	5	5
PRIA	2	4	4	4.38	5	5
TU Wien	2	4	4	4.08	5	5
UoA	2	4	5	4.62	5	5

Table 154 Prequestionnaire Analysis: Likert scale. I like learning about how things work per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	1	6	20	65	88	180
AL	M	0	0	4	16	27	47
CU	F	0	0	3	9	24	36
CU	M	0	0	0	15	12	27
ESI	F	0	0	2	3	6	11
ESI	M	1	0	4	5	15	25
PRIA	F	0	1	11	36	27	75
PRIA	M	0	1	11	58	87	157
TU Wien	F	0	3	10	14	13	40
TU Wien	M	0	1	4	18	15	38
UoA	F	0	0	0	14	23	37
UoA	M	0	1	1	18	41	61
Total		**2**	**13**	**70**	**271**	**378**	**734**

Table 155 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like learning about how things work per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	4	4	4.29	5	5
AL	M	3	4	5	4.49	5	5
CU	F	3	4	5	4.58	5	5
CU	M	4	4	4	4.44	5	5
ESI	F	3	4	5	4.36	5	5
ESI	M	1	4	5	4.32	5	5
PRIA	F	2	4	4	4.19	5	5
PRIA	M	2	4	5	4.47	5	5
TU Wien	F	2	3	4	3.92	5	5
TU Wien	M	2	4	4	4.24	5	5

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
UoA	F	4	4	5	4.62	5	5
UoA	M	2	4	5	4.62	5	5

Table 156 Prequestionnaire Analysis: Likert scale. I like learning about how things work per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	0	0	1	0	0	1
AL	(10,14]	1	6	23	81	115	226
CU	(10,14]	0	0	3	21	36	60
ESI	(10,14]	1	0	6	8	20	35
PRIA	(6,10]	0	0	2	0	16	18
PRIA	(10,14]	0	1	11	66	50	128
PRIA	(14,18]	0	1	8	25	42	76
TU Wien	(10,14]	0	2	8	20	16	46
TU Wien	(14,18]	0	2	6	12	12	32
UoA	(10,14]	0	1	1	20	42	64
UoA	(14,18]	0	0	0	13	21	34
Total		**2**	**13**	**69**	**266**	**370**	**720**

Table 157 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like learning about how things work per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	3	3.00	3	3.00	3	3
AL	(10,14]	1	4.00	5	4.34	5	5
CU	(10,14]	3	4.00	5	4.55	5	5
ESI	(10,14]	1	4.00	5	4.31	5	5
PRIA	(6,10]	3	5.00	5	4.78	5	5
PRIA	(10,14]	2	4.00	4	4.29	5	5

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
PRIA	(14,18]	2	4.00	5	4.42	5	5
TU Wien	(10,14]	2	4.00	4	4.09	5	5
TU Wien	(14,18]	2	3.75	4	4.06	5	5
UoA	(10,14]	2	4.00	5	4.61	5	5
UoA	(14,18]	4	4.00	5	4.62	5	5

Table 158 Prequestionnaire Analysis: Likert scale. I like learning about how things work per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	M	0	0	1	0	0	1
AL	(10,14]	F	1	6	20	65	88	180
AL	(10,14]	M	0	0	3	16	27	46
CU	(10,14]	F	0	0	3	9	24	36
CU	(10,14]	M	0	0	0	12	12	24
ESI	(10,14]	F	0	0	2	3	6	11
ESI	(10,14]	M	1	0	4	5	14	24
PRIA	(6,10]	F	0	0	1	0	6	7
PRIA	(6,10]	M	0	0	1	0	10	11
PRIA	(10,14]	F	0	1	7	32	15	55
PRIA	(10,14]	M	0	0	4	34	34	72
PRIA	(14,18]	F	0	0	3	3	6	12
PRIA	(14,18]	M	0	1	5	22	36	64
TU Wien	(10,14]	F	0	1	6	13	9	29
TU Wien	(10,14]	M	0	1	2	7	7	17
TU Wien	(14,18]	F	0	2	4	1	4	11
TU Wien	(14,18]	M	0	0	2	11	8	21
UoA	(10,14]	F	0	0	0	8	14	22
UoA	(10,14]	M	0	1	1	12	28	42

Partner	Age Group	Gender	1	2	3	4	5	Total
UoA	(14,18]	F	0	0	0	6	8	14
UoA	(14,18]	M	0	0	0	6	13	19
Total			**2**	**13**	**69**	**265**	**369**	**718**

Table 159 Prequestionnaire Analysis: Likert scale. Descriptive statistics for the question I like learning about how things work per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	M	(6,10]	3	3.00	3.0	3.00	3	3
AL	F	(10,14]	1	4.00	4.0	4.29	5	5
AL	M	(10,14]	3	4.00	5.0	4.52	5	5
CU	F	(10,14]	3	4.00	5.0	4.58	5	5
CU	M	(10,14]	4	4.00	4.5	4.50	5	5
ESI	F	(10,14]	3	4.00	5.0	4.36	5	5
ESI	M	(10,14]	1	4.00	5.0	4.29	5	5
PRIA	F	(6,10]	3	5.00	5.0	4.71	5	5
PRIA	M	(6,10]	3	5.00	5.0	4.82	5	5
PRIA	F	(10,14]	2	4.00	4.0	4.11	5	5
PRIA	M	(10,14]	3	4.00	4.0	4.42	5	5
PRIA	F	(14,18]	3	3.75	4.5	4.25	5	5
PRIA	M	(14,18]	2	4.00	5.0	4.45	5	5
TU Wien	F	(10,14]	2	4.00	4.0	4.03	5	5
TU Wien	M	(10,14]	2	4.00	4.0	4.18	5	5
TU Wien	F	(14,18]	2	3.00	3.0	3.64	5	5
TU Wien	M	(14,18]	3	4.00	4.0	4.29	5	5
UoA	F	(10,14]	4	4.00	5.0	4.64	5	5
UoA	M	(10,14]	2	4.00	5.0	4.60	5	5
UoA	F	(14,18]	4	4.00	5.0	4.57	5	5
UoA	M	(14,18]	4	4.00	5.0	4.68	5	5

9.14.2.18 CONCLUSIONS

As it could be observed in Figure 10, a majority of participants from all partners strongly agree and agree to the following questions: *“I like using computers”, “I like learning about how things work”, “I like working in teams”, “I like when I can solve problems quickly”, “I think it is important to learn about science”, “I like to keep working on a project until it is perfect”, “I learn best with other people”, “I like science”, “I like maths”, “I want to understand more about mechanical things”, “I like trying to solve difficult problems”, “I want to solve problems that can help people”*, and *“I am good at solving problems”.* Also it could be seen that the answers obtained in the following questions are almost evenly distributed disagree, neutral and agree: *“I need help solving problems”, “I like working on my own”*, and *“I know a lot about robots”.*

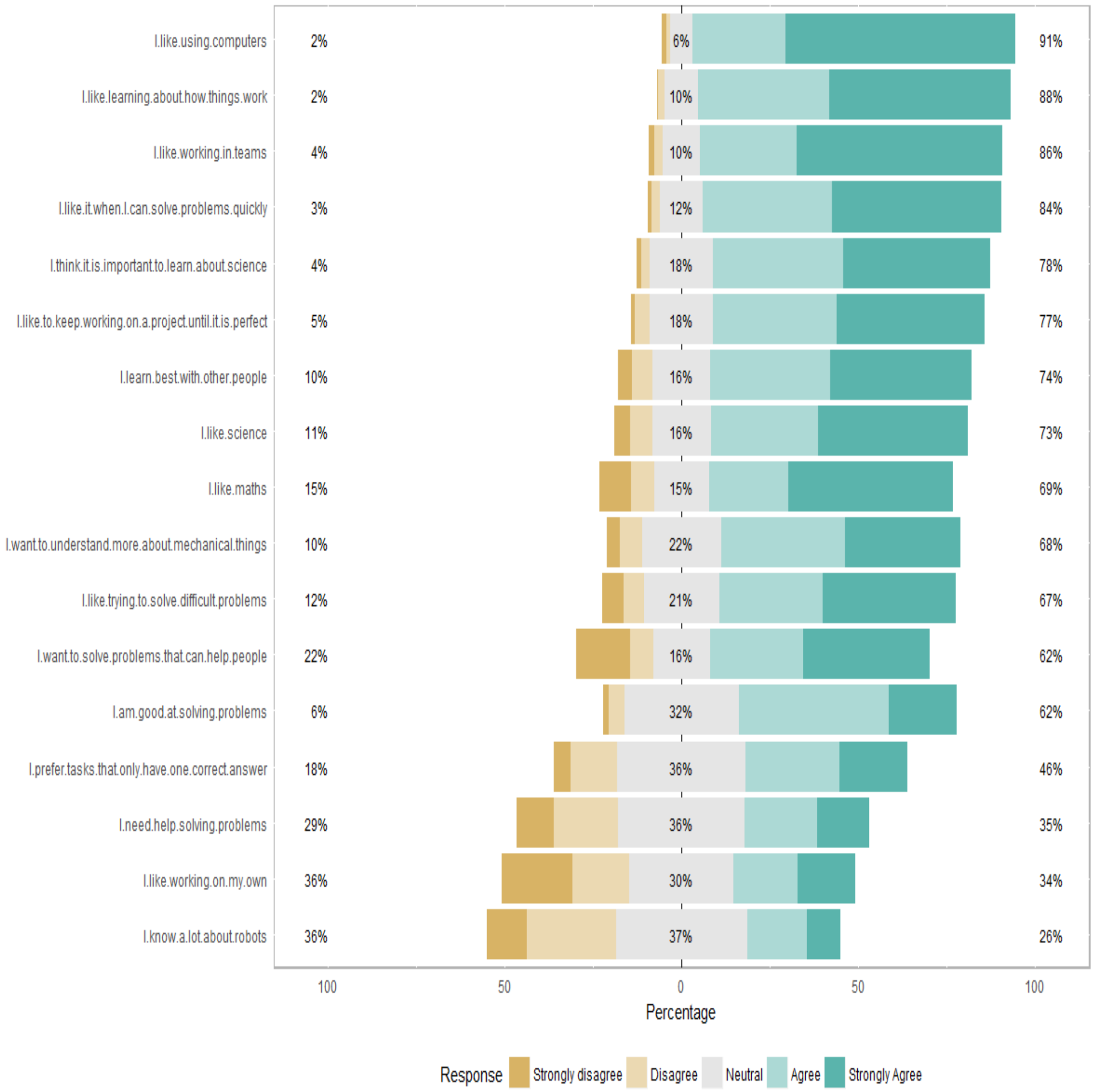


Figure 17 Percentage for all questions presented in the section Prequestionnaire Analysis: Likert scale.

Most of the participants from all partner strongly agree and agree with the questions *“I like using computers”.* The partner with the lowest percentage is TU Wien with 77%. The main difference between TU Wien and the others is that 17% of the TU Wien participants selected neutral, while in the others is below 7%.

37% of the participants answered neutral to the statement "*I know a lot of robots".* ESI has the biggest percentage (40%) of participants who agree and strongly with the statement. On the other hand, participants from TU Wien and CU are the ones with the biggest percentage of participants who disagree and strongly disagree, 56% and 58% respectively. There is difference between age groups in PRIA. There is also difference between genders per age group in AL, ESI and PRIA.

A majority of participants from all partner agree and strongly agree with the statement "*I learn best with other people"*, with the lowest percentage in TU Wien (61%). The biggest percentage of participants who disagree and strongly disagree with the statement is found in TU Wien (23%).

A majority of participants from all partners agree and strongly agree with the statement "*I like science",* with the lowest percentage in CU (57%), which also has the biggest percentage of neutral answers (27%). The biggest percentage of participants who disagree and strongly disagree with the statement is found in PRIA (20%). The majority of participants from ESI selected strongly agree. The age group 7-10 from PRIA has an interesting distribution of answers. The biggest number of participants is found in strongly agree (n=28) but the second is found in strongly disagree (n=10). Female participants from TU Wien's age group 15-18 mainly selected disagree and strongly disagree, while male participants mainly selected agree and strongly agree. Female participants from TU Wien's age group 15-18 mainly selected disagree and strongly disagree, while male participants mainly selected agree and strongly agree.

A majority participants from UoA, PRIA, ESI, CU and AL selected strongly agree and agree with the statement "*I like maths"*. Just 48% of participants from TU Wien selected agree and strongly agree. TU Wien and PRIA are the partners with the biggest number of participants who selected neutral, 22% and 26% respectively. TU Wien and CU are the partners with the biggest number of participants who selected disagree and strongly disagree, 30% and 29% respectively.

There is a tendency in all the partners to be divided in all three main options with the statement "*I like working on my own"*, considering strongly disagree and disagree as one, and strongly agree and agree as one. ESI is the partner with the biggest number of participants that selected disagree and strongly disagree (51%), followed by TU Wien (38%) and AL (33%). The partner with the biggest number of participants who selected neutral is UoA (41%) and the one with the lowest is ESI (22%). The partner with the biggest number of participants who selected agree and strongly agree is PRIA (43%) and the lowest ESI (27%).

All the partners has at least 70% of participants who selected agree and strongly agree with the statement "*I like working in teams".* UoA is the partner with the lowest percentage with 70% and ESI with the biggest (91%). UoA is the partner with the biggest number of participants who selected neutral (26%), the rest of partners have a percentage lower than 12%. All partners have a percentage of participants who disagree and strongly disagree lower than 8%.

All partners, exception of TU Wien, have more than 62% of participants who strongly agree and agree. TU Wien is the only partner with a lower percentage of 50% that selected agree and strongly agree. It also is the partner with the biggest number of participants who selected disagree and strongly disagree (23%). On the other hand, ESI is the one with the lowest percentage (8%). PRIA is the partner with the biggest number of participants who selected neutral (29%), followed very close by TU Wien (28%).

There is not a precise pattern for the statement "*I need help solving problems".* ESI is the partner with the biggest percentage of participants who agree and strongly agree (56%) and it is with the lowest percentage who disagree and strongly disagree (16%). Nevertheless, most of the participants in the last group selected strongly disagree. UoA is the partner with the lowest percentage of participants who strongly agree and agree (25%) but it is the biggest number of participants who selected neutral (46%). TU Wien is the partner with the biggest percentage of participants who disagree and strongly disagree (37%), but most of the participants selected disagree. PRIA and AL have the same percentage of participants who disagree and strongly disagree (34%), and almost equal percentage in the other options.

A majority of the participants from all partners selected agree and strongly agree in the statement "*I am good at solving problems".* CU is the partner with the biggest percentage of participants who agree and strongly agree (71%) and the only without any percentage in disagree and strongly disagree. The percentage of people from the rest of the partners who disagree and strongly disagree is below the 8% (AL). TU Wien is the partner with the biggest percentage of participants who selected neutral (43%) and PRIA the lowest (27%).

All the partners, an exception of TU Wien, has more than 67% of participants who agree and strongly agree with the statement "*I want to understand more about mechanical things".* ESI is the partner with the biggest percentage of participants who agree and strongly agree (81%) and at the same time the one with the lowest in the rest of the options. TU Wien is the partner with the lowest percentage of participants who agree and strongly agree (48%) and at the same times is the one with the biggest number in the rest of the options.

More than 76% of the participants from AL, CU, PRIA and UoA selected strongly agree and strongly agree in the statement "*I want to solve problems that can help people".* UoA and CU is the partner with the biggest percentage of participants who agree and strongly agree (86%). CU is the only partner with 0% of participants who selected disagree and strongly disagree. ESI is the partner with the lowest percentage of participants who agree and strongly agree (20%) and the one with the biggest percentage in disagree and strongly disagree (60%). The youngest age group from ESI and TU Wien tend to disagree and strongly disagree with the statement.

There is no a clear pattern among all partners for the statement "*I prefer tasks that only have one correct answer".* ESI is the partner with the biggest number of participants who agree and strongly agree (81%) and at the same time the one with the lowest percentage of participants who disagree and strongly disagree (14%). Participants from TU Wien, AL, and CU are mainly distributed between neutral and strongly agree. 35%, 43% and 39% of the participants from TU Wien, CU and AL, respectively, selected neutral. 53%, 52% and 49% of the participants from TU Wien, CU and AL, respectively, selected agree and strongly agree. Participants from UoA and PRIA tend to move slightly towards disagree and strongly disagree. Just 30% and 39% of UoA and PRIA, respectively, selected strongly agree and agree. On the other hand, 32% and 25% of UoA and PRIA, respectively, selected strongly disagree and disagree.

A majority of participants from all the partners agree and strongly agree with the statement "*I like to keep working on a project until it is perfect*". Most of the partners, an exception of PRIA and TU Wien, have a percentage of participants higher than 80%, with the biggest percentage found in ESI (89%), which is also the partner with the lowest percentage who selected neutral (8%). TU Wien is the partner with the lowest percentage of participants who selected agree and strongly agree (56%) and it is the one with the biggest percentage in the rest of the options, 29% in neutral, and 15% in disagree and strongly disagree.

Most of the participants from all the partners strongly agree and agree with the statement "*I like it when I can solve problems quickly".* CU is the partner with the biggest percentage of participants who agree and strongly agree (90%), followed by ESI (89%), which has a biggest number of people in strongly agree than CU. CU and TU Wien are the partners with a 0% of participants in disagree and strongly disagree. UoA is the partner with the biggest percentage (9%) of participants who disagree and strongly disagree.

More than 70% of participants from all partners selected agree and strongly agree in the statement "*I think it is important to learn about science".* The partner with the biggest percentage is UoA (87%) and the one with the lowest is PRIA (70%). The percentage of participants who disagree and strongly disagree is inferior in all partners of 6%.

More than 77% of participants from all partners selected agree and strongly agree in the statement "*I like learning about how things work".* UoA is the partner with the biggest percentage of participants (98%) who agree and strongly agree, and with the lowest percentage who selected neutral (1%). TU Wien is the partner with the biggest percentage of participants (18%) who selected neutral, followed closed by ESI (17%). TU Wien is also the partner with the lowest percentage of participants (77%) who agree and strongly agree.

9.14.3 Prequestionnaire Analysis: Maths Related Questions

This section presents the results obtained from the maths related questions.

9.14.3.1 IN GENERAL I FIND MATHS EASY

Table 161 reports the frequencies for the question In general I find maths easy and Table 162 reports the descriptive statistics. As it could be observed, a majority of participants from UoA, PRIA, ESI and AL agree and strongly agree with the statement. 39% of participants from CU selected neutral, while TU Wien's percentage is 28%. TU Wien is the partner with the biggest percentage of participants who selected disagree and strongly disagree (23%). The lowest is ESI and AL with 10%.

Table 160 Prequestionnaire Analysis: Maths Related Questions. In general I find maths easy per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	17	22	70	145	133	387
CU	14	1	40	15	32	102
ESI	17	17	72	85	145	336
PRIA	19	23	69	78	78	267
TU Wien	13	18	38	49	17	135
UoA	1	6	22	52	38	119
Total	**81**	**87**	**311**	**424**	**443**	**1346**

Table 161 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question In general I find maths easy per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	4	3.92	5	5
CU	1	3	3	3.49	5	5
ESI	1	3	4	3.96	5	5
PRIA	1	3	4	3.65	5	5
TU Wien	1	3	3	3.29	4	5
UoA	1	4	4	4.01	5	5

9.14.3.2 MATHS LESSONS ARE BORING

Table 163 reports the frequencies for the question Maths lessons are boring and Table 164 reports the descriptive statistics. A significant number (40%) of CU's participants agree and strongly agree with the statement, followed by TU Wien with 30%. Participants from UoA, ESI and AL are the ones with the biggest percentage who selected disagree and strongly disagree, 66%, 70% and 69% respectively. TU Wien is the partner with biggest percentage of participants who selected neutral (29%).

Table 162 Prequestionnaire Analysis: Maths Related Questions. Maths lessons are boring per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	201	67	60	40	18	386
CU	27	11	23	18	23	102
ESI	183	51	42	16	41	333
PRIA	68	61	71	36	29	265
TU Wien	26	30	39	23	18	136
UoA	50	28	24	9	7	118
Total	**555**	**248**	**259**	**142**	**136**	**1340**

Table 163 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question Maths lessons are boring per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	1	1	1.98	3	5
CU	1	1	3	2.99	4	5
ESI	1	1	1	2.04	3	5
PRIA	1	1	3	2.61	3	5
TU Wien	1	2	3	2.83	4	5
UoA	1	1	2	2.11	3	5

9.14.3.3 WE HAVE FUN IN MATHS LESSONS

Table 165 reports the frequencies for the question We have fun in maths lessons and Table 166 reports the descriptive statistics. As it could be observed, a majority of the participants from UoA, PRIA, ESI and AL agree and strongly agree with the statement. The biggest percentage of the participants is found in AL (72%). TU Wien is the partner with the biggest percentage of participants who selected disagree and strongly disagree (35%), and neutral (30%). A similar tendency is found in CU, which 27% of participants selected disagree and strongly disagree, with a vast majority on strongly disagree. It is also possible to observe that CU has three peaks, one in strongly disagree, one in neutral and one in agree.

Table 164 Prequestionnaire Analysis: Maths Related Questions. We have fun in maths lessons per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	14	23	71	78	196	382
CU	26	2	25	30	19	102
ESI	33	18	57	71	151	330
PRIA	28	29	75	74	60	266
TU Wien	22	25	40	30	18	135
UoA	7	15	31	34	30	117
Total	**130**	**112**	**299**	**317**	**474**	**1332**

Table 165 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question We have fun in maths lessons per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3.00	5	4.10	5	5
CU	1	1.25	3	3.14	4	5
ESI	1	3.00	4	3.88	5	5
PRIA	1	3.00	4	3.41	4	5
TU Wien	1	2.00	3	2.98	4	5
UoA	1	3.00	4	3.56	5	5

9.14.3.4 MATHS IS IMPORTANT FOR THE JOB I WANT TO DO

Table 167 reports the frequencies for the question Maths is important for the job I want to do and Table 168 reports the descriptive statistics. As it could be observed, TU Wien is the only partner where a majority of participants (62%) selected disagree and strongly disagree. This is big a number considering that the second biggest percentage is 15%, which is found at CU. On the other hand, a majority of participants from the rest of participants selected agree and strongly agree. PRIA and TU Wien are the partners with the biggest percentage of participants who selected neutral, 30% and 29% respectively. ESI is the partner with the biggest percentage of participants who selected agree and strongly agree, with a big percentage in strongly agree.

Table 166 Prequestionnaire Analysis: Maths Related Questions. Maths is important for the job I want to do per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	11	17	55	47	88	218
CU	9	0	6	24	21	60
ESI	1	1	3	9	23	37
PRIA	7	22	68	58	74	229
TU Wien	22	23	21	5	2	73
UoA	5	7	15	34	38	99
Total	**55**	**70**	**168**	**177**	**246**	**716**

Table 167 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question Maths is important for the job I want to do per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3.00	4	3.84	5	5
CU	1	3.75	4	3.80	5	5
ESI	1	4.00	5	4.41	5	5
PRIA	1	3.00	4	3.74	5	5
TU Wien	1	1.00	2	2.21	3	5
UoA	1	3.00	4	3.94	5	5

9.14.3.5 MATHS IS IMPORTANT

Table 169 reports the frequencies for the question Maths is important and Table 170 reports the descriptive statistics. Most of the participants from all partners recognized that math is important.

Table 168 Prequestionnaire Analysis: Maths Related Questions. Maths is important per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	0	0	5	20	140	165
CU	1	1	3	9	25	39
ESI	2	2	10	26	254	294

Partner	1	2	3	4	5	Total
PRIA	1	0	1	2	30	34
TU Wien	1	0	4	7	47	59
UoA	0	0	3	2	15	20
Total	**5**	**3**	**26**	**66**	**511**	**611**

Table 169 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question Maths is important per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	3	5.00	5	4.82	5	5
CU	1	4.00	5	4.44	5	5
ESI	1	5.00	5	4.80	5	5
PRIA	1	5.00	5	4.76	5	5
TU Wien	1	5.00	5	4.68	5	5
UoA	3	4.75	5	4.60	5	5

9.14.3.6 MY TEACHER THINKS I AM GOOD AT MATHS

Table 171 reports the frequencies for the question My teacher thinks I am good at maths and Table 172 reports the descriptive statistics. As it could be seen, a majority of participants from all partners selected agree and strongly agree, with the biggest percentage found in AL (78%). The biggest percentage of participants who selected neutral is found in PRIA (34%). Although TU Wien is not the partner with the lowest percentage in agree and strongly agree, it is the partner with the biggest number in disagree and strongly disagree (20%).

Table 170 Prequestionnaire Analysis: Maths Related Questions. My teacher thinks I am good at maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	8	8	69	159	137	381
CU	8	0	30	35	29	102
ESI	12	7	74	91	144	328
PRIA	12	19	91	65	77	264
TU Wien	12	15	29	46	30	132
UoA	2	3	27	50	36	118

Partner	1	2	3	4	5	Total
Total	**54**	**52**	**320**	**446**	**453**	**1325**

Table 171 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question My teacher thinks I am good at maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	4	4.07	5	5
CU	1	3	4	3.75	5	5
ESI	1	3	4	4.06	5	5
PRIA	1	3	4	3.67	5	5
TU Wien	1	3	4	3.51	4	5
UoA	1	3	4	3.97	5	5

9.14.3.7 I GET GOOD GRADES IN MATHS

Table 173 reports the frequencies for the question I get good grades in maths and Table 174 reports the descriptive statistics. As it could be seen, a majority of the participants from all, an exception of TU Wien, selected agree and strongly agree. The biggest percentage is found in UoA with 82% and the lowest in TU Wien with 42%. The partner with the biggest percentage of participants who selected neutral is PRIA with 32% and the lowest is UoA with 15%. TU Wien is the partner with the biggest percentage of participants who selected disagree and strongly agree (34%). UoA, ESI CU and AL has less than 6% of participants who selected disagree and strongly disagree.

Table 172 Prequestionnaire Analysis: Maths Related Questions. I get good grades in maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	6	8	38	82	84	218
CU	0	3	15	30	15	63
ESI	2	0	7	16	12	37
PRIA	11	26	74	61	62	234
TU Wien	12	14	18	16	16	76
UoA	1	2	15	40	40	98
Total	**32**	**53**	**167**	**245**	**229**	**726**

Table 173 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question I get good grades in maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	4	4.06	5	5
CU	2	3	4	3.90	4	5
ESI	1	4	4	3.97	5	5
PRIA	1	3	4	3.59	5	5
TU Wien	1	2	3	3.13	4	5
UoA	1	4	4	4.18	5	5

9.14.3.8 I THINK MATHS IS DIFFICULT

Table 175 reports the frequencies for the question I think maths is difficult and Table 176 reports the descriptive statistics. TU Wien and CU are the partners with a percentage of participants who selected agree and strongly agree over 30%. UoA is the partner with the lowest percentage of participants who selected agree and strongly agree (10%). UoA is the partner with the biggest percentage of participants who selected disagree and strongly disagree (71%), followed by AL with 61%. TU Wien is the partner with the biggest percentage of participants who selected neutral (32%), followed very close by PRIA (31%).

Table 174 Prequestionnaire Analysis: Maths Related Questions. I think maths is difficult per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	62	71	52	21	12	218
CU	12	12	18	6	15	63
ESI	8	14	7	4	4	37
PRIA	43	59	71	40	19	232
TU Wien	5	19	25	16	13	78
UoA	29	41	18	9	1	98
Total	**159**	**216**	**191**	**96**	**64**	**726**

Table 175 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question I think maths is difficult per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	1	2	2.31	3	5

Partner	Min	1 Q	Median	Average	3 Q	Max
CU	1	2	3	3.00	4	5
ESI	1	2	2	2.51	3	5
PRIA	1	2	3	2.71	4	5
TU Wien	1	2	3	3.17	4	5
UoA	1	1	2	2.10	3	5

9.14.3.9 I HAVE TO WORK ON MY OWN IN MATHS

Table 177 reports the frequencies for the question I have to work on my own in maths and Table 178 reports the descriptive statistics. As it could be observed, most of the participants from all partners, except CU, selected agree and strongly agree. UoA is the participant with the biggest percentage of participants who selected agree and strongly agree (63%), while CU is the one with the lowest (31%) CU, TU Wien and PRIA are the partners with the biggest percentage of participants who selected neutral, all 34%. CU is the partner with the biggest percentage of participants who selected disagree and strongly disagree (34%), while AL is the one with the lowest percentage (12%).

Table 176 Prequestionnaire Analysis: Maths Related Questions. I have to work on my own in maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	23	21	116	95	123	378
CU	17	17	34	20	11	99
ESI	51	31	66	59	123	330
PRIA	12	25	91	61	76	265
TU Wien	10	10	45	38	30	133
UoA	5	11	27	38	35	116
Total	**118**	**115**	**379**	**311**	**398**	**1321**

Table 177 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question I have to work on my own in maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	4	3.72	5	5
CU	1	2	3	2.91	4	5

Partner	Min	1 Q	Median	Average	3 Q	Max
ESI	1	3	4	3.52	5	5
PRIA	1	3	4	3.62	5	5
TU Wien	1	3	4	3.51	4	5
UoA	1	3	4	3.75	5	5

9.14.3.10 I AM GOOD AT MATHS

Table 179 reports the frequencies for the question I am good at maths and Table 180 reports the descriptive statistics. As it could be seen, 100% of participants from UoA selected agree and strongly agree. CU has 64% of participants who selected agree and strongly agree. The biggest percentage of participants who selected neutral is found in TU Wien (15%). The biggest percentage of participants who selected disagree and strongly disagree is found in CU.

Table 178 Prequestionnaire Analysis: Maths Related Questions. I am good at maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	3	5	16	61	77	162
CU	4	5	5	9	16	39
ESI	12	5	40	83	152	292
PRIA	4	1	2	5	22	34
TU Wien	0	2	8	20	25	55
UoA	0	0	0	5	15	20
Total	**23**	**18**	**71**	**183**	**307**	**602**

Table 179 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question I am good at maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4.00	4	4.26	5	5
CU	1	3.00	4	3.72	5	5
ESI	1	4.00	5	4.23	5	5
PRIA	1	4.00	5	4.18	5	5
TU Wien	2	4.00	4	4.24	5	5

Partner	Min	1 Q	Median	Average	3 Q	Max
UoA	4	4.75	5	4.75	5	5

9.14.3.11 MATHS IS THE MOST INTERESTING SUBJECT IN SCHOOL

Table 181 reports the frequencies for the question Maths is the most interesting subject in school and Table 182 reports the descriptive statistics. As it could be observed, a majority of the participants from CU and TU Wien selected disagree and strongly disagree, 62% and 64% respectively. On the other side, AL, ESI and UoA are the partners with the biggest percentage of participants who selected agree and strongly agree, 39%, 41% and 45% respectively. The biggest percentage of participants who selected neutral is found in ESI (38%), followed by AL and UoA with 30% both.

Table 180 Prequestionnaire Analysis: Maths Related Questions. Maths is the most interesting subject in school per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	29	38	65	42	44	218
CU	30	9	18	6	0	63
ESI	1	7	14	5	10	37
PRIA	46	49	73	29	34	231
TU Wien	28	21	14	9	5	77
UoA	9	16	29	19	25	98
Total	143	140	213	110	118	724

Table 181 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question Maths is the most interesting subject in school per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	2.00	3	3.16	4.00	5
CU	1	1.00	2	2.00	3.00	4
ESI	1	3.00	3	3.43	5.00	5
PRIA	1	2.00	3	2.81	4.00	5
TU Wien	1	1.00	2	2.25	3.00	5
UoA	1	2.25	3	3.36	4.75	5

9.14.3.12 MATHS IS IMPORTANT TO LEARN

Table 183 reports the frequencies for the question Maths is important to learn and Table 184 reports the descriptive statistics. As it could be seen, most of the participants from all partners selected agree and strongly agree.

Table 182 Prequestionnaire Analysis: Maths Related Questions. Maths is important to learn per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	2	1	15	51	147	216
CU	0	3	9	18	33	63
ESI	1	0	1	5	30	37
PRIA	5	4	26	85	113	233
TU Wien	1	1	11	36	27	76
UoA	2	1	4	33	58	98
Total	**11**	**10**	**66**	**228**	**408**	**723**

Table 183 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question Maths is important to learn per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	5	4.57	5	5
CU	2	4	5	4.29	5	5
ESI	1	5	5	4.70	5	5
PRIA	1	4	4	4.27	5	5
TU Wien	1	4	4	4.14	5	5
UoA	1	4	5	4.47	5	5

9.14.3.13 MOST OF MY FRIENDS ARE GOOD AT MATHS

Table 185 reports the frequencies for the question Most of my friends are good at maths and Table 186 reports the descriptive statistics. As it could be observed, a considerable number of participants selected neutral. Nevertheless more than 49% of participants from all partners selected agree and strongly agree. The 49% corresponds to PRIA, while the biggest number corresponds to CU (76%).

Table 184 Prequestionnaire Analysis: Maths Related Questions. Most of my friends are good at maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	8	9	94	112	156	379
CU	2	3	19	27	51	102
ESI	8	2	81	74	167	332
PRIA	19	26	90	67	64	266
TU Wien	8	12	38	41	33	132
UoA	5	12	34	49	18	118
Total	**50**	**64**	**356**	**370**	**489**	**1329**

Table 185 Prequestionnaire Analysis: Maths Related Questions. Descriptive statistics for the question Most of my friends are good at maths per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	4.0	4.05	5.00	5
CU	1	4	4.5	4.20	5.00	5
ESI	1	3	5.0	4.17	5.00	5
PRIA	1	3	3.0	3.49	4.00	5
TU Wien	1	3	4.0	3.60	4.25	5
UoA	1	3	4.0	3.53	4.00	5

9.14.3.14 WOULD YOU LIKE TO STUDY MATHS WHEN YOU ARE OLDER?

As it could be observed in Table 187, a majority of participants from AL, ESI and UoA would like to study maths when they are older. Most of the participants from TU Wien would not like to study maths. A majority of the participants from PRIA would not like to study maths when they are older.

Table 186 Prequestionnaire Analysis: Maths Related Questions. Would you like to study maths when you are older? Per partner.

Partner	No	Yes	Total
AL	85	246	331
CU	59	42	101
ESI	87	204	291
PRIA	182	70	252
TU Wien	67	1	68
UoA	50	67	117
Total	**530**	**630**	**1160**

9.14.3.15 SELF-EFFICACY SCORE: MATHS

This score was calculated using the following formula:

$$factor = \sum_{i=1}^{i=number\_questions} \left(\sum_{j=1}^{j=5} \frac{Question_i^j}{number\_participants_i^j} \right)$$

i represents the questions, and j the partners. $number\_participants_i^j$ is the number of participants who answered the i question for the j partner.

It is important to clarify that answers to the question "*Maths lessons are boring*" and "*I think maths is difficult*" were inverted. Also to calculated the factor, it was not used the question "Maths are important for the job I want to do". As it could be observed in Table 188, ESI, AL and UoA are the partners with the highest score. On the other hand CU and TU Wien are the partners with the lowest score.

Table 187 Prequestionnaire Analysis: Maths Related Questions. Self-Efficacy score: Maths

Partner	Factor
AL	44.4
CU	37.6
ESI	44.0
PRIA	40.6
TU Wien	37.7
UoA	44.4

9.14.3.16 CONCLUSIONS

Most of the participants from all partners selected agree and strongly agree in the statement "*Math is important to learn*"

Most of the participants from all partners selected agree and strongly agree in the statement "*Math is important*"

100% of the participants from UoA selected agree and strongly agree in the statement "*I am good at maths*".

71% of UoA's participants selected disagree and strongly disagree in the statement "*I think maths is difficult*".

Most of the participants from TU Wien would not like to study maths when they are older.

9.14.4 Prequestionnaire Analysis: Science Related Questions

This section presents the results obtained from the science related questions.

9.14.4.1 SCIENCE IS THE MOST INTERESTING SUBJECT IN SCHOOL

Table 189 reports the frequencies for the question Science is the most interesting subject in school and Table 190 reports the descriptive statistics. As it could be observed, a majority of participants from UoA, PRIA, ESI and AL selected agree and strongly agree. Participants from CU are almost evenly divide between the three groups, which are i) agree and strongly agree, ii) neutral and iii) disagree and strongly disagree. The biggest percentage of participants who selected disagree and strongly disagree is found in CU (29%), followed very close by TU Wien (28%).

Table 188 Prequestionnaire Analysis: Science Related Questions. Science is the most interesting subject in school per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	**1**	**2**	**3**	**4**	**5**	**Total**
AL	18	23	60	59	54	214
CU	9	9	24	15	6	63
ESI	2	2	14	16	9	43
PRIA	8	31	77	61	56	233
TU Wien	8	13	20	27	8	76
UoA	1	4	26	30	38	99
Total	**46**	**82**	**221**	**208**	**171**	**728**

Table 189 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question Science is the most interesting subject in school per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	**Min**	**1 Q**	**Median**	**Average**	**3 Q**	**Max**
AL	1	3	4	3.50	4.75	5
CU	1	2	3	3.00	4.00	5
ESI	1	3	4	3.65	4.00	5
PRIA	1	3	4	3.54	4.00	5
TU Wien	1	2	3	3.18	4.00	5
UoA	1	3	4	4.01	5.00	5

9.14.4.2 IN GENERAL I FIND SCIENCE EASY

Table 191 reports the frequencies for the question In general I find science easy and Table 192 reports the descriptive statistics. As it could be observed, a majority of participants from all partners selected agree and strongly agree. The partner with the biggest percentage is UoA (66%) and the lowest is ESI (51%). CU is the partner with the biggest percentage of people who selected neutral (32%), followed by TU Wien and PRIA with 30% both. CU is the partner with the biggest percentage of participants who selected disagree and strongly disagree (25%).

Table 190 Prequestionnaire Analysis: Science Related Questions. In general I find science easy per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	17	28	107	112	104	368
CU	10	16	23	34	19	102
ESI	30	29	107	77	93	336
PRIA	8	16	79	101	62	266
TU Wien	6	17	39	43	27	132
UoA	3	8	29	52	27	119
Total	**74**	**114**	**384**	**419**	**332**	**1323**

Table 191 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question In general I find science easy per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3.00	4	3.70	5	5
CU	1	2.25	4	3.35	4	5
ESI	1	3.00	4	3.52	5	5
PRIA	1	3.00	4	3.73	4	5
TU Wien	1	3.00	4	3.52	4	5
UoA	1	3.00	4	3.77	4	5

9.14.4.3 SCIENCE LESSONS ARE BORING

Table 193 reports the frequencies for the question Science lessons are boring and Table 194 reports the descriptive statistics. As it could be seen, a majority of participants from AL, ESI, PRIA, TU Wien and UoA selected disagree and strongly disagree. CU is the only partner with less than 50% of the participants in disagree and strongly disagree. PRIA is the partner with the biggest percentage of participants who selected neutral (32%). CU is the partner with the biggest percentage of participants who selected agree and strongly agree (23%), followed by TU Wien (21%). ESI is the partner with the biggest percentage of participants who disagree and strongly disagree (67%) and at the same time with the lowest percentage of participants who agree and strongly agree (13%).

Table 192 Prequestionnaire Analysis: Science Related Questions. Science lessons are boring per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	169	75	58	33	30	365
CU	20	28	27	10	12	97
ESI	159	65	66	18	26	334
PRIA	66	70	84	24	20	264
TU Wien	35	39	34	21	7	136
UoA	39	32	30	12	5	118
Total	**488**	**309**	**299**	**118**	**100**	**1314**

Table 193 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question Science lessons are boring per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	1.00	2	2.12	3	5
CU	1	2.00	3	2.65	3	5
ESI	1	1.00	2	2.06	3	5
PRIA	1	1.75	2	2.48	3	5
TU Wien	1	1.00	2	2.46	3	5
UoA	1	1.00	2	2.25	3	5

9.14.4.4 WE HAVE FUN IN SCIENCE LESSONS

Table 195 reports the frequencies for the question We have fun in science lessons and Table 196 reports the descriptive statistics. As it could be seen, a majority of participants from UoA, PRIA, ESI, CU and AL agree and strongly agree. ESI is the partner with the biggest percentage of participants who selected agree and strongly agree (76%), followed by CU and AL with 68% both. UoA and TU Wien are the partners with the biggest percentage of participants who selected neutral with 34%. TU Wien is the partner with the biggest percentage of participants who selected disagree and strongly disagree (20%), and ESI is the one with the lowest percentage (11%).

Table 194 Prequestionnaire Analysis: Science Related Questions. We have fun in science lessons per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	27	24	63	84	161	359
CU	10	5	20	35	32	102
ESI	20	15	45	91	160	331
PRIA	13	20	70	86	76	265
TU Wien	8	19	46	32	29	134
UoA	1	13	40	46	18	118
Total	**79**	**96**	**284**	**374**	**476**	**1309**

Table 195 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question We have fun in science lessons per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	4	3.91	5	5
CU	1	3	4	3.73	5	5
ESI	1	4	4	4.08	5	5
PRIA	1	3	4	3.72	5	5
TU Wien	1	3	3	3.41	4	5
UoA	1	3	4	3.57	4	5

9.14.4.5 SCIENCE IS IMPORTANT

Table 197 reports the frequencies for the question Science is important and Table 198 reports the descriptive statistics. As it could be seen, most of the participants from TU Wien, PRIA, ESI and AL selected agree and strongly agree. PRIA is the partner where 94% of the participants selected strongly agree. UoA is the participants with the biggest percentage of participants who selected neutral (45%). A majority of the participants from CU selected agree and strongly agree (69%). UoA's participants is the partner with the lowest percentage in agree and strongly agree (35%). UoA is the partner with the biggest percentage of participants who selected disagree and strongly disagree (20%), while the other partners' percentage is lower than 8% with a minimum of 3% in PRIA.

Table 196 Prequestionnaire Analysis: Science Related Questions. Science is important per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	2	4	18	31	93	148
CU	1	2	9	11	16	39
ESI	2	1	13	45	230	291
PRIA	1	0	1	0	31	33
TU Wien	2	2	3	12	40	59
UoA	3	1	9	3	4	20
Total	**11**	**10**	**53**	**102**	**414**	**590**

Table 197 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question Science is important per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	5	4.41	5	5
CU	1	3	4	4.00	5	5
ESI	1	5	5	4.72	5	5
PRIA	1	5	5	4.82	5	5
TU Wien	1	4	5	4.46	5	5
UoA	1	3	3	3.20	4	5

9.14.4.6 SCIENCE IS IMPORTANT FOR THE JOB I WANT TO DO

Table 199 reports the frequencies for the question Science is important for the job I want to do and Table 200 reports the descriptive statistics. As it could be observed, a majority of participants from UoA, PRIA and AL selected agree and strongly agree. TU Wien is the partner with the lowest percentage of participants who selected agree and strongly agree (27%) and UoA the one with the biggest (62%). The biggest percentage of participants who selected neutral is found in PRIA (32%), followed by CU and ESI, 29% and 28% respectively. TU Wien is the partner with the biggest percentage of participants who selected disagree and strongly disagree (51%), while ESI and UoA are the ones with the lowest percentage (19%).

Table 198 Prequestionnaire Analysis: Science Related Questions. Science is important for the job I want to do per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total

Partner	1	2	3	4	5	Total
AL	27	35	43	26	79	210
CU	9	6	18	3	27	63
ESI	2	6	12	9	14	43
PRIA	27	43	75	39	48	232
TU Wien	18	20	17	12	8	75
UoA	6	13	19	25	36	99
Total	**89**	**123**	**184**	**114**	**212**	**722**

Table 199 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question Science is important for the job I want to do per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	2	3.5	3.45	5	5
CU	1	3	3.0	3.52	5	5
ESI	1	3	4.0	3.63	5	5
PRIA	1	2	3.0	3.16	4	5
TU Wien	1	2	2.0	2.63	4	5
UoA	1	3	4.0	3.73	5	5

9.14.4.7 MY TEACHER THINKS I AM GOOD AT SCIENCE

Table 201 reports the frequencies for the question My teacher thinks I am good at science and Table 202 reports the descriptive statistics. As it could be observed, a majority of the participants from all partners selected agree and strongly agree. UoA is the partner with the biggest percentage (75%) and CU the one with the lowest (51%). The partner with the biggest percentage of participants who selected neutral are TU Wien and ESI (36%). The percentage of participants who selected neutral in all partners is bigger than 20%. Participants who selected disagree and strongly disagree is below 14%.

Table 200 Prequestionnaire Analysis: Science Related Questions. My teacher thinks I am good at science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	17	19	108	114	102	360
CU	6	8	36	33	19	102

Partner	1	2	3	4	5	Total
ESI	14	16	117	89	92	328
PRIA	9	11	83	91	70	264
TU Wien	4	13	47	42	26	132
UoA	0	5	24	59	30	118
Total	**50**	**72**	**415**	**428**	**339**	**1304**

Table 201 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question My teacher thinks I am good at science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	4	3.74	5.00	5
CU	1	3	4	3.50	4.00	5
ESI	1	3	4	3.70	5.00	5
PRIA	1	3	4	3.77	5.00	5
TU Wien	1	3	4	3.55	4.00	5
UoA	2	4	4	3.97	4.75	5

9.14.4.8 I HAVE TO WORK ON MY OWN IN SCIENCE

Table 203 reports the frequencies for the question I have to work on my own in science and Table 204 reports the descriptive statistics. As it could be seen, there is not a general partner among all partners. UoA is the only partner with 50% of participants who selected agree and strongly agree, followed by ESI (49%). There is a considerable percentage of participants who selected neutral in CU (53%) and TU Wien (44%). The biggest percentage of participants who selected disagree and strongly disagree are in CU (37%) and TU Wien (36%).

Table 202 Prequestionnaire Analysis: Science Related Questions. I have to work on my own in science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	44	49	116	74	77	360
CU	16	22	54	2	8	102
ESI	52	29	89	63	102	335
PRIA	19	37	99	53	59	267
TU Wien	21	26	58	18	8	131

Partner	1	2	3	4	5	Total
UoA	9	20	30	35	24	118
Total	**161**	**183**	**446**	**245**	**278**	**1313**

Table 203 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question I have to work on my own in science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	2	3.0	3.25	4	5
CU	1	2	3.0	2.65	3	5
ESI	1	3	3.0	3.40	5	5
PRIA	1	3	3.0	3.36	4	5
TU Wien	1	2	3.0	2.74	3	5
UoA	1	3	3.5	3.38	4	5

9.14.4.9 I AM GOOD AT SCIENCE

Table 205 reports the frequencies for the question I am good at science and Table 206 reports the descriptive statistics. A majority of the participants from UoA, TU Wien, PRIA, ESI and AL selected agree and strongly agree. CU is the only partner with a percentage lower than 50%, with 46%. UoA is the one with the biggest percentage 95%. The biggest percentage of participants who selected disagree and strongly disagree is PRIA (24%), followed by CU (18%). There is a significant number of participants who selected neutral, especially in TU Wien (37%) and CU (36%).

Table 204 Prequestionnaire Analysis: Science Related Questions. I am good at science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	7	10	28	38	67	150
CU	4	3	14	9	9	39
ESI	12	14	84	95	86	291
PRIA	5	2	8	6	13	34
TU Wien	0	0	21	20	16	57
UoA	1	0	0	4	15	20
Total	**29**	**29**	**155**	**172**	**206**	**591**

Table 205 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question I am good at science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3.00	4	3.99	5	5
CU	1	3.00	3	3.41	4	5
ESI	1	3.00	4	3.79	5	5
PRIA	1	3.00	4	3.59	5	5
TU Wien	3	3.00	4	3.91	5	5
UoA	1	4.75	5	4.60	5	5

9.14.4.10 I THINK SCIENCE IS DIFFICULT

Table 207 reports the frequencies for the question I think science is difficult and Table 208 reports the descriptive statistics. As it could be observed, there is a tendency from all partners' participants towards disagree and strongly disagree. 53% and 52% of participants from PRIA and ESI, respectively, selected disagree and strongly disagree, while the lowest percentage is 34% from TU Wien. Also there is a big percentage from some partners on the participants who selected neutral. TU Wien is the partner with the biggest percentage (42%), followed by UoA (37%). CU is the only partner with the biggest percentage of participants who selected agree and strongly disagree (43%), which is the same percentage of participants who selected disagree and strongly disagree.

Table 206 Prequestionnaire Analysis: Science Related Questions. I think science is difficult per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	51	43	54	40	22	210
CU	6	21	9	27	0	63
ESI	12	9	10	3	6	40
PRIA	44	79	69	25	14	231
TU Wien	7	19	32	14	5	77
UoA	11	26	37	15	10	99
Total	**131**	**197**	**211**	**124**	**57**	**720**

Table 207 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question I think science is difficult per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	2	3	2.71	4.0	5
CU	1	2	3	2.90	4.0	4
ESI	1	1	2	2.55	3.0	5
PRIA	1	2	2	2.51	3.0	5
TU Wien	1	2	3	2.88	3.0	5
UoA	1	2	3	2.87	3.5	5

9.14.4.11 SCIENCE IS IMPORTANT TO LEARN

Table 209 reports the frequencies for the question Science is important to learn and Table 210 reports the descriptive statistics. More than 70% of the participants from all partners selected agree and strongly agree, with the biggest percentage in ESI (93%). The percentage of participants who selected neutral is below 20%, PRIA is the partner with the biggest percentage (19%). The percentage of participants who selected disagree and strongly disagree is below 10%.

Table 208 Prequestionnaire Analysis: Science Related Questions. Science is important to learn per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	6	9	20	59	116	210
CU	0	6	6	15	36	63
ESI	1	1	1	14	26	43
PRIA	7	13	43	84	81	228
TU Wien	0	1	13	48	16	78
UoA	0	1	12	36	50	99
Total	**14**	**31**	**95**	**256**	**325**	**721**

Table 209 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question Science is important to learn per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	5	4.29	5	5

Partner	Min	1 Q	Median	Average	3 Q	Max
CU	2	4	5	4.29	5	5
ESI	1	4	5	4.47	5	5
PRIA	1	3	4	3.96	5	5
TU Wien	2	4	4	4.01	4	5
UoA	2	4	5	4.36	5	5

9.14.4.12 I GET GOOD GRADES IN SCIENCE

Table 211 reports the frequencies for the question I get good grades in science and Table 212 reports the descriptive statistics. A majority of participants from all partners selected agree and strongly agree. The partner with the biggest percentage is UoA (79%), followed by ESI (76%), CU (71%) and AL (71%). The partners with the lowest percentage is TU Wien and PRIA with (71%). PRIA has the biggest percentage of participants who selected neutral with 29%, followed by TU Wien (22%) and AL (21%). The percentage of participants who selected disagree and strongly disagree is below the 13% (TU Wien).

Table 210 Prequestionnaire Analysis: Science Related Questions. I get good grades in science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	5	11	44	67	83	210
CU	6	0	12	30	15	63
ESI	1	1	8	8	24	42
PRIA	8	7	67	80	69	231
TU Wien	1	9	17	36	14	77
UoA	0	2	19	41	36	98
Total	**21**	**30**	**167**	**262**	**241**	**721**

Table 211 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question I get good grades in science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	4	4.01	5	5
CU	1	3	4	3.76	4	5

Partner	Min	1 Q	Median	Average	3 Q	Max
ESI	1	4	5	4.26	5	5
PRIA	1	3	4	3.84	5	5
TU Wien	1	3	4	3.69	4	5
UoA	2	4	4	4.13	5	5

9.14.4.13 MOST OF THE STUDENTS IN MY CLASS ARE GOOD AT SCIENCE

Table 213 reports the frequencies for the question Most of the students in my class are good at science and Table 214 reports the descriptive statistics. A majority of the participants from all partners selected agree and strongly agree. UoA is the partner with the lowest percentage (50%), and ESI and AL the ones with the biggest, 65% and 66% respectively. UoA is the partner with the biggest percentage of participants who selected neutral (36%), followed by CU (30%). The percentage of participants who selected disagree and strongly disagree is small, below 15%.

Table 212 Prequestionnaire Analysis: Science Related Questions. Most of the students in my class are good at science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	9	20	94	123	113	359
CU	4	6	30	33	28	101
ESI	17	11	88	101	114	331
PRIA	13	11	72	84	86	266
TU Wien	1	16	40	43	37	137
UoA	7	9	43	47	12	118
Total	**51**	**73**	**367**	**431**	**390**	**1312**

Table 213 Prequestionnaire Analysis: Science Related Questions. Descriptive statistics for the question Most of the students in my class are good at science per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	4.0	3.87	5	5
CU	1	3	4.0	3.74	5	5
ESI	1	3	4.0	3.86	5	5
PRIA	1	3	4.0	3.82	5	5

Partner	Min	1 Q	Median	Average	3 Q	Max
TU Wien	1	3	4.0	3.72	5	5
UoA	1	3	3.5	3.41	4	5

9.14.4.14 WOULD YOU LIKE TO STUDY SCIENCE WHEN YOU ARE OLDER?

Table 215 reports the answers obtained to the question. As it could be observed, most the participants would like to study science when they are older. A majority of the participants from AL, ESI and UoA would to study science when they are older. The opposite case is found in CU, PRIA and TU Wien.

Table 214 Prequestionnaire Analysis: Science Related Questions. Would you like to study science when you are older? Per partner.

Partner	No	Yes	Total
AL	120	212	332
CU	58	44	102
ESI	99	191	290
PRIA	147	92	239
TU Wien	47	20	67
UoA	56	63	119
Total	**527**	**622**	**1149**

9.14.4.15 SELF-EFFICACY SCORE: SCIENCE

This score was calculated using the following formula:

$$\sum_{i=1}^{i=number\_questions}\left(\sum_{j=1}^{j=5}\frac{Question_i^j}{number\_participants_i^j}\right)$$

i represents the questions, and j the partners. $number\_participants_i^j$ is the number of participants who answered the i question for the j partner.

It is important to clarify that answers to the question "Science lessons are boring" and "I think science is difficult" were inverted. Also to calculated the factor, it was not used the question "Science are important for the job I want to do". As it could be seen in Table 216, all partners have a coefficient over 40. ESI is the partner with the biggest coefficient and CU with the smallest.

Table 215 Prequestionnaire Analysis: Science Related Questions. Self-Efficacy score: Science

Partner	Factor
AL	45.8
CU	41.9

ESI	46.8
PRIA	45.2
TU Wien	42.9
UoA	45.3

9.14.4.16 CONCLUSIONS

A majority of participants from all partners selected agree and strongly agree in the question "*In general I find science easy*".

A 45% of UoA's participants selected neutral in the statement "*science is important*".

A majority of participants from all participants selected agree and strongly agree in the questions "*My teacher thinks I am good at science".* There is also a considerable percentage of participants who selected neutral, the lowest percentage is 20% which is found in UoA.

There is no a general pattern among all the partners for the question "*I have to work on my own in science".* There are a considerable percentage of participants who selected neutral in CU (53%) and TU Wien (44%).

Participants from CU are equally divided between agree and strongly agree, and disagree and strongly disagree in the question "*I think science is difficult".*

More than 70% of participants from all partners selected agree and strongly agree in the question "*Science is important to learn".*

More than 60% of participants from all partners selected agree and strongly agree in the question "*I get good grades in science".*

9.14.5 Postquestionnaire Analysis: General

This section uses the whole answers provided by the participants who answered the postquestionnaire. A total of 1354 were obtained for the postquestionnaire.

9.14.5.1 CAREER PREFERENCES – POSTQUESTIONNAIRE

The number total of participants who answered the question "*what job would you like to do?*" is 1205. Table 217 reports the number of participants who wrote a STEM career. The answers considered as STEM are reported at the beginning of this document. As it could be seen in the table just 215 are considering to pursuit a STEM career, with the lowest percentage in CU. There were 7 participants that did not specified their gender and from those 2 wrote a STEM career, so they were omitted in Table 218. As it could be seen, the number of male participants double the number of female participants. There were 7 participants that did not specified their age and from those 2 wrote a STEM career, so they were omitted in Table 219 and Figure 11. As it could be observed the biggest number of participants is found at age of 10, followed by the age of 12. As it could be seen in Figure 12 and Table 220, there are more male participants in almost all ages interested in STEM careers than female participants. The biggest difference is found at the age of 10, where 48 male participants wrote a STEM career in comparison 14 female participants.

Table 216 Postquestionnaire Analysis: General. Career preferences – Postquestionnaire. Number of participants who answered the question "What job would you like to do?" and the ones who wrote a STEM career per partner.

Partner	Number of Participants who wrote a STEM career	Total
AL	58	374
CU	4	98
ESI	48	270
PRIA	55	217
TU Wien	19	127
UoA	31	119
Total	**215**	**1205**

Table 217 Postquestionnaire Analysis: General. Career preferences – Postquestionnaire. Number of participants who answered the question "What job would you like to do?" and the ones who wrote a STEM career per partner and gender.

	Number of Participants who wrote a STEM career		Total Number of Participants	
Partner	**Male**	**Female**	**Male**	**Female**
AL	30	28	138	236
CU	3	1	46	48
ESI	38	10	144	126
PRIA	44	11	133	83
TU Wien	14	5	60	67
UoA	20	9	69	48
Total	**149**	**64**	**590**	**608**

Table 218 Postquestionnaire Analysis: General. Career preferences – Postquestionnaire. Number of participants who answered the question “What job would you like to do?” and the ones who wrote a STEM career per partner and age.

Number of Participants who wrote a STEM career													Total Number of Participants													
Partner	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**Total**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**Total**
AL				2	30	9	15	2				**58**				10	156	99	86	22						**374**
CU						3		1				**4**			1	13	12	12	31	22	7					**98**
ESI			3	16	24	3	2					**48**			14	104	121	11	18							**270**
PRIA				2	4	11	20	14	3			**55**		10	25	7	17	30	62	39	16	9	1			**217**
TU Wien	1	5		7	3	1		1		1		**19**	16	14	11	23	13	3		17	20	7		1	1	**127**
UoA					1	3	4	3	4	11	4	**31**					4	22	11	16	26	28	10			**119**
Total	**1**	**5**	**3**	**27**	**62**	**30**	**41**	**21**	**7**	**12**	**4**	**213**	**16**	**24**	**51**	**157**	**323**	**177**	**208**	**116**	**69**	**44**	**11**	**1**	**1**	**1198**

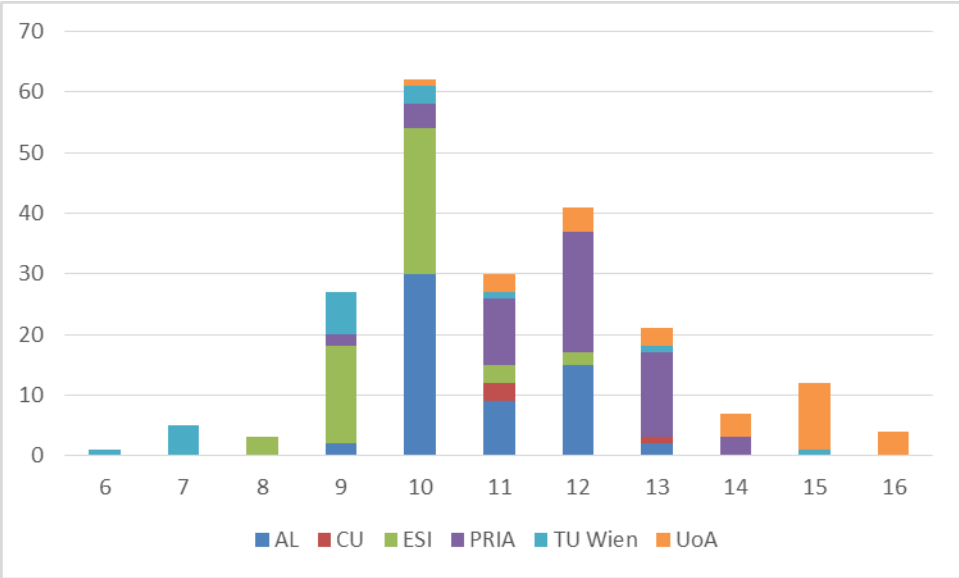


Figure 18 Postquestionnaire Analysis: General. Career preferences – Postquestionnaire. Number of participants who answered the question “What job would you like to do?” and the ones who wrote a STEM career per partner and age.

Table 219 Postquestionnaire Analysis: General. Career preferences – Postquestionnaire. Number of participants who answered the question "What job would you like to do?" and the ones who wrote a STEM career per partner, gender and age.

	Number of Participants who wrote a STEM career																			
	6	**7**		**8**		**9**		**10**		**11**		**12**		**13**		**14**	**15**		**16**	**Total**
Partner	**M**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**M**	**F**	**M**	
AL						2		22	8		9	5	10	1	1					58
CU										2	1			1						4
ESI				2	1	12	4	20	4	2	1	2								48
PRIA						2		3	1	8	3	16	4	11	3	3				55
TU Wien	1	4	1			5	2	3			1				1		1			19
UoA									1	2	1	3	1	2	1	4	6	5	3	31
Total	**1**	**4**	**1**	**2**	**1**	**21**	**6**	**48**	**14**	**14**	**16**	**26**	**15**	**15**	**6**	**7**	**7**	**5**	**3**	**215**

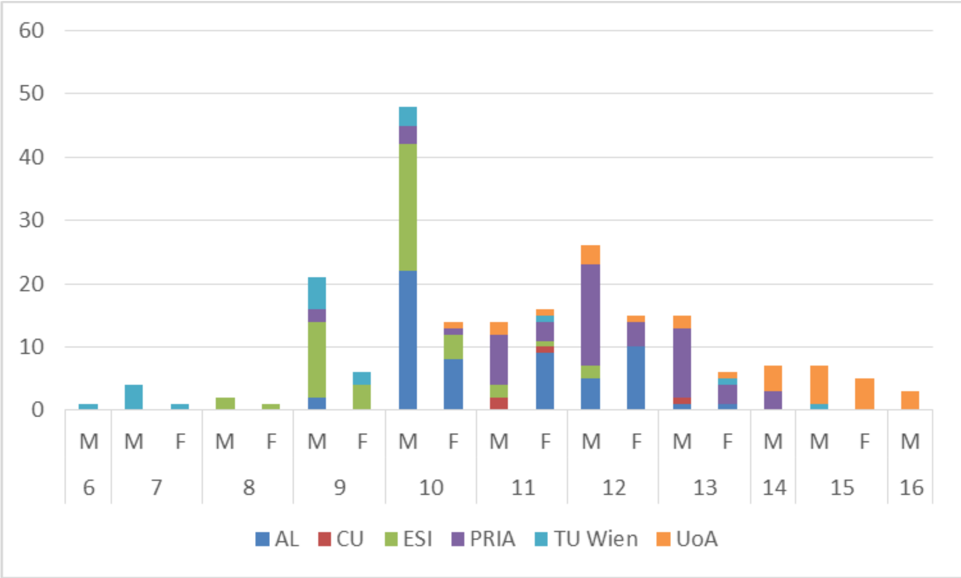


Figure 19 Postquestionnaire Analysis: General. Career preferences – Postquestionnaire. Number of participants who answered the question "What job would you like to do?" and the ones who wrote a STEM career per partner, gender and age

9.14.5.2 CHANGES IN CAREER

This was done comparing the answers provided by the participants in the pre and post questionnaires. Participants that did not answered this questions in the prequestionnaire were 74 and in the postquestionnaire 131. Participants that did not answered in the pre and post questionnaire were just 39. Therefore 166 participants were eliminated from the study because without knowing the answer in both cases is impossible to know if their change their mind or not.
From the remaining participants were calculated:

- To find the participants who changed from STEM career to a non-STEM career were used the columns STEM career, which were added in the pre and postquestionnaires. To check which answers were considered as STEM career refer to the general comments. To find these participants, it was looked on the ones who in the prequestionnaire wrote a STEM career and in the postquestionnaire wrote a non-STEM career. A total of 27 participants went away from STEM. 6 participants changed from STEM to I don't know. Table 4 reports the number of participants who changed per partner. As it could be observed, PRIA and ESI are the partners with the biggest number of participants who changed. As it could be seen in Table 5, there is not big difference between genders per partner. The division per age was omitted due to the small numbers.

Table 220 Pre and Post questionnaires analysis. Changes in Career away from STEM per partner.

Partner	Participants who Changed	Total
AL	5	326
ESI	9	231
CU	0	20
PRIA	9	180
TU Wien	0	119
UoA	4	111
Grand Total	**27**	**987**

Table 221 Pre and Post questionnaires analysis. Changes in Career away from STEM per partner and gender.

Partner	Participants who changed		Total of participants		Total
	Male	Female	Male	Female	
AL	2	3	123	203	326
ESI	6	3	13	7	231
CU	0	0	13	7	20

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PRIA	4	5	106	73	180
TU Wien	0	0	59	60	119
UoA	3	1	64	46	111
Total	**15**	**12**	**484**	**501**	**987**

- To find the participants who changed from non-STEM career to STEM career were used the columns STEM career, which were added in the pre and postquestionnaires. To check which answers were considered as STEM career refer to the general comments. To find these participants, it was looked on the ones who in the prequestionnaire wrote a non-STEM career and in the postquestionnaire wrote a STEM career. Table 6 presents the final number of participants who move into STEM. As it could be observed there is just 26 participants who move, with the biggest number in ESI. Three of these move from I don't know to STEM careers. Table 7 reports the frequency per gender, as it could observed there is not significant difference between them. The division per age was omitted due to the small numbers.

Table 222 Pre and Post questionnaires analysis. Changes in Career towards STEM per partner.

Partner	Participants who Changed	Total
AL	7	326
ESI	9	231
CU	0	20
PRIA	5	180
TU Wien	2	119
UoA	3	111
Total	**26**	**987**

Table 223 Pre and Post questionnaires analysis. Changes in Career away from STEM per partner and gender.

	Participants who changed		Total of participants		Total
Partner	Male	Female	Male	Female	
AL	4	3	123	203	326
ESI	6	3	13	7	231
CU	0	0	13	7	20
PRIA	1	4	106	73	180

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TU Wien	1	1	59	60	119
UoA	3	0	64	46	111
Total	**15**	**11**	**484**	**501**	**987**

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9.14.6 Postquestionnaire Analysis: Activity

9.14.6.1 THE PROBLEMS WE HAD TO SOLVE WERE INTERESTING

Table 221 reports the frequencies for the question The problems we had to solve were Interesting and Table 222 reports the descriptive statistics. As it could be seen, most of the participants from all partners selected agree and strongly agree. As it could be observed in Table 223 and Table 224, there is not significant difference between genders in all partners. As it could be seen in Table 225 and Table 226, there is difference between age groups in TU Wien and PRIA. Most of the age groups 7-10 and 14-18 from PRIA selected strongly agree, while the age group 11-14 are mainly distributed between agree and strongly agree. A majority of the participants from age group 7-10 from TU Wien selected strongly agree, while the other two groups are distributed between agree and strongly agree. As it could be seen in

Table 227 and Table 228, there is not significant difference between genders per gender and age group in all partners.

Table 224 Postquestionnaire Analysis: Activity. The problems we had to solve were Interesting per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	3	9	31	108	229	380
CU	0	5	9	33	30	77
ESI	2	1	5	27	295	330
PRIA	9	9	25	62	136	241
TU Wien	1	2	21	44	78	146
UoA	2	2	2	37	75	118
Total	**17**	**28**	**93**	**311**	**843**	**1292**

Table 225 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Interesting per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	5	4.45	5	5
CU	2	4	4	4.14	5	5
ESI	1	5	5	4.85	5	5
PRIA	1	4	5	4.27	5	5

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Partner	Min	1 Q	Median	Average	3 Q	Max
TU Wien	1	4	5	4.34	5	5
UoA	1	4	5	4.53	5	5

Table 226 Postquestionnaire Analysis: Activity. The problems we had to solve were Interesting per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	2	9	20	72	137	240
AL	M	1	0	11	36	92	140
CU	F	0	2	7	15	14	38
CU	M	0	2	2	18	15	37
ESI	F	0	1	0	15	136	152
ESI	M	2	0	5	12	159	178
PRIA	F	1	2	7	24	54	88
PRIA	M	8	7	18	38	80	151
TU Wien	F	1	0	14	24	40	79
TU Wien	M	0	2	7	20	38	67
UoA	F	2	0	2	17	26	47
UoA	M	0	2	0	18	49	69
Total		**17**	**27**	**93**	**309**	**840**	**1286**

Table 227 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Interesting per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	4	5	4.39	5	5
AL	M	1	4	5	4.56	5	5
CU	F	2	4	4	4.08	5	5
CU	M	2	4	4	4.24	5	5
ESI	F	2	5	5	4.88	5	5

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Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
ESI	M	1	5	5	4.83	5	5
PRIA	F	1	4	5	4.45	5	5
PRIA	M	1	4	5	4.16	5	5
TU Wien	F	1	4	5	4.29	5	5
TU Wien	M	2	4	5	4.40	5	5
UoA	F	1	4	5	4.38	5	5
UoA	M	2	4	5	4.65	5	5

Table 228 Postquestionnaire Analysis: Activity. The problems we had to solve were Interesting per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	2	4	7	33	119	165
AL	(10,14]	1	5	24	75	108	213
CU	(6,10]	0	1	3	6	11	21
CU	(10,14]	0	4	6	27	19	56
ESI	(6,10]	2	1	5	27	252	287
ESI	(10,14]	0	0	0	0	39	39
PRIA	(6,10]	3	1	3	6	43	56
PRIA	(10,14]	6	8	20	52	83	169
PRIA	(14,18]	0	0	1	3	9	13
TU Wien	(6,10]	1	0	6	15	44	66
TU Wien	(10,14]	0	0	7	19	17	43
TU Wien	(14,18]	0	2	3	6	1	12
UoA	(6,10]	0	0	0	2	2	4
UoA	(10,14]	2	1	1	18	51	73
UoA	(14,18]	0	1	1	16	21	39

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Partner	Age Group	1	2	3	4	5	Total
Total		**17**	**28**	**87**	**305**	**819**	**1256**

Table 229 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Interesting per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	4	5.0	4.59	5	5
AL	(10,14]	1	4	5.0	4.33	5	5
CU	(6,10]	2	4	5.0	4.29	5	5
CU	(10,14]	2	4	4.0	4.09	5	5
ESI	(6,10]	1	5	5.0	4.83	5	5
ESI	(10,14]	5	5	5.0	5.00	5	5
PRIA	(6,10]	1	5	5.0	4.52	5	5
PRIA	(10,14]	1	4	4.0	4.17	5	5
PRIA	(14,18]	3	4	5.0	4.62	5	5
TU Wien	(6,10]	1	4	5.0	4.53	5	5
TU Wien	(10,14]	3	4	4.0	4.23	5	5
TU Wien	(14,18]	2	3	4.0	3.50	4	5
UoA	(6,10]	4	4	4.5	4.50	5	5
UoA	(10,14]	1	4	5.0	4.58	5	5
UoA	(14,18]	2	4	5.0	4.46	5	5

Table 230 Postquestionnaire Analysis: Activity. The problems we had to solve were Interesting per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	1	4	3	18	46	72
AL	(6,10]	M	1	0	4	15	73	93
AL	(10,14]	F	1	5	17	54	90	167

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Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(10,14]	M	0	0	7	21	18	46
CU	(6,10]	F	0	0	2	3	6	11
CU	(6,10]	M	0	1	1	3	5	10
CU	(10,14]	F	0	2	5	12	8	27
CU	(10,14]	M	0	1	1	15	10	27
ESI	(6,10]	F	0	1	0	15	123	139
ESI	(6,10]	M	2	0	5	12	129	148
ESI	(10,14]	F	0	0	0	0	13	13
ESI	(10,14]	M	0	0	0	0	26	26
PRIA	(6,10]	F	1	0	1	2	21	25
PRIA	(6,10]	M	2	1	2	4	22	31
PRIA	(10,14]	F	0	2	5	22	28	57
PRIA	(10,14]	M	6	6	15	30	54	111
PRIA	(14,18]	F	0	0	1	0	5	6
PRIA	(14,18]	M	0	0	0	3	4	7
TU Wien	(6,10]	F	1	0	5	6	18	30
TU Wien	(6,10]	M	0	0	1	9	26	36
TU Wien	(10,14]	F	0	0	4	14	12	30
TU Wien	(10,14]	M	0	0	3	5	5	13
TU Wien	(14,18]	F	0	0	1	3	0	4
TU Wien	(14,18]	M	0	2	2	3	1	8
UoA	(6,10]	F	0	0	0	1	2	3
UoA	(6,10]	M	0	0	0	1	0	1
UoA	(10,14]	F	2	0	1	7	17	27
UoA	(10,14]	M	0	1	0	11	34	46
UoA	(14,18]	F	0	0	1	9	6	16

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Partner	Age Group	Gender	1	2	3	4	5	Total
UoA	(14,18]	M	0	1	0	6	15	22
Total			**17**	**27**	**87**	**304**	**817**	**1252**

Table 231 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Interesting per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	4.00	5.0	4.44	5	5
AL	M	(6,10]	1	5.00	5.0	4.71	5	5
AL	F	(10,14]	1	4.00	5.0	4.36	5	5
AL	M	(10,14]	3	4.00	4.0	4.24	5	5
CU	F	(6,10]	3	4.00	5.0	4.36	5	5
CU	M	(6,10]	2	4.00	4.5	4.20	5	5
CU	F	(10,14]	2	3.50	4.0	3.96	5	5
CU	M	(10,14]	2	4.00	4.0	4.26	5	5
ESI	F	(6,10]	2	5.00	5.0	4.87	5	5
ESI	M	(6,10]	1	5.00	5.0	4.80	5	5
ESI	F	(10,14]	5	5.00	5.0	5.00	5	5
ESI	M	(10,14]	5	5.00	5.0	5.00	5	5
PRIA	F	(6,10]	1	5.00	5.0	4.68	5	5
PRIA	M	(6,10]	1	4.00	5.0	4.39	5	5
PRIA	F	(10,14]	2	4.00	4.0	4.33	5	5
PRIA	M	(10,14]	1	4.00	4.0	4.08	5	5
PRIA	F	(14,18]	3	5.00	5.0	4.67	5	5
PRIA	M	(14,18]	4	4.00	5.0	4.57	5	5
TU Wien	F	(6,10]	1	4.00	5.0	4.33	5	5
TU Wien	M	(6,10]	3	4.00	5.0	4.69	5	5

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Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
TU Wien	F	(10,14]	3	4.00	4.0	4.27	5	5
TU Wien	M	(10,14]	3	4.00	4.0	4.15	5	5
TU Wien	F	(14,18]	3	3.75	4.0	3.75	4	4
TU Wien	M	(14,18]	2	2.75	3.5	3.38	4	5
UoA	F	(6,10]	4	4.50	5.0	4.67	5	5
UoA	M	(6,10]	4	4.00	4.0	4.00	4	4
UoA	F	(10,14]	1	4.00	5.0	4.37	5	5
UoA	M	(10,14]	2	4.25	5.0	4.70	5	5
UoA	F	(14,18]	3	4.00	4.0	4.31	5	5
UoA	M	(14,18]	2	4.00	5.0	4.59	5	5

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9.14.6.2 THE PROBLEMS WE HAD TO SOLVE WERE DIFFICULT

Table 229 reports the frequencies for the question The problems we had to solve were Difficult and Table 230 reports the descriptive statistics. As it could be seen, there is not a specific pattern for all the partners. CU is the partner with the biggest percentage of participants who selected agree and strongly agree (52%) and ESI with the lowest (17%). The biggest percentage of participants who selected neutral is found in UoA (41%), followed by AL (38%). ESI is the partner with the lowest percentage (25%). A majority of participants from ESI selected disagree and strongly disagree. The lowest percentage is found in CU. As it could be seen in Table 231 and Table 232, there is no significant difference between genders per partner. As it could be observed in Table 233 and Table 234, there is a difference between age groups in TU Wien, PRIA and CU. Table 235Table 236

Table 232 Postquestionnaire Analysis: Activity. The problems we had to solve were Difficult per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	31	53	143	104	41	372
CU	5	8	25	34	7	79
ESI	125	64	79	37	16	321
PRIA	65	40	72	42	19	238
TU Wien	31	16	47	34	16	144
UoA	10	17	47	30	12	116
Total	**267**	**198**	**413**	**281**	**111**	**1270**

Table 233 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Difficult per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	3	3	3.19	4	5
CU	1	3	4	3.38	4	5
ESI	1	1	2	2.24	3	5
PRIA	1	1	3	2.62	4	5
TU Wien	1	2	3	2.92	4	5
UoA	1	3	3	3.15	4	5

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Table 234 Postquestionnaire Analysis: Activity. The problems we had to solve were Difficult per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	13	29	105	64	23	234
AL	M	18	24	38	40	18	138
CU	F	4	4	12	18	3	41
CU	M	1	3	13	15	4	36
ESI	F	46	37	48	14	4	149
ESI	M	79	27	31	23	12	172
PRIA	F	24	15	24	17	6	86
PRIA	M	41	25	47	25	13	151
TU Wien	F	15	10	28	19	7	79
TU Wien	M	16	6	19	15	9	65
UoA	F	6	7	19	10	3	45
UoA	M	4	9	27	20	9	69
Total		**267**	**196**	**411**	**280**	**111**	**1265**

Table 235 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Difficult per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	3	3	3.24	4.0	5
AL	M	1	2	3	3.12	4.0	5
CU	F	1	3	4	3.29	4.0	5
CU	M	1	3	4	3.50	4.0	5
ESI	F	1	1	2	2.28	3.0	5
ESI	M	1	1	2	2.20	3.0	5
PRIA	F	1	1	3	2.60	4.0	5

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Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
PRIA	M	1	1	3	2.63	3.5	5
TU Wien	F	1	2	3	2.91	4.0	5
TU Wien	M	1	2	3	2.92	4.0	5
UoA	F	1	2	3	2.93	4.0	5
UoA	M	1	3	3	3.30	4.0	5

Table 236 Postquestionnaire Analysis: Activity. The problems we had to solve were Difficult per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	16	20	52	54	21	163
AL	(10,14]	15	33	91	48	20	207
CU	(6,10]	3	3	6	7	1	20
CU	(10,14]	2	5	19	27	6	59
ESI	(6,10]	108	51	72	35	13	279
ESI	(10,14]	15	13	6	1	3	38
PRIA	(6,10]	31	6	9	4	5	55
PRIA	(10,14]	31	31	60	33	13	168
PRIA	(14,18]	2	3	3	5	0	13
TU Wien	(6,10]	21	10	19	11	5	66
TU Wien	(10,14]	1	4	19	16	2	42
TU Wien	(14,18]	0	1	2	6	2	11
UoA	(6,10]	3	0	0	1	0	4
UoA	(10,14]	5	11	30	19	7	72
UoA	(14,18]	2	6	15	10	5	38
Total		**255**	**197**	**403**	**277**	**103**	**1235**

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Table 237 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Difficult per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	3.0	3	3.27	4.00	5
AL	(10,14]	1	3.0	3	3.12	4.00	5
CU	(6,10]	1	2.0	3	3.00	4.00	5
CU	(10,14]	1	3.0	4	3.51	4.00	5
ESI	(6,10]	1	1.0	2	2.26	3.00	5
ESI	(10,14]	1	1.0	2	2.05	2.75	5
PRIA	(6,10]	1	1.0	1	2.02	3.00	5
PRIA	(10,14]	1	2.0	3	2.80	4.00	5
PRIA	(14,18]	1	2.0	3	2.85	4.00	4
TU Wien	(6,10]	1	1.0	3	2.53	3.00	5
TU Wien	(10,14]	1	3.0	3	3.33	4.00	5
TU Wien	(14,18]	2	3.5	4	3.82	4.00	5
UoA	(6,10]	1	1.0	1	1.75	1.75	4
UoA	(10,14]	1	3.0	3	3.17	4.00	5
UoA	(14,18]	1	3.0	3	3.26	4.00	5

Table 238 Postquestionnaire Analysis: Activity. The problems we had to solve were Difficult per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	4	5	26	27	8	70
AL	(6,10]	M	12	15	26	27	13	93
AL	(10,14]	F	9	24	79	36	15	163
AL	(10,14]	M	6	9	12	12	5	44
CU	(6,10]	F	2	3	3	3	0	11
CU	(6,10]	M	1	0	3	4	1	9

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Partner	Age Group	Gender	1	2	3	4	5	Total
CU	(10,14]	F	2	1	9	15	3	30
CU	(10,14]	M	0	3	10	11	3	27
ESI	(6,10]	F	41	32	45	14	4	136
ESI	(6,10]	M	67	19	27	21	9	143
ESI	(10,14]	F	5	5	3	0	0	13
ESI	(10,14]	M	10	8	3	1	3	25
PRIA	(6,10]	F	16	3	3	1	0	23
PRIA	(6,10]	M	15	3	6	3	5	32
PRIA	(10,14]	F	7	12	19	13	6	57
PRIA	(10,14]	M	24	19	40	20	7	110
PRIA	(14,18]	F	1	0	2	3	0	6
PRIA	(14,18]	M	1	3	1	2	0	7
TU Wien	(6,10]	F	11	5	8	7	0	31
TU Wien	(6,10]	M	10	5	11	4	5	35
TU Wien	(10,14]	F	0	4	14	11	1	30
TU Wien	(10,14]	M	1	0	5	5	1	12
TU Wien	(14,18]	F	0	0	1	0	2	3
TU Wien	(14,18]	M	0	1	1	6	0	8
UoA	(6,10]	F	3	0	0	0	0	3
UoA	(6,10]	M	0	0	0	1	0	1
UoA	(10,14]	F	2	6	13	4	2	27
UoA	(10,14]	M	3	5	17	15	5	45
UoA	(14,18]	F	1	1	5	6	1	14
UoA	(14,18]	M	1	4	10	4	4	23
Total			**255**	**195**	**402**	**276**	**103**	**1231**

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Table 239 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Difficult per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	3.00	3.5	3.43	4.00	5
AL	M	(6,10]	1	2.00	3.0	3.15	4.00	5
AL	F	(10,14]	1	3.00	3.0	3.15	4.00	5
AL	M	(10,14]	1	2.00	3.0	3.02	4.00	5
CU	F	(6,10]	1	2.00	3.0	2.64	3.50	4
CU	M	(6,10]	1	3.00	4.0	3.44	4.00	5
CU	F	(10,14]	1	3.00	4.0	3.53	4.00	5
CU	M	(10,14]	2	3.00	4.0	3.52	4.00	5
ESI	F	(6,10]	1	1.00	2.0	2.32	3.00	5
ESI	M	(6,10]	1	1.00	2.0	2.20	3.00	5
ESI	F	(10,14]	1	1.00	2.0	1.85	2.00	3
ESI	M	(10,14]	1	1.00	2.0	2.16	3.00	5
PRIA	F	(6,10]	1	1.00	1.0	1.52	2.00	4
PRIA	M	(6,10]	1	1.00	2.0	2.38	3.25	5
PRIA	F	(10,14]	1	2.00	3.0	2.98	4.00	5
PRIA	M	(10,14]	1	2.00	3.0	2.70	3.00	5
PRIA	F	(14,18]	1	3.00	3.5	3.17	4.00	4
PRIA	M	(14,18]	1	2.00	2.0	2.57	3.50	4
TU Wien	F	(6,10]	1	1.00	2.0	2.35	3.00	4
TU Wien	M	(6,10]	1	1.00	3.0	2.69	3.50	5
TU Wien	F	(10,14]	2	3.00	3.0	3.30	4.00	5
TU Wien	M	(10,14]	1	3.00	3.5	3.42	4.00	5
TU Wien	F	(14,18]	3	4.00	5.0	4.33	5.00	5
TU Wien	M	(14,18]	2	3.75	4.0	3.62	4.00	4
UoA	F	(6,10]	1	1.00	1.0	1.00	1.00	1

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Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
UoA	M	(6,10]	4	4.00	4.0	4.00	4.00	4
UoA	F	(10,14]	1	2.00	3.0	2.93	3.00	5
UoA	M	(10,14]	1	3.00	3.0	3.31	4.00	5
UoA	F	(14,18]	1	3.00	3.5	3.36	4.00	5
UoA	M	(14,18]	1	3.00	3.0	3.26	4.00	5

9.14.6.3 THE PROBLEMS WE HAD TO SOLVE WERE FUN

Table 237 reports the frequencies for the question The problems we had to solve were Fun and Table 238 reports the descriptive statistics. As it could be observed, most of the participants from all partners selected agree and strongly agree. As it could be observed in Table 239 and Table 240, there is not significant difference between genders per partner. As it could be observed in Table 241 and Table 242, there is difference between age groups in AL, CU, PRIA, and TU Wien, in which the youngest group considered the problems funnier than the older groups. As it could be seen in Table 243 and Table 244, there is no significant difference between genders per group age in all partners.

Table 240 Postquestionnaire Analysis: Activity. The problems we had to solve were Fun per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	7	6	31	80	249	373
CU	3	6	3	30	35	77
ESI	3	2	12	26	280	323
PRIA	9	10	38	64	123	244
TU Wien	3	8	24	42	72	149
UoA	0	4	15	45	52	116
Total	**25**	**36**	**123**	**287**	**811**	**1282**

Table 241 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Fun per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	4	5	4.50	5	5
CU	1	4	4	4.14	5	5

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Partner	Min	1 Q	Median	Average	3 Q	Max
ESI	1	5	5	4.79	5	5
PRIA	1	4	5	4.16	5	5
TU Wien	1	4	4	4.15	5	5
UoA	2	4	4	4.25	5	5

Table 242 Postquestionnaire Analysis: Activity. The problems we had to solve were Fun per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	6	6	23	55	144	234
AL	M	1	0	8	25	105	139
CU	F	2	2	3	15	16	38
CU	M	0	4	0	14	19	37
ESI	F	0	1	7	13	129	150
ESI	M	3	1	5	13	151	173
PRIA	F	2	2	14	25	46	89
PRIA	M	7	8	24	38	76	153
TU Wien	F	2	4	13	26	35	80
TU Wien	M	1	4	11	16	37	69
UoA	F	0	1	8	18	18	45
UoA	M	0	3	7	26	33	69
Total		**24**	**36**	**123**	**284**	**809**	**1276**

Table 243 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Fun per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	4	5	4.39	5	5
AL	M	1	5	5	4.68	5	5

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Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
CU	F	1	4	4	4.08	5	5
CU	M	2	4	5	4.30	5	5
ESI	F	2	5	5	4.80	5	5
ESI	M	1	5	5	4.78	5	5
PRIA	F	1	4	5	4.25	5	5
PRIA	M	1	3	4	4.10	5	5
TU Wien	F	1	4	4	4.10	5	5
TU Wien	M	1	4	5	4.22	5	5
UoA	F	2	4	4	4.18	5	5
UoA	M	2	4	4	4.29	5	5

Table 244Postquestionnaire Analysis: Activity. The problems we had to solve were Fun per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	3	0	3	19	137	162
AL	(10,14]	4	6	28	61	110	209
CU	(6,10]	1	1	0	5	14	21
CU	(10,14]	2	5	3	25	21	56
ESI	(6,10]	3	2	12	23	241	281
ESI	(10,14]	0	0	0	3	35	38
PRIA	(6,10]	2	0	8	7	42	59
PRIA	(10,14]	7	8	29	51	74	169
PRIA	(14,18]	0	1	1	5	6	13
TU Wien	(6,10]	1	1	10	14	43	69
TU Wien	(10,14]	0	3	7	20	13	43
TU Wien	(14,18]	0	4	3	3	2	12

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Partner	Age Group	1	2	3	4	5	Total
UoA	(6,10]	0	0	0	3	1	4
UoA	(10,14]	0	3	8	27	34	72
UoA	(14,18]	0	1	7	14	16	38
Total		**23**	**35**	**119**	**280**	**789**	**1246**

Table 245 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Fun per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	5	5	4.77	5.00	5
AL	(10,14]	1	4	5	4.28	5.00	5
CU	(6,10]	1	4	5	4.43	5.00	5
CU	(10,14]	1	4	4	4.04	5.00	5
ESI	(6,10]	1	5	5	4.77	5.00	5
ESI	(10,14]	4	5	5	4.92	5.00	5
PRIA	(6,10]	1	4	5	4.47	5.00	5
PRIA	(10,14]	1	3	4	4.05	5.00	5
PRIA	(14,18]	2	4	4	4.23	5.00	5
TU Wien	(6,10]	1	4	5	4.41	5.00	5
TU Wien	(10,14]	2	4	4	4.00	5.00	5
TU Wien	(14,18]	2	2	3	3.25	4.00	5
UoA	(6,10]	4	4	4	4.25	4.25	5
UoA	(10,14]	2	4	4	4.28	5.00	5
UoA	(14,18]	2	4	4	4.18	5.00	5

Table 246 Postquestionnaire Analysis: Activity. The problems we had to solve were Fun per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total

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Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	3	0	0	7	59	69
AL	(6,10]	M	0	0	3	12	78	93
AL	(10,14]	F	3	6	23	48	84	164
AL	(10,14]	M	1	0	5	13	26	45
CU	(6,10]	F	1	0	0	3	8	12
CU	(6,10]	M	0	1	0	2	6	9
CU	(10,14]	F	1	2	3	12	8	26
CU	(10,14]	M	0	3	0	12	13	28
ESI	(6,10]	F	0	1	7	12	117	137
ESI	(6,10]	M	3	1	5	11	124	144
ESI	(10,14]	F	0	0	0	1	12	13
ESI	(10,14]	M	0	0	0	2	23	25
PRIA	(6,10]	F	1	0	2	4	19	26
PRIA	(6,10]	M	1	0	6	3	23	33
PRIA	(10,14]	F	1	2	12	17	25	57
PRIA	(10,14]	M	6	6	17	33	49	111
PRIA	(14,18]	F	0	0	0	4	2	6
PRIA	(14,18]	M	0	1	1	1	4	7
TU Wien	(6,10]	F	1	1	5	8	17	32
TU Wien	(6,10]	M	0	0	5	6	26	37
TU Wien	(10,14]	F	0	2	5	13	10	30
TU Wien	(10,14]	M	0	1	2	7	3	13
TU Wien	(14,18]	F	0	1	0	2	0	3
TU Wien	(14,18]	M	0	3	3	1	2	9
UoA	(6,10]	F	0	0	0	2	1	3
UoA	(6,10]	M	0	0	0	1	0	1

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Partner	Age Group	Gender	1	2	3	4	5	Total
UoA	(10,14]	F	0	0	5	8	13	26
UoA	(10,14]	M	0	3	3	19	21	46
UoA	(14,18]	F	0	1	3	7	4	15
UoA	(14,18]	M	0	0	4	6	12	22
Total			**22**	**35**	**119**	**277**	**789**	**1242**

Table 247 Postquestionnaire Analysis: Activity. Descriptive statistics for the question The problems we had to solve were Fun per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	5.00	5.0	4.72	5.00	5
AL	M	(6,10]	3	5.00	5.0	4.81	5.00	5
AL	F	(10,14]	1	4.00	5.0	4.24	5.00	5
AL	M	(10,14]	1	4.00	5.0	4.40	5.00	5
CU	F	(6,10]	1	4.00	5.0	4.42	5.00	5
CU	M	(6,10]	2	4.00	5.0	4.44	5.00	5
CU	F	(10,14]	1	4.00	4.0	3.92	5.00	5
CU	M	(10,14]	2	4.00	4.0	4.25	5.00	5
ESI	F	(6,10]	2	5.00	5.0	4.79	5.00	5
ESI	M	(6,10]	1	5.00	5.0	4.75	5.00	5
ESI	F	(10,14]	4	5.00	5.0	4.92	5.00	5
ESI	M	(10,14]	4	5.00	5.0	4.92	5.00	5
PRIA	F	(6,10]	1	4.25	5.0	4.54	5.00	5
PRIA	M	(6,10]	1	4.00	5.0	4.42	5.00	5
PRIA	F	(10,14]	1	3.00	4.0	4.11	5.00	5
PRIA	M	(10,14]	1	3.00	4.0	4.02	5.00	5
PRIA	F	(14,18]	4	4.00	4.0	4.33	4.75	5

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Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
PRIA	M	(14,18]	2	3.50	5.0	4.14	5.00	5
TU Wien	F	(6,10]	1	4.00	5.0	4.22	5.00	5
TU Wien	M	(6,10]	3	4.00	5.0	4.57	5.00	5
TU Wien	F	(10,14]	2	4.00	4.0	4.03	5.00	5
TU Wien	M	(10,14]	2	4.00	4.0	3.92	4.00	5
TU Wien	F	(14,18]	2	3.00	4.0	3.33	4.00	4
TU Wien	M	(14,18]	2	2.00	3.0	3.22	4.00	5
UoA	F	(6,10]	4	4.00	4.0	4.33	4.50	5
UoA	M	(6,10]	4	4.00	4.0	4.00	4.00	4
UoA	F	(10,14]	3	4.00	4.5	4.31	5.00	5
UoA	M	(10,14]	2	4.00	4.0	4.26	5.00	5
UoA	F	(14,18]	2	3.50	4.0	3.93	4.50	5
UoA	M	(14,18]	3	4.00	5.0	4.36	5.00	5

9.14.6.4 WORKING WITH ROBOTS WAS INTERESTING

Table 245 reports the frequencies for the question Working with robots was interesting and Table 246 reports the descriptive statistics. As it could be observed, most of the participants from all partners selected agree and strongly agree. The lowest percentage of participants is found in CU (78%), and the biggest in ESI (99%). CU is the partner with the biggest percentage of participants who selected neutral (20%), followed by TU Wien (14%). As it could be observed in Table 247 and Table 248, there is no significant difference between genders per partner. As it could be observed in Table 249 and Table 250, there is not significant difference between age groups per partner. As it could be seen in Table 251 and Table 252, there is no difference between genders per age group in all partners.

Table 248 Postquestionnaire Analysis: Activity. Working with robots was interesting per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	6	2	7	64	297	376
CU	1	0	16	27	35	79

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Partner	1	2	3	4	5	Total
ESI	1	1	1	28	294	325
PRIA	10	8	16	57	152	243
TU Wien	4	0	19	48	69	140
UoA	2	2	1	27	87	119
Total	**24**	**13**	**60**	**251**	**934**	**1282**

Table 249 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was interesting per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	5	5	4.71	5	5
CU	1	4	4	4.20	5	5
ESI	1	5	5	4.89	5	5
PRIA	1	4	5	4.37	5	5
TU Wien	1	4	4	4.27	5	5
UoA	1	4	5	4.64	5	5

Table 250 Postquestionnaire Analysis: Activity. Working with robots was interesting per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	5	1	6	35	190	237
AL	M	1	1	1	29	107	139
CU	F	0	0	10	12	20	42
CU	M	1	0	5	15	14	35
ESI	F	0	0	0	13	139	152
ESI	M	1	1	1	15	155	173
PRIA	F	4	1	5	19	58	87
PRIA	M	6	7	10	38	93	154

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Partner	Gender	1	2	3	4	5	Total
TU Wien	F	3	0	14	27	32	76
TU Wien	M	1	0	5	21	37	64
UoA	F	0	1	1	12	34	48
UoA	M	2	1	0	15	51	69
Total		**24**	**13**	**58**	**251**	**930**	**1276**

Table 251 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was interesting per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	5	5	4.70	5	5
AL	M	1	5	5	4.73	5	5
CU	F	3	4	4	4.24	5	5
CU	M	1	4	4	4.17	5	5
ESI	F	4	5	5	4.91	5	5
ESI	M	1	5	5	4.86	5	5
PRIA	F	1	4	5	4.45	5	5
PRIA	M	1	4	5	4.33	5	5
TU Wien	F	1	4	4	4.12	5	5
TU Wien	M	1	4	5	4.45	5	5
UoA	F	2	4	5	4.65	5	5
UoA	M	1	4	5	4.62	5	5

Table 252 Postquestionnaire Analysis: Activity. Working with robots was interesting per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	2	1	0	20	141	164
AL	(10,14]	4	1	7	44	154	210

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Partner	Age Group	1	2	3	4	5	Total
CU	(6,10]	0	0	2	5	13	20
CU	(10,14]	1	0	14	22	22	59
ESI	(6,10]	1	1	1	25	254	282
ESI	(10,14]	0	0	0	3	36	39
PRIA	(6,10]	3	0	3	6	45	57
PRIA	(10,14]	7	6	12	49	96	170
PRIA	(14,18]	0	1	0	2	10	13
TU Wien	(6,10]	4	0	4	11	45	64
TU Wien	(10,14]	0	0	4	22	17	43
TU Wien	(14,18]	0	0	3	9	1	13
UoA	(6,10]	0	0	0	1	3	4
UoA	(10,14]	2	2	1	13	56	74
UoA	(14,18]	0	0	0	13	26	39
Total		**24**	**12**	**51**	**245**	**919**	**1251**

Table 253 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was interesting per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	5.00	5	4.81	5	5
AL	(10,14]	1	4.00	5	4.63	5	5
CU	(6,10]	3	4.00	5	4.55	5	5
CU	(10,14]	1	3.50	4	4.08	5	5
ESI	(6,10]	1	5.00	5	4.88	5	5
ESI	(10,14]	4	5.00	5	4.92	5	5
PRIA	(6,10]	1	5.00	5	4.58	5	5
PRIA	(10,14]	1	4.00	5	4.30	5	5

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Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
PRIA	(14,18]	2	5.00	5	4.62	5	5
TU Wien	(6,10]	1	4.00	5	4.45	5	5
TU Wien	(10,14]	3	4.00	4	4.30	5	5
TU Wien	(14,18]	3	4.00	4	3.85	4	5
UoA	(6,10]	4	4.75	5	4.75	5	5
UoA	(10,14]	1	5.00	5	4.61	5	5
UoA	(14,18]	4	4.00	5	4.67	5	5

Table 254 Postquestionnaire Analysis: Activity. Working with robots was interesting per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	1	0	0	6	64	71
AL	(6,10]	M	1	1	0	14	77	93
AL	(10,14]	F	4	1	6	29	125	165
AL	(10,14]	M	0	0	1	15	29	45
CU	(6,10]	F	0	0	2	3	7	12
CU	(6,10]	M	0	0	0	2	6	8
CU	(10,14]	F	0	0	8	9	13	30
CU	(10,14]	M	1	0	5	13	8	27
ESI	(6,10]	F	0	0	0	12	127	139
ESI	(6,10]	M	1	1	1	13	127	143
ESI	(10,14]	F	0	0	0	1	12	13
ESI	(10,14]	M	0	0	0	2	24	26
PRIA	(6,10]	F	1	0	1	1	21	24
PRIA	(6,10]	M	2	0	2	5	24	33
PRIA	(10,14]	F	3	1	4	17	32	57

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Partner	Age Group	Gender	1	2	3	4	5	Total
PRIA	(10,14]	M	4	5	8	32	63	112
PRIA	(14,18]	F	0	0	0	1	5	6
PRIA	(14,18]	M	0	1	0	1	5	7
TU Wien	(6,10]	F	3	0	3	5	19	30
TU Wien	(6,10]	M	1	0	1	6	26	34
TU Wien	(10,14]	F	0	0	3	17	10	30
TU Wien	(10,14]	M	0	0	1	5	7	13
TU Wien	(14,18]	F	0	0	2	2	0	4
TU Wien	(14,18]	M	0	0	1	7	1	9
UoA	(6,10]	F	0	0	0	1	2	3
UoA	(6,10]	M	0	0	0	0	1	1
UoA	(10,14]	F	0	1	1	5	21	28
UoA	(10,14]	M	2	1	0	8	35	46
UoA	(14,18]	F	0	0	0	6	10	16
UoA	(14,18]	M	0	0	0	7	15	22
Total			**24**	**12**	**50**	**245**	**916**	**1247**

Table 255 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was interesting per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	5.00	5.0	4.86	5	5
AL	M	(6,10]	1	5.00	5.0	4.77	5	5
AL	F	(10,14]	1	5.00	5.0	4.64	5	5
AL	M	(10,14]	3	4.00	5.0	4.62	5	5
CU	F	(6,10]	3	4.00	5.0	4.42	5	5
CU	M	(6,10]	4	4.75	5.0	4.75	5	5

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Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
CU	F	(10,14]	3	3.25	4.0	4.17	5	5
CU	M	(10,14]	1	4.00	4.0	4.00	5	5
ESI	F	(6,10]	4	5.00	5.0	4.91	5	5
ESI	M	(6,10]	1	5.00	5.0	4.85	5	5
ESI	F	(10,14]	4	5.00	5.0	4.92	5	5
ESI	M	(10,14]	4	5.00	5.0	4.92	5	5
PRIA	F	(6,10]	1	5.00	5.0	4.71	5	5
PRIA	M	(6,10]	1	4.00	5.0	4.48	5	5
PRIA	F	(10,14]	1	4.00	5.0	4.30	5	5
PRIA	M	(10,14]	1	4.00	5.0	4.29	5	5
PRIA	F	(14,18]	4	5.00	5.0	4.83	5	5
PRIA	M	(14,18]	2	4.50	5.0	4.43	5	5
TU Wien	F	(6,10]	1	4.00	5.0	4.23	5	5
TU Wien	M	(6,10]	1	5.00	5.0	4.65	5	5
TU Wien	F	(10,14]	3	4.00	4.0	4.23	5	5
TU Wien	M	(10,14]	3	4.00	5.0	4.46	5	5
TU Wien	F	(14,18]	3	3.00	3.5	3.50	4	4
TU Wien	M	(14,18]	3	4.00	4.0	4.00	4	5
UoA	F	(6,10]	4	4.50	5.0	4.67	5	5
UoA	M	(6,10]	5	5.00	5.0	5.00	5	5
UoA	F	(10,14]	2	4.75	5.0	4.64	5	5
UoA	M	(10,14]	1	5.00	5.0	4.59	5	5
UoA	F	(14,18]	4	4.00	5.0	4.62	5	5
UoA	M	(14,18]	4	4.00	5.0	4.68	5	5

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9.14.6.5 WORKING WITH ROBOTS WAS DIFFICULT

Table 253 reports the frequencies for the question Working with robots was difficult and Table 254 reports the descriptive statistics. As it could be seen, there is no a specific pattern. ESI is the only partner where more than 50% of the participants selected disagree and strongly disagree, with 61%. The rest of the partners were below 50%, AL (48%), PRIA (40%), UoA (31%), TU Wien (29%) and CU (21%). There is a considerable percentage of participants from all partner who selected neutral, mora than 25%. As it could be seen in Table 255 and Table 256, there is no significant difference between genders per partner. As it could be seen in Table 257 and Table 258, there is a tendency in all partners that the sense of difficult tend to increase in the older groups. As it could be seen in Table 259 and Table 260, there is difference between genders in the age groups in AL (7-10), ESI (11-14) and PRIA (7-10, 11-14 and 15-18).

Table 256 Postquestionnaire Analysis: Activity. Working with robots was difficult per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	105	71	109	65	19	369
CU	6	10	25	22	13	76
ESI	135	61	79	28	16	319
PRIA	55	40	62	49	29	235
TU Wien	17	21	44	30	17	129
UoA	15	21	43	30	7	116
Total	**333**	**224**	**362**	**224**	**101**	**1244**

Table 257 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was difficult per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	1	3	2.52	3	5
CU	1	3	3	3.34	4	5
ESI	1	1	2	2.15	3	5
PRIA	1	2	3	2.82	4	5
TU Wien	1	2	3	3.07	4	5
UoA	1	2	3	2.94	4	5

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Table 258 Postquestionnaire Analysis: Activity. Working with robots was difficult per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	56	48	75	45	9	233
AL	M	49	23	34	20	10	136
CU	F	3	6	13	11	5	38
CU	M	3	3	11	11	8	36
ESI	F	57	35	42	9	5	148
ESI	M	78	26	37	19	11	171
PRIA	F	20	16	13	22	12	83
PRIA	M	34	24	49	26	17	150
TU Wien	F	11	10	22	20	9	72
TU Wien	M	6	11	22	10	8	57
UoA	F	10	8	15	9	4	46
UoA	M	5	12	28	20	3	68
Total		**332**	**222**	**361**	**222**	**101**	**1238**

Table 259 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was difficult per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	2.00	3	2.58	3	5
AL	M	1	1.00	2	2.40	3	5
CU	F	1	3.00	3	3.24	4	5
CU	M	1	3.00	4	3.50	4	5
ESI	F	1	1.00	2	2.12	3	5
ESI	M	1	1.00	2	2.18	3	5
PRIA	F	1	2.00	3	2.88	4	5

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Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
PRIA	M	1	2.00	3	2.79	4	5
TU Wien	F	1	2.00	3	3.08	4	5
TU Wien	M	1	2.00	3	3.05	4	5
UoA	F	1	2.00	3	2.76	4	5
UoA	M	1	2.75	3	3.06	4	5

Table 260 Postquestionnaire Analysis: Activity. Working with robots was difficult per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	55	19	46	30	10	160
AL	(10,14]	49	51	63	35	9	207
CU	(6,10]	3	3	6	6	2	20
CU	(10,14]	3	7	19	16	11	56
ESI	(6,10]	121	52	69	23	12	277
ESI	(10,14]	13	9	8	4	4	38
PRIA	(6,10]	26	5	9	4	7	51
PRIA	(10,14]	26	33	50	37	22	168
PRIA	(14,18]	3	1	3	6	0	13
TU Wien	(6,10]	12	11	18	10	6	57
TU Wien	(10,14]	1	6	17	14	4	42
TU Wien	(14,18]	0	1	2	6	3	12
UoA	(6,10]	3	0	1	0	0	4
UoA	(10,14]	9	13	27	18	5	72
UoA	(14,18]	3	8	14	11	2	38
Total		**327**	**219**	**352**	**220**	**97**	**1215**

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Table 261 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was difficult per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	1.00	3	2.51	3.25	5
AL	(10,14]	1	2.00	3	2.54	3.00	5
CU	(6,10]	1	2.00	3	3.05	4.00	5
CU	(10,14]	1	3.00	3	3.45	4.00	5
ESI	(6,10]	1	1.00	2	2.11	3.00	5
ESI	(10,14]	1	1.00	2	2.39	3.00	5
PRIA	(6,10]	1	1.00	1	2.24	3.00	5
PRIA	(10,14]	1	2.00	3	2.98	4.00	5
PRIA	(14,18]	1	2.00	3	2.92	4.00	4
TU Wien	(6,10]	1	2.00	3	2.77	4.00	5
TU Wien	(10,14]	1	3.00	3	3.33	4.00	5
TU Wien	(14,18]	2	3.75	4	3.92	4.25	5
UoA	(6,10]	1	1.00	1	1.50	1.50	3
UoA	(10,14]	1	2.00	3	2.96	4.00	5
UoA	(14,18]	1	2.00	3	3.03	4.00	5

Table 262 Postquestionnaire Analysis: Activity. Working with robots was difficult per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	20	6	22	18	3	69
AL	(6,10]	M	35	13	24	12	7	91
AL	(10,14]	F	36	41	53	27	6	163
AL	(10,14]	M	13	10	10	8	3	44
CU	(6,10]	F	1	2	5	3	0	11
CU	(6,10]	M	2	1	1	3	2	9

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Partner	Age Group	Gender	1	2	3	4	5	Total
CU	(10,14]	F	2	4	8	8	5	27
CU	(10,14]	M	1	2	10	8	6	27
ESI	(6,10]	F	52	31	38	9	5	135
ESI	(6,10]	M	69	21	31	14	7	142
ESI	(10,14]	F	5	4	4	0	0	13
ESI	(10,14]	M	8	5	4	4	4	25
PRIA	(6,10]	F	14	2	3	1	1	21
PRIA	(6,10]	M	12	3	6	3	6	30
PRIA	(10,14]	F	5	14	9	17	11	56
PRIA	(10,14]	M	20	19	41	20	11	111
PRIA	(14,18]	F	1	0	1	4	0	6
PRIA	(14,18]	M	2	1	2	2	0	7
TU Wien	(6,10]	F	7	4	6	9	3	29
TU Wien	(6,10]	M	5	7	12	1	3	28
TU Wien	(10,14]	F	1	5	11	10	2	29
TU Wien	(10,14]	M	0	1	6	4	2	13
TU Wien	(14,18]	F	0	0	1	1	1	3
TU Wien	(14,18]	M	0	1	1	5	2	9
UoA	(6,10]	F	3	0	0	0	0	3
UoA	(6,10]	M	0	0	1	0	0	1
UoA	(10,14]	F	5	6	9	5	2	27
UoA	(10,14]	M	4	7	18	13	3	45
UoA	(14,18]	F	2	2	5	4	2	15
UoA	(14,18]	M	1	5	9	7	0	22
Total			**326**	**217**	**351**	**220**	**97**	**1211**

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Table 263 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was difficult per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	1.00	3.0	2.68	4.00	5
AL	M	(6,10]	1	1.00	2.0	2.37	3.00	5
AL	F	(10,14]	1	2.00	3.0	2.55	3.00	5
AL	M	(10,14]	1	1.00	2.0	2.50	3.25	5
CU	F	(6,10]	1	2.50	3.0	2.91	3.50	4
CU	M	(6,10]	1	2.00	4.0	3.22	4.00	5
CU	F	(10,14]	1	3.00	3.0	3.37	4.00	5
CU	M	(10,14]	1	3.00	4.0	3.59	4.00	5
ESI	F	(6,10]	1	1.00	2.0	2.14	3.00	5
ESI	M	(6,10]	1	1.00	2.0	2.08	3.00	5
ESI	F	(10,14]	1	1.00	2.0	1.92	3.00	3
ESI	M	(10,14]	1	1.00	2.0	2.64	4.00	5
PRIA	F	(6,10]	1	1.00	1.0	1.71	2.00	5
PRIA	M	(6,10]	1	1.00	2.5	2.60	4.00	5
PRIA	F	(10,14]	1	2.00	3.5	3.27	4.00	5
PRIA	M	(10,14]	1	2.00	3.0	2.85	4.00	5
PRIA	F	(14,18]	1	3.25	4.0	3.33	4.00	4
PRIA	M	(14,18]	1	1.50	3.0	2.57	3.50	4
TU Wien	F	(6,10]	1	2.00	3.0	2.90	4.00	5
TU Wien	M	(6,10]	1	2.00	3.0	2.64	3.00	5
TU Wien	F	(10,14]	1	3.00	3.0	3.24	4.00	5
TU Wien	M	(10,14]	2	3.00	3.0	3.54	4.00	5
TU Wien	F	(14,18]	3	3.50	4.0	4.00	4.50	5
TU Wien	M	(14,18]	2	4.00	4.0	3.89	4.00	5
UoA	F	(6,10]	1	1.00	1.0	1.00	1.00	1

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Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
UoA	M	(6,10]	3	3.00	3.0	3.00	3.00	3
UoA	F	(10,14]	1	2.00	3.0	2.74	3.50	5
UoA	M	(10,14]	1	3.00	3.0	3.09	4.00	5
UoA	F	(14,18]	1	2.50	3.0	3.13	4.00	5
UoA	M	(14,18]	1	2.25	3.0	3.00	4.00	4

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9.14.6.6 WORKING WITH ROBOTS WAS FUN

Table 261 reports the frequencies for the question Working with robots was Fun and Table 262 reports the descriptive statistics. As it could be seen, most of the participants selected agree and strongly agree. There are two peaks in the percentage of participants who selected neutral, one in TU Wien (21%) and the other in CU (15%). As it could be seen in Table 263 and Table 264, there is no significant different between genders per partner. As it could be seen in Table 265 and Table 266, there is difference between age groups in CU, PRIA, and TU Wien. Younger age groups considered funnier to work with robots that older groups. As it could be seen in Table 267 and Table 268, there is difference between genders per age group in TU Wien (7-10).

Table 264 Postquestionnaire Analysis: Activity. Working with robots was Fun per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	1	2	3	4	5	Total
AL	4	2	14	49	309	378
CU	0	1	12	27	39	79
ESI	4	1	9	26	285	325
PRIA	3	7	19	60	136	225
TU Wien	4	2	28	29	71	134
UoA	1	1	6	37	72	117
Total	**16**	**14**	**88**	**228**	**912**	**1258**

Table 265 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was Fun per partner. 5 mean strongly agree and 1 strongly disagree.

Partner	Min	1 Q	Median	Average	3 Q	Max
AL	1	5.00	5	4.74	5	5
CU	2	4.00	4	4.32	5	5
ESI	1	5.00	5	4.81	5	5
PRIA	1	4.00	5	4.42	5	5
TU Wien	1	3.25	5	4.20	5	5
UoA	1	4.00	5	4.52	5	5

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Table 266 Postquestionnaire Analysis: Activity. Working with robots was Fun per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	1	2	3	4	5	Total
AL	F	4	1	10	30	194	239
AL	M	0	1	4	19	115	139
CU	F	0	1	7	12	18	38
CU	M	0	0	5	14	20	39
ESI	F	1	0	2	16	132	151
ESI	M	3	1	7	10	153	174
PRIA	F	1	2	7	21	49	80
PRIA	M	2	5	12	39	86	144
TU Wien	F	4	1	14	16	36	71
TU Wien	M	0	1	14	13	35	63
UoA	F	0	0	2	20	23	45
UoA	M	1	1	4	15	49	70
Total		**16**	**14**	**88**	**225**	**910**	**1253**

Table 267 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was Fun per partner and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
AL	F	1	5	5	4.71	5	5
AL	M	2	5	5	4.78	5	5
CU	F	2	4	4	4.24	5	5
CU	M	3	4	5	4.38	5	5
ESI	F	1	5	5	4.84	5	5
ESI	M	1	5	5	4.78	5	5
PRIA	F	1	4	5	4.44	5	5
PRIA	M	1	4	5	4.40	5	5

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Partner	Gender	Min	1 Q	Median	Average	3 Q	Max
TU Wien	F	1	3	5	4.11	5	5
TU Wien	M	2	4	5	4.30	5	5
UoA	F	3	4	5	4.47	5	5
UoA	M	1	4	5	4.57	5	5

Table 268 Postquestionnaire Analysis: Activity. Working with robots was Fun per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	1	2	3	4	5	Total
AL	(6,10]	1	1	3	10	149	164
AL	(10,14]	3	1	11	39	158	212
CU	(6,10]	0	0	1	3	18	22
CU	(10,14]	0	1	11	24	21	57
ESI	(6,10]	4	1	8	22	248	283
ESI	(10,14]	0	0	1	4	33	38
PRIA	(6,10]	0	1	3	7	45	56
PRIA	(10,14]	3	4	15	48	84	154
PRIA	(14,18]	0	1	1	4	7	13
TU Wien	(6,10]	2	1	8	8	43	62
TU Wien	(10,14]	1	0	11	14	16	42
TU Wien	(14,18]	1	1	3	5	2	12
UoA	(6,10]	0	0	0	2	2	4
UoA	(10,14]	1	1	4	16	51	73
UoA	(14,18]	0	0	2	18	18	38
Total		**16**	**13**	**82**	**224**	**895**	**1230**

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Table 269 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was Fun per partner and age group. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	(6,10]	1	5	5.0	4.86	5	5
AL	(10,14]	1	4	5.0	4.64	5	5
CU	(6,10]	3	5	5.0	4.77	5	5
CU	(10,14]	2	4	4.0	4.14	5	5
ESI	(6,10]	1	5	5.0	4.80	5	5
ESI	(10,14]	3	5	5.0	4.84	5	5
PRIA	(6,10]	2	5	5.0	4.71	5	5
PRIA	(10,14]	1	4	5.0	4.34	5	5
PRIA	(14,18]	2	4	5.0	4.31	5	5
TU Wien	(6,10]	1	4	5.0	4.44	5	5
TU Wien	(10,14]	1	3	4.0	4.05	5	5
TU Wien	(14,18]	1	3	4.0	3.50	4	5
UoA	(6,10]	4	4	4.5	4.50	5	5
UoA	(10,14]	1	4	5.0	4.58	5	5
UoA	(14,18]	3	4	4.0	4.42	5	5

Table 270 Postquestionnaire Analysis: Activity. Working with robots was Fun per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Age Group	Gender	1	2	3	4	5	Total
AL	(6,10]	F	1	0	0	2	68	71
AL	(6,10]	M	0	1	3	8	81	93
AL	(10,14]	F	3	1	10	28	125	167
AL	(10,14]	M	0	0	1	11	33	45
CU	(6,10]	F	0	0	1	2	8	11

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Partner	Age Group	Gender	1	2	3	4	5	Total
CU	(6,10]	M	0	0	0	1	10	11
CU	(10,14]	F	0	1	6	10	10	27
CU	(10,14]	M	0	0	5	13	10	28
ESI	(6,10]	F	1	0	2	15	120	138
ESI	(6,10]	M	3	1	6	7	128	145
ESI	(10,14]	F	0	0	0	1	12	13
ESI	(10,14]	M	0	0	1	3	21	25
PRIA	(6,10]	F	0	0	3	0	21	24
PRIA	(6,10]	M	0	1	0	7	24	32
PRIA	(10,14]	F	1	2	4	19	24	50
PRIA	(10,14]	M	2	2	11	29	59	103
PRIA	(14,18]	F	0	0	0	2	4	6
PRIA	(14,18]	M	0	1	1	2	3	7
TU Wien	(6,10]	F	2	1	4	4	17	28
TU Wien	(6,10]	M	0	0	4	4	26	34
TU Wien	(10,14]	F	1	0	7	9	12	29
TU Wien	(10,14]	M	0	0	4	5	4	13
TU Wien	(14,18]	F	1	0	0	2	0	3
TU Wien	(14,18]	M	0	1	3	3	2	9
UoA	(6,10]	F	0	0	0	1	2	3
UoA	(6,10]	M	0	0	0	1	0	1
UoA	(10,14]	F	0	0	2	8	16	26
UoA	(10,14]	M	1	1	2	8	35	47
UoA	(14,18]	F	0	0	0	11	4	15
UoA	(14,18]	M	0	0	2	6	14	22
Total			**16**	**13**	**82**	**222**	**893**	**1226**

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Table 271 Postquestionnaire Analysis: Activity. Descriptive statistics for the question Working with robots was Fun per partner, age group and gender. 5 mean strongly agree and 1 strongly disagree.

Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
AL	F	(6,10]	1	5.00	5	4.92	5.0	5
AL	M	(6,10]	2	5.00	5	4.82	5.0	5
AL	F	(10,14]	1	4.50	5	4.62	5.0	5
AL	M	(10,14]	3	4.00	5	4.71	5.0	5
CU	F	(6,10]	3	4.50	5	4.64	5.0	5
CU	M	(6,10]	4	5.00	5	4.91	5.0	5
CU	F	(10,14]	2	3.50	4	4.07	5.0	5
CU	M	(10,14]	3	4.00	4	4.18	5.0	5
ESI	F	(6,10]	1	5.00	5	4.83	5.0	5
ESI	M	(6,10]	1	5.00	5	4.77	5.0	5
ESI	F	(10,14]	4	5.00	5	4.92	5.0	5
ESI	M	(10,14]	3	5.00	5	4.80	5.0	5
PRIA	F	(6,10]	3	5.00	5	4.75	5.0	5
PRIA	M	(6,10]	2	4.75	5	4.69	5.0	5
PRIA	F	(10,14]	1	4.00	4	4.26	5.0	5
PRIA	M	(10,14]	1	4.00	5	4.37	5.0	5
PRIA	F	(14,18]	4	4.25	5	4.67	5.0	5
PRIA	M	(14,18]	2	3.50	4	4.00	5.0	5
TU Wien	F	(6,10]	1	3.75	5	4.18	5.0	5
TU Wien	M	(6,10]	3	5.00	5	4.65	5.0	5
TU Wien	F	(10,14]	1	3.00	4	4.07	5.0	5
TU Wien	M	(10,14]	3	3.00	4	4.00	5.0	5
TU Wien	F	(14,18]	1	2.50	4	3.00	4.0	4
TU Wien	M	(14,18]	2	3.00	4	3.67	4.0	5

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Partner	Gender	Age Group	Min	1 Q	Median	Average	3 Q	Max
UoA	F	(6,10]	4	4.50	5	4.67	5.0	5
UoA	M	(6,10]	4	4.00	4	4.00	4.0	4
UoA	F	(10,14]	3	4.00	5	4.54	5.0	5
UoA	M	(10,14]	1	4.50	5	4.60	5.0	5
UoA	F	(14,18]	4	4.00	4	4.27	4.5	5
UoA	M	(14,18]	3	4.00	5	4.55	5.0	5

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9.14.6.7 CONCLUSIONS

Most of the participants from all partners selected agree and strongly agree in the question “*the problems we had to solve were interesting*”, “*working with robots was interesting*”, “*the problems we had to solve were fun*”, and “*working with robots was fun*”.

A majority of participants from ESI selected disagree and strongly disagree in the question “*the problems we had to solve were difficult*”. CU is the partner with the opposite result of ESI, therefore a majority of participants selected agree and strongly agree.

Age group 7-10 from AL, CU, PRIA and TU Wien considered the problems funnier than the older groups.

46% of CU’s participants selected agree and strongly agree in the question “*working with robots was difficult”*. 33% of participants from TU Wien considered similarly.

37% of UoA, 34% of TU Wien, 33% of CU and 30% of AL selected neutral in the question “*working with robots was difficult”.*

Younger age groups considered funnier to work with robots that older groups in CU, PRIA and TU Wien.

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9.14.7 Postquestionnaire Analysis: Average Number of Stars

Table 269 reports the number of stars per partner. As it could be observed, ESI has the highest rating with 4.92 while CU the lowest with 4.18. As it could be observed in Table 270, male participants tend to provide higher rating that their counterparts in AL, CU, TU Wien and UoA. The difference between male and female participants in ESI is very small, but there is a tendency of female participants to give a better rating. As it could be observed in Table 271, the youngest age group from AL, CU, PRIA, TU Wien and UoA gave a higher rating than the other two age groups. It is important to notice that participants with age of 6 years old were not counted because they do not belong to any of the age groups established in the proposal. Table 272 reports the average number of stars per workshop.

Table 272 Postquestionnaire Analysis: Average Number of Stars per partner.

Partner	Average
AL	4.38
CU	4.13
ESI	4.92
PRIA	4.30
TU Wien	4.32
UoA	4.61
Grand Total	**4.50**

Table 273 Postquestionnaire Analysis: Average Number of Stars per partner and gender.

Partner	Gender	Total
AL	M	4.42
	F	4.36
CU	M	4.28
	F	4.05
ESI	M	4.91
	F	4.93
PRIA	M	4.22
	F	4.43
TU Wien	M	4.45

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	F	4.22
UoA	M	4.63
	F	4.55
Total		**4.50**

Table 274 Postquestionnaire Analysis: Average Number of Stars per partner and group age.

Partner	Age Group	Total
AL	**7-10**	4.65
	11-14	4.16
CU	**7-10**	4.50
	11-14	3.98
ESI	**7-10**	4.91
	11-14	4.97
PRIA	**7-10**	4.60
	11-14	4.18
	15-18	4.46
TU Wien	**7-10**	4.61
	11-14	3.76
	15-18	3.73
UoA	**7-10**	5.00
	11-14	4.59
	15-18	4.58
Total		**4.49**

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