ROBOTICS WORKSHOPS 2ND YEAR

[Deliverable 2.2]

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ER4STEM - EDUCATIONAL ROBOTICS FOR STEM

The ER4STEM project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 665972

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1 EXECUTIVE SUMMARY

1.1 ROLE, PURPOSE AND OBJECTIVES OF THE DELIVERABLE

The purpose of this deliverable is to inform on the process of WP2 “Educational Robotics Workshops” describing the generic curriculum applied to deliver Educational Robotics Workshops (henceforth: ERW), as well as to present the progress achieved so far along with the quantitative data obtained during the ERWs delivery. The report provides an update on the process, which will be used for further modification and improvement of the ERWs’ curriculum throughout the ER4STEM project lifecycle. Quantitative data in this deliverable is based on the information obtained through the collection of data from the workshop participants, reported through the workshop information forms, provided by each partner.

1.2 CORRELATION TO OTHER ER4STEM DELIVERABLES

Draft descriptions of the ER4STEM framework, the criteria for selecting good practices and the activity plan template were initially presented in D1.1 Best Practice & Requirements. These elements correlate with D1.2 ER4STEM Framework First Structure and Roadmap 2nd Year and D4.1 First Version of the Activity Plans.

The ERWs process takes under consideration D6.2 Evaluation Tool Kit. Likewise, the data from the ERWs and Evaluation process based on D6.2 Evaluation Tool Kit for Evaluation. The data collction process was organized following the data structure defined in D8.1 Data Management Plan. Conclusions in D6.3 Year 1 Evaluation were taken into account when the ERWs implementation process was updated.

The structure of this report follows the already established structure and guidelines in D2.1 Workshop Report 1st Year.

This report provides essential information about the ERWs progress, implementation process and generic curriculum. The generic curriculum and progress indicators are based on the Workshop Information forms and Activity plans as they were presented in July 2017. More details and analysis on the curriculum content represented by specific Activity plans will be provided in D4.2 Operational Release of Activity Plans. Details about ERWs evaluation will be provided in D6.4 Evaluation and Analysis of 2nd Project Year.

1.3 STRUCTURE OF THIS DOCUMENT

Section 2 A GENERIC CURRICULUM FOR EDUCATIONAL ROBOTICS presents the concept of a Generic curriculum. Section 3 Development of a Generic Educational Robotics Curriculum provides sample learning paths and details about how the workshops were implemented and logically, Section 4 ER4STEM Workshops Progress Review represents the current status of the workshops, as well as the quantitative indicators for the progress of ERWs implementation. Section 5

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Conclusion / Outlook provides a summary of the conclusions and the next steps to follow for the ERWs development and continuous improvement.

2 A GENERIC CURRICULUM FOR EDUCATIONAL ROBOTICS

Among the core goals of the ER4STEM project is to, in its end, deliver a generic educational robotics curriculum, functioning as a mediating instrument between several of the work packages working under the project and ensuring the usability of the project's products by a broader community of relevant stakeholders, identified in D1.1, including but not limited to teachers, educators, researchers and academia.

Educational robotics, as a rapidly changing educational domain, is an uneasy subject to structure under a single definition of curriculum. The rationale behind an educational curriculum tends to gravitate towards the demand of skills, knowledge and competences of a society and the importance for a given individual to master those. This poses the need of a generic curriculum to be developed, to ensure the integrity of the approaches presented and their reliability in the context of technological evolvement and changing demand.

Assuming the general definition of curriculum being a general plan for educational activities, Adams and Adams [1] define a curriculum as "***everything that goes in the learners' live such as planned and not planned interaction of pupils with educational objectives, instructional content, materials and resources used and materials and resources not used, the sequence of courses, objective, standards and interpersonal relationships***".

Following this definition, the ER4STEM project correspondingly presents the ERW curriculum in three integrated components: context of generic educational robotics curriculum, content of generic educational robotics curriculum, and generic process for the implementation of the educational robotics activities.

1. Context of a generic educational robotics curriculum

The context of an educational robotics curriculum provides the necessary background information for the integrated organization of educational robotics activities. This component is of paramount importance to the adequate development, implementation and evaluation of the educational robotics activities. The context refers to the Framework of the ER4STEM project, which is being under development in WP1, and further provides a summarized overview of high level, process, indicators and prerequisites for conducting educational robotics activities under this curriculum.

2. Content of the generic educational robotics curriculum

To serve the objective of this generic educational robotics curriculum, as initial content, the activity plans developed from the partners under the ER4STEM project WP4 will be applied. The content of the curriculum will follow, as much as possible, the structure of the activity plans, and apart from information about the exact learning activities, related to the respective activity plan, will provide the necessary context on a meso level for the implementation of the activities, such as the recommended age groups for those activities, the specific learning objectives, space, materials (incl. technological tools, manual, handouts, etc.), social orchestration, teaching and learning procedures

3. Generic process for the implementation of the educational robotics activities.

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The need for such process stemmed out of the necessity to describe to a larger community outside the project the sequence of activities, related to the initiation, preparation, delivery and finalization of a workshop. Major organization steps will be described and broken down into sets of actions, in order to facilitate the transfer of expertise, acquired throughout this project. This process could serve teachers, researchers, educators and academia as a systematic walkthrough of a successful workshop delivery. Finally, but yet importantly, this deliverable will present some aggregated results from the data, obtained throughout the second project year. This would serve the curriculum, at this point of its development of course, as estimated outcomes from its successful implementation and adaptation to a tailored context.

3 DEVELOPMENT OF A GENERIC EDUCATIONAL ROBOTICS CURRICULUM

A generic educational robotics curriculum, as understood by the ER4STEM project, is a product aiming to serve as a mediating artifact between the project framework, as under development in WP1, and the implementation of workshops (WP2), integrating products developed in WP4, in alignment to the evaluation results from the workshops (WP6). A generic curriculum is the combined integrated knowledge about context, content and process as described in the previous chapter.

Furthermore, a generic curriculum will serve the meso and the macro levels of ICT integration in the classroom, as identified by Wang and Woo [2] **- a) *micro level* where integration of ICT involves a specific lesson, aiming to support student learning in specific concepts b) *meso level*: where integration involves a specific topic and c) *macro level* where integration of ICT happens at the level of a course.**

The curriculum developed under the ER4STEM project will fit in the meso and macro levels. Specifically, for **formal education setting, we could focus on the meso level**. We will map, where it is possible, topic-specific learning activities to the curriculum of STE(A)M. **For non-formal settings, ER4STEM will mostly provide a "curriculum" at the macro level, providing a plan for courses focusing on robotics for STEAM and Business.** The concept of curriculum in non-formal learning settings might seem contradictory in the sense that non-formal learning is not structured in a way that includes a unified curriculum, accreditation and syllabus as it is the case in formal education. However, in the case of Educational Robotics we can define a technology-oriented curriculum that can be followed in camps and conferences and/or contests so that the participants gain a set of specific skills and knowledge about robotics.

Within the ER4STEM project, a set of good practices in the field of Educational Robotics was defined during Year 1 and reported in the D1.1. Following an analysis of those practices, a set of principles for a well-structured curriculum could be extracted. Those principles served as a baseline for the development of a generic educational robotics curriculum:

- The generic curricula will be developed using empirical bottom up approach (from the individual elements of the curriculum to the curriculum in its entirety) based on the experience gained by the delivery of the ERWs within the scope of WP2.
- A generic curriculum touches both the meso and the macro levels of ICT integration within a learning setting (the curriculum, developed under the ER4STEM project does not include micro levels).

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- The organization of age groups will follow a three-fold structure, namely, the ER4STEM age groups: 7-10 years old, 11-14 years old and 15-18 years old.
- The generic curriculum will be organized according to the respective educational activity may address for instance in the case of UoA05 (please reference Table 1 and Table 2 for more details), the technology applied is Arduino. Certain technology could include but may not be limited to one or more primary domains, as it is again in the example with UoA05, where the primary domains are technology and engineering.
- The learning activities introduced may be connected to standards and formal curricula, when applicable.
- All activities included in the generic educational robotics curriculum on the meso and macro levels are related to explicit pedagogical backgrounds.
- The learning objectives of the different activities are divided into subject related objectives, technology use related objectives, social and action related objectives and argumentation and fostering of maker culture objectives.

For the purposes of this generic educational robotics curriculum, we will start from the improved activity plans already created by the ER4STEM project partners and applied during the second year of the project. In the following year, we will refine this curriculum based on the evaluation of the workshops and oriented towards unifying the activity plans under an overarching pedagogical approach that takes into account the affordances and the special characteristics of robotics as a scientific field and as a domain for contextualized STE(A)M learning.

3.1 CURRICULUM: CONTEXT

Regardless of all similarities and common elements that the educational robotics learning activities might share, components of those activities might appear fragmented, especially due to the multidisciplinary nature of the field of robotics. Thusly, the need of a framework, effectively making evident the relations between seemingly distant activities, is required. The framework behind the pedagogical approaches applied, or the targeted and estimated outcomes in terms of 21st century skills cultivation, is in fact a wholesome but yet complex structure with the goal to provide generic guidelines on how to create, implement, sustain and evaluate successful educational robotics activities. (For more information, please refer to D1.2).

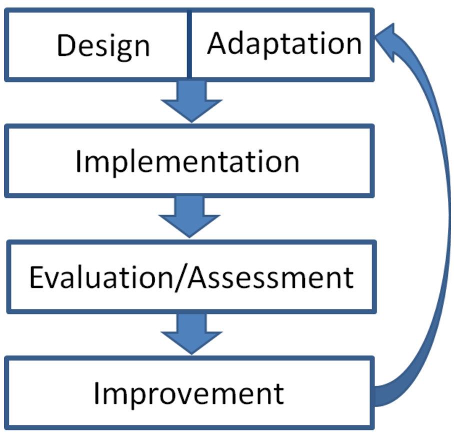

Figure 1 Framework's macro process definition

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On a macro level the context underlying the delivery of any educational robotics activities, consists of four main macro steps (Figure 1): design or adaptation, implementation, evaluation or assessment, and improvement. This aims to suggest that all activities presented could be adapted to fit a certain context, be it pedagogical, logistical or technological. The framework behind the ER4STEM project will also aim to guide teachers, researchers and educators towards a generic process for developing and structuring their own educational robotics activity or curriculum. The first phase is divided in two possible steps, which represents the possibility to design an activity from scratch or adapt one from other existing activities. The second phase is implementation, which mainly focuses on considerations involving the settings and the context in which the activity is going to take place. The third phase provides instruments and procedures for evaluating the implementation in order to address the need for possible improvements. The fourth and last phase focuses on possible improvements of the activity plan based on information derived from the implementation in real settings, reflections from the teachers, students and the designers. Once the activity has been improved, the cycle should be continuing with the adaptation of the activity for future groups.

All of the above-mentioned levels, along with the processes relevant to each level, are supported by a glossary and a skills tree, which are presented in detail in WP1. The aim of both the glossary and the skills three is to establish a common language between and align relevant stakeholders to the context of the ER4STEM project in general. The skills tree serves to provide an interconnected representation to the skills, targeted by the educational robotics activities.

The framework developed by WP1 should be applied along and prior to the generic educational robotics curriculum, in order to serve as a baseline for the design or adaptation of educational robotics activities. It will furthermore, explain the common ground and the interconnectivity behind the educational content addressed by the activity plans (for detailed information on the content and the activity plans, please refer to WP4 Pedagogical Activities).

Last but not least, within the framework, a general understanding of 21st century skills and what they stand for is crucial. The P21 Partnership has developed a framework known as "The Framework for 21st Century Learning"[1], one of the most important definitions of the 21st century learning skills. The framework is a blend of knowledge, skills, expertise and literacies that 21st century students must master in order to succeed in 21st century work and life. Other recognized 21st century learning skills include the "ISTE Educational Technology Standards" which is a set of standards published by the International Society for Technology in Education (ISTE) to leverage the use of technology in K-12 education[2], the "7 survival skills" by Tony Wagner who identifies the most important skills needed for today's workspace[3], as well as the "enGauge® 21st Century Skills: Literacy in the Digital Age" report[4], issued by the North Central Regional Educational Laboratory and the Metiri Group. Below is a list of the skills that we aim to cultivate through the ER4STEM project, based on the above researches for the 21st century skills[5]:

1 http://www.p21.org/our-work/p21-framework
2 http://www.iste.org/standards/standards/for-students-2016
3 http://www.tonywagner.com/7-survival-skills
4 http://pict.sdsu.edu/engauge21st.pdf
5 This initial definition of the 21st century skills was developed and adopted by ER4STEM partners after the "Y1 Evaluaiton and Y2Roadmap" meeting in Malta in September 2016.

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- *Creativity*: By "creativity skill", we mean the ability to think creatively, which includes: a) constructing and generating new and useful ideas b) using a variety of techniques to create these ideas c) coming up with innovative, unique or imaginative solutions to problems d) implementing the creative ideas in tangible artefacts.
- *Communication*: Students must be able to communicate with others effectively. This includes the ability to a) articulate thoughts and ideas effectively using oral, written or nonverbal communication skills b) communicate complex ideas clearly and effectively c) publish or present content that customizes the message and medium for their intended audience d) utilize multiple media and technologies in order to communicate and know how to judge their effectiveness e) communicate effectively in diverse environments.
- *Collaboration*: Students must be able to work effectively and respectfully with others. More specifically to a) contribute constructively to project teams; b) be helpful and make necessary compromises to accomplish a common goal; c) assume shared responsibility and value the individual contributions when working in a team and d) use collaborative technologies to connect and work with others (i.e. peers, experts or community members etc.) globally.
- *Critical Thinking*: More specifically to be able to a) use various types of reasoning depending on the situation b) analyze and evaluate major alternative points of views c) synthesize and make connections between information and arguments d) Interpret information and draw conclusions based on the best analysis e) reflect critically on learning experiences and processes.
- *Problem solving*: This includes a) to solve different kind of problems in both conventional and innovative ways; b)to devise effective solutions to real-world problems; c) to identify and ask significant questions that clarify various points of views and lead to better solutions
- *Information literacy*: This skill refers to a) accessing information efficiently and effectively and evaluate this information critically and b) use and manage the digital information.
- *Digital fluency*: It refers to the technological knowledge of the students. Thus, it includes the ability to understand the fundamental concepts of technology operations and to know how to use digital technology and media as tools to research, organize, evaluate and communicate information.
- Be a digital citizen: apart from knowing how to use, the new technology and media students must use it in appropriate ways. In order to become "digital citizens" they should be able to a) engage in positive, safe, legal and ethical behavior when using technology; b) have a fundamental understanding of the ethical/legal issues surrounding the access and use of information technologies (their rights and their obligations); c) manage their personal data to maintain digital privacy and personal security and d) be aware of the permanence and the results of their actions in the digital world.
- *Computational Thinking (CT)*: CT involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science. More specifically some skills related to CT are to be able to a) break problems into component parts, extract key information, develop models to understand complex systems b) use algorithmic thinking to develop a sequence of steps to create and test solutions d) understand basic computational concepts that can be transferred to programming or not programming concepts such as conditionals, data handling, events, sequences etc. e) be able to make abstraction and create patterns.

▪ Life/career skills

- *Flexibility and adaptability:* a) being flexible refers to incorporate feedback effectively, understand, negotiate and balance diverse views and beliefs to reach workable solutions. b) Adapt to change refers to be able to adapt to varied roles, schedules and contexts.

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- *Leadership and responsibility:* a) use interpersonal and problem-solving skills to influence and guide others toward a common goal, b) leverage strengths of others to accomplish a common goal c) inspire others to reach their very best d) demonstrating integrity and ethical behavior in using influence and power e) act responsibly with the interests of the larger community in mind
- *Global and cultural awareness:* a) use the 21st century skills to understand and address global issues b) Learning from and collaborate with individuals representing diverse cultures, religions and lifestyles in a spirit of mutual respect and open dialogue c) understand other nations and cultures
- *Initiative and entrepreneurship:* This includes a) goals and time management; b) monitor, define, prioritize and complete tasks without direct oversight; c) demonstration of initiative to advance skill levels towards a professional level and d) going beyond basic mastery of skills or curriculum to explore and expand one's own learning and opportunities to gain expertise.

3.2 CURRICULUM: CONTENT

During the adaptation or the conceptual design of an educational robotics activity, the current contextual background of the ER4STEM might be applied as reference or as a guideline on choosing suitable activity, based on ER4STEM project partners' experience.

The rationale behind the generic educational robotics curriculum frame, presented below, is multi-layered. On the one hand, as it organizes the activity plans developed by the project partners in a brief but yet structured way – e.g. by age group, targeted domains, etc., which enables it to serve as a table of contents for the activity plans. On the other hand, it will allow pedagogues, teachers and other relevant stakeholders, who are unfamiliar with the project's content, to construct an educational robotics curriculum on a higher level, based on their needs.

With this generic educational robotics frame, we want to assist teachers in adapting a learning path, consisting of a set of educational robotics activities, that are suitable for their students, based on specific objectives, prior knowledge requirements and the student's interests, strengths and even weaknesses, age and abilities. The idea we want to put forward with this generic educational robotics curriculum is that of an individual approach to every class or group of students. This resonates with the idea that the ER4STEM project aims to target all students – not only those who already have experience or are already passionate about robotics. We want to offer educational robotics as a tool for learning to every student, regardless of age, ability and prior knowledge.

In order to target the students with no prior experience or established motivation in robotics whatsoever, this generic curriculum applies the concept of entry points. As a general entry point, we consider educational robotics activities that do not require any prior knowledge (marked below in green). This allows a student with no prior experience in the field to enter at multiple levels, working with different technologies, and targeting a variety of domains. After completing an entry point activity, a student might continue, based on their interest, their journey in robotics following different activities, based on their interests and/or specific objectives.

An educational path build under the generic curriculum, could be based on:

- Specific robotics set/s or programing language/s;
- A single domain of interest within the STE(A)M fields, for instance mathematics;
- A requirement to cover all domains in STE(A)M, through a series of trainings;
- Specific age or skills group and others;

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While providing this generic educational curriculum, we still consider it of utmost importance for teachers, pedagogues and researchers while following a curriculum path to adapt the activity plans to their context and thus design their own, separate curriculum.

As motivation and the targeted outcomes in terms of 21st century skills fostering may vary between countries, schools and even classrooms, we believe that tutor's judgement and intuition about their classroom's needs is of high importance for the success of the workshops.

The cultural background and social status characteristics are based upon what worked in the ER4STEM partners' instance and has to be taken under consideration by the tutor. This corresponds to the necessity of tailoring the duration and schedules of the educational robotics workshops to the learning pace of the class – along with the fact that not all students would share the same level of ability, which might affect the choice of workshops or the grouping criteria, for example. All this being said, the generic curriculum, as intended by the ER4STEM project is based and structured upon 4 principles, that further clarify the curriculum as it was described in Chapter 3 "DEVELOPMENT OF A GENERIC EDUCATIONAL ROBOTICS CURRICULUM" and that should be considered altogether in the instance of application.

1. Context: WP1 Framework - the Framework of the ER4STEM project contains the valuable context information, presented in detail. Furthermore, the Framework consists of glossaries, taxonomies, skills trees, etc. which are of paramount importance for the design or adaptation of an educational robotics curriculum, based on the ER4STEM principles.
2. Content: WP4 Pedagogical Activities and WP6 Evaluation – those work package presents the elements of the curriculum – activity plans, and the mechanisms to monitor and assess their impact, effectiveness, success and provide for father research purposes – the evaluation protocol and evaluation kits. An important topic, presented by those two work packages is the variety of pedagogical approaches, followed by the ER4STEM project partners in their workshops and represents an approach to a more holistic education, combining different pedagogical approaches and activities to reach ambitious outcomes.
3. Relationships between the elements of the content: The possible learning paths are a curriculum property which will be further elaborated in year 3 of the ER4STEM project, which will present certain relationships between the activity plans contained in the curriculum. The learning paths are intended to be only presented as an opportunity in the generic educational robotics curriculum. The idea behind the flexible learning paths is for relevant stakeholders, such as teachers, educators and researchers to be able to modify, shape and fit them to suit their context.
4. Process: The process, presented in the "Curricula: Process of ERWS Implementation (Delivery)" section of this deliverable contained the principle of organization behind the generic curriculum and is intended as a walkthrough and an accurate representation of the ER4STEM project partners' experience, which led to achieving the results, presented in "Quantitative Data from ER Workshops Performed by ER4STEM Partners". It is of course recommended for teachers to adapt this process if needed, in order to fit to the context of the process application.

In the curriculum frame, presented below in Table 2, those principles are applied and will be further developed in year 3 in order to make the relationships between the elements clearer and more flexible. Furthermore, in year 3, the content of this generic curriculum frame will be enriched with the improvement of the activity plans and the development of new such activity plans. Finally, yet

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importantly, table 1 will present the relationships between the activity plans, which are part of the curriculum frame presented, and the activity plans codes, assigned for the purposes of the curriculum.

Table 1 A reference table of activity plans code and activity plans names as applied in this curriculum

Code	Activity plan name
AL01	AL_Elementary_ActivityPlanTemplateV02
AL02	Secondary APJune2017-AL (1)
CU01	MaryMac1_SLurtleOrientation
CU02	NEWTSS1_SLurtleOrientation_Shapes
CU03	OakField1_SLurtleOrientation_Shapes
ESICEE01	ER4STEM-ESICEE-Activity-Plan-Educational-Robotics-for-Creativity-with-esItank-v1
ESICEE02	ER4STEM-ESICEE-Activity-Plan-Visualizing-Mathematics-With-The-Mathbot-v1
PRIA01	PRIA_20161124_ActivityPlan_Beebot_LEGOMindstorms_ElementarySchool
PRIA02	PRIA_20170127_ActivityPlan_LEGOMindstorms_Middleschool
PRIA03	PRIA_20170130_ActivityPlan_Hedgehog
TUWien01	TUWien-ActivityPlan Robot_video_elementary
TUWien02	TUWien-ActivityPlan Robot_video_upperclass
UoA01	UoA421_ActivityPlan_6thPrimarySchoolOfKArditsa_v04
UoA02	UoA427_a_ActivityPlanTemplateV02
UoA03	UoA426_ActivityPlanTemplateV02
UoA04	UoA425_ActivityPlanTemplateV02
UoA05	UoA424a_b_ActivityPlanTemplateV02-ionidios
UoA06	UoA422_ActivityPlanTemplateV02
UoA07	UoA423_a_ActivityPlanTemplateV02

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Table 2 ER4STEM activity plans represented as generic curricula elements

Ppartner Activity Plan Code	Suitable for ER4STEM Age Group			Prior knowledge required	Out of school	Robot	Programming language	Duration in hours	Science	Technology	Engineering	Math	Business	Arts	Objectives: Technology use	Objectives: Social & action	Objectives: Argumentation and fostering of maker culture
	7-10	11-14	15-18														
AL01		y		**No ->**		Dash and Dot	Drag and Drop Visuals	8		10		10			Using remote control and Drag and Drop visuals	Develop collaborative skills, learn how to take turns and listen to each other, reach a compromise and decision etc.	Groups were encouraged to make the robot intelligent and to work at any point in time and not only once. They were encouraged to test before they tell the tutors that their work was ready.
AL02	y			Knowledge of Scratch language is desirable, possibly Lego Mindstorms.		Dash and Dot	Drag and Drop Visuals	8		10		10			Drag and drop visuals	Develop collaborative skills, learn how to take turns and listen to each other, reach a compromise and decision etc.	Groups were encouraged to make the robot intelligent and to work at any point in time and not only once. They were encouraged to test before they tell the tutors that their work was ready.
CU01		y		**No ->**		SLurtles	Scratch	6		10		3			Develop an understanding of what a virtual world is, how to move and interact within it.	Develop an awareness of how to communicate with others in a virtual world.	Application of mathematical knowledge to solve problems.
CU02		y		Properties of 2D and 3D shapes; programming in Scratch;		SLurtles	Scratch	5		7		7			Develop an understanding of what a virtual world is, how to move and interact within it.	Develop written communication skills.	Application of mathematical knowledge to solve problems.

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Ppartner Activity Plan Code	Suitable for ER4STEM Age Group			Prior knowledge required	Out of school	Robot	Programming language	Duration in hours	Science	Technology	Engineering	Math	Business	Arts	Objectives: Technology use	Objectives: Social & action	Objectives: Argumentation and fostering of maker culture
	7-10	11-14	15-18														
CU03		y		Y3 Mathematics (UK curriculum), Recursion in Scratch. Good ability for reading and writing instructions; creating flow diagrams.		SLurtles	Scratch	8		7		5			Develop an understanding of what a virtual world is, how to move and interact within it.	Develop written communication skills.	Application of mathematical knowledge to solve problems.
ESICEE01	y	y		**No ->**	**Y**	Arduino	Scratch	8	5	10	10				Arduino custom robotics kit.	Creativity and Collaboration (ER4STEM accepted definition)	Communication (ER4STEM accepted definition)
ESICEE02	y	y		Assumed third grade (Bulgarian education system) mathematics knowledge. Basic command of Scratch is a recommendation but not an obligation.		The Finch robot	Scratch	8		5		10			Programming The Finch robot developed by Birdbrain Technologies with the visual programming software Scratch.	Problem solving, effective communication, flexibility and adaptability. Foster collaboration and argumentation skills.	Formulating and expressing ideas, encourage curiosity, tinkering and experimentation, Identifying and solving problems as well as decision-making. Stimulate proportional thinking and proportional reasoning and exercise logical thinking;
PRIA01	y			**No ->**	**Y**	BeeBots & LEGO Mindstorms	LEGO EV3	9		10	6			2	Programming the Beebots, programming with Lego Mindstorms EV3 programming environment	Develop collaborative skills, take different roles within groups	Class discussion

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Ppartner Activity Plan Code	Suitable for ER4STEM Age Group			Prior knowledge required	Out of school	Robot	Programming language	Duration in hours	Science	Technology	Engineering	Math	Business	Arts	Objectives: Technology use	Objectives: Social & action	Objectives: Argumentation and fostering of maker culture
	7-10	11-14	15-18														
PRIA02	y	y		**No ->**	**Y**	LEGO Mindstorms	LEGO EV3	6 h on block	2	10	6				Programming with LEGO Mindstorms EV3.	Develop collaborative skills, take different roles within groups, fostering of presentation skills	Class discussion
PRIA03	y	y	y	Basic English understanding for Python programming	Y	Hedgehog	Python	8 h on block	2	10	6				Programming with Hedgehog Programming Environment	Develop collaborative skills, take different roles within groups, fostering of presentation skills	Class discussion
TUWien01	y	y		**No ->**		Thymio	Aseba VPL	6		2	6		5	4	Making the video with a given amount of time and resources	School classes are split up into groups. Each group has its own area of responsibility (design, programming etc.).	
TUWien02		y	y	Thymio fundamentals		Thymio	Aseba Blockly and Textual	6		10	6		5	4	Making the video with a given amount of time and resources	School classes are split up into groups. Each group has its own area of responsibility (design, programming etc.).	

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Ppartner Activity Plan Code	Suitable for ER4STEM Age Group			Prior knowledge required	Out of school	Robot	Programming language	Duration in hours	Science	Technology	Engineering	Math	Business	Arts	Objectives: Technology use	Objectives: Social & action	Objectives: Argumentation and fostering of maker culture
	7-10	11-14	15-18														
UoA01	y	y		Basics of Scratch programming		LEGO WeDo	Scratch	9	7	8	10	2		2	a) LEGO WeDo 2.0. kit b) Programming in scratch environment	Develop collaborative skills, take roles within groups, solve practical problems as a team, and communicate with other groups to exchange ideas and tips.	Practice making conjectures about how the robot will react based on the program given.
UoA02		y	y	**No ->**	**Y**	LEGO NXT	LEGO Programming environment	8		10	5	7			Programming with LEGO NXT in LEGO programming environment	Develop collaborative skills, take roles within groups, communicate with other groups to exchange ideas and tips, compare strategies and artefacts	Students make and test hypotheses in practice about the robot actions based on their own program, make assumptions, test possible solutions, trying to develop their strategy in order to achieve the best solution.
UoA03			y	Basic command of EV3 and knowledge of programming concepts.	Y	LEGO Mindstorms	LEGO EV3	8		10	6				Programming LEGO in LEGO programming environment	Develop collaborative skills, take roles within groups, communicate with other groups to exchange ideas and tips, compare strategies and artefacts	Students make and test hypotheses in practice about the robot actions based on their own program, make assumptions, test possible solutions, trying to develop their strategy in order to achieve the best solution.

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Ppartner Activity Plan Code	**Suitable for ER4STEM Age Group**			**Prior knowledge required**	**Out of school**	**Robot**	**Programming language**	**Duration in hours**	**Science**	**Technology**	**Engineering**	**Math**	**Business**	**Arts**	**Objectives: Technology use**	**Objectives: Social & action**	**Objectives: Argumentation and fostering of maker culture**
	7-10	**11-14**	**15-18**														
UoA04			y	Yes	Y	LEGO Mindstorms	LEGO EV3	6	4	8	10				Programming LEGO in LEGO programming environment	Develop collaborative skills, take roles within groups, communicate with other groups to exchange ideas and tips, advice, analysis and synthesis of solutions	test possible solutions, choose the best solution, communicate with other “makers”, collaborate with others “makers”, decision taking, brainstorming
UoA05		y	y	Little knowledge of Arduino and electronic parts (resistances, led). Good knowledge of programming concepts (like if-then concepts) in Scratch environment.		Arduino Uno based robotic insect	C	6		10	10				Design with Arduino Uno board, a mini breadboard, some electronic parts (resistances, led, sonar sensor, piezo, servo motor) and programming with open-source Arduino Software (IDE)	Improve collaborative skills, exchange ideas, take roles within groups	Identifying an authentic problem, make assumptions, test possible solutions, choose the best solution
UoA06		y		Yes	Y	LEGO WeDo	LEGO WeDo Graphical Language	8		10	8				LEGO EV3 programming environment	Develop collaborative skills, shift roles, communication and exchange of ideas and tips, advice, analysis and	Test possible solutions, choose the best solution, communicate with other “makers”, collaborate with others “makers”, decision taking, brainstorming

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Ppartner Activity Plan Code	Suitable for ER4STEM Age Group			Prior knowledge required	Out of school	Robot	Programming language	Duration in hours	Science	Technology	Engineering	Math	Business	Arts	Objectives: Technology use	Objectives: Social & action	Objectives: Argumentation and fostering of maker culture
	7-10	11-14	15-18														
																synthesis of solutions	
UoA07		y		**No ->**	**Y**	LEGO Mindstorms	LEGO Mindstorms	7.5		10	7	3			Programming in LEGO programming environment, assembling LEGO sensors and motors	Taking and exchanging roles in a group. Communicate with other groups to find solutions	Identifying an authentic problem, make assumptions, test possible solutions choose the best solution, communicate with other “makers”.

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This curriculum frame is intended for an end user to apply as a tool, for creating customized learning paths, in order to fit to the context of application. To illustrate the concept of learning paths, which will be further elaborated throughout year 3 of the project; three sample learning paths are summarized below.

1. A teacher wants to design an Arduino-based curriculum. A good entry point considering this goal would be ESICEE01, as it involves Arduino programming and still requires no prior knowledge. As UoA05 requires a certain experience – knowledge of the elements of a robot, at least, it will be a good way to continue to deepen the understanding of the Arduino technology. Those two workshops provide a good technological understanding and aim to develop the creativity skills necessary to find innovative solutions to problems. They will also deepen the engineering understanding of the students and will allow for them to work on more complex engineering tasks. The workshops further develop communication and collaboration skills and both involve teamwork. Following those two workshops, students might decide to continue with PRIA03, which will further deepen their understanding on ICT and programming in particular and will broaden student's horizons, related to technology, which goes beyond hardware. In order to compliment the knowledge already gained with stronger focus on mathematics, and namely proportional reasoning, students might continue with CU03.

   ESICEE01 → UoA05 → PRIA03 → CU03

2. A group of students has an already established interest in STEM and would like to enroll in an extra-curricular robotics activity, targeting the STEM domains, but have no prior experience in robotics and they ask their teacher for advice. In order to begin their learning path, their teacher advises them to choose as an entry point PRIA02, which will give them the programming and the technological background to further work with robotics. In order to work on their problem solving skills and exercise the fundamentals of programming, the teacher might recommend ESICEE02, which will also allow them to connect the world of robotics and programming, to real mathematical problems, thus making them aware of the concept of problem solving in robotics and creativity in terms of solution. Once a programming base and a hardware awareness are established, students may continue with PRIA03 to deepen their understanding of technology and mainly programming. This way, students will become more familiar with the STEM representation in educational robotics, thus making it a good opportunity to enroll in an engineering-oriented workshop, such as UoA05 and formulate a very good technological grip of robotics. This way, students are expected to reach good outcomes in terms of their creativity, teamwork abilities, digital fluency, computational thinking and adaptability. This very diverse and exciting learning path is expected to motivate students with different skills and abilities and motivate them to learn more about STEM. This tailored curriculum can also be applied as an after-school-hours, in order to compliment the formal school curriculum.

   PRIA02 → ESICEE02 → PRIA03 → UoA05

3. A public school wants to organize extra-curricular activities with educational robotics in order to maintain students' engagement in the education process, but still deepen their STEM understanding. Last but not least, they have limited physical space, but still want to teach

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students the basics of programming. An excellent entry point in such case could be TUWien01, which targets multiple domains, without requiring extensive programming background. With this workshop, students will not only exercise their creative talents and business skills, but will also get familiar with the foundations of programming and apply an interdisciplinary approach, challenging students to be fully engaged with the process, and making it possible for every student to contribute. To deepen the students understanding about programming and still provide them with the chance to exercise valuable concepts from the mathematics educational curriculum, teachers or other educators and decision-makers might choose to continue with SLurtles following the CU01 activity plan. This way, students will exercise their proportional and computational thinking, along with the problem-solving and teamwork skills. Following this, to continue with Thymio, TUWien02 will be a good continuation of the learning path. This will allow students to exercise, and thus make sustainable the lessons learned and the objectives in terms of 21st century skills fostering. A good end stop to this educational curriculum would be AL02, which will further allow for work on the collaborative skills on the students and will present a nice diversity of technology applied. This workshop will also touch mathematical concepts, so it would nicely compliment the formal school curricula, but will further allow students to have a positive reinforcement of their motivation to study STEM.

TUWien01 → CU01 → TUWien02 → AL02

Following these examples, the generic educational robotics curriculum is intended to offer an opportunity for teachers, educators, pedagogues along with the students themselves, to create individual learning paths. It is important, however to note that all those specific plans make for a curriculum on a generic level. After a path of learning activities is established, teachers, researchers or other relevant stakeholders might choose to further browse through the specific ERW activity plans of which this path consists and design or adapt this learning curve as a separate and elaborated in specific curriculum.

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3.3 CURRICULUM: PROCESS OF ERWS IMPLEMENTATION (DELIVERY)

While the PEDAGOGICAL ACTIVITIES PROCESS described in D 1.2 FRAMEWORK (Chapter 5, pp 24 -25) informs on the Process of ERWS Implementation (Delivery), the scope of the Process of ERWS Implementation (Delivery) is limited to the adaptation and delivery of the workshops and does not cover ERW pedagogical design, which is a subject of WP4.

Description and support of the ERW implementation process aims to provide a clear picture to researchers and teachers on the key steps that were planned and executed within the second year of the project implementation. From a research perspective, the process complements the evaluation data received from the workshops with detailed information on how this data was generated through the ERWs execution. This section of the report represents the process as it was implemented within the second year of the project.

The process description is continuously updated based on the experience gained and serves as a reference during the remaining implementation phases of the project and therefore, for any stakeholders that might be interested in the application of the Activity Plans and similarly, to deliver the ERWs designed and elaborated on within the ER4STEM project.

The ERW process contains four phases, namely Initiation, Preparation, Execution, and Closure that are visually represented within the process scheme as horizontal lines (see The ERW Implementation process, presented in Figure 2 ERW Implementation Process starts with an Initiation phase. At this stage, the major objective is to make aware all relevant stakeholders and to establish the generic learning objectives on a contextual level. Once the stakeholders are committed to the ERW, we enter in Preparation phase in which an individual curriculum is tailored from the ER4STEM generic curricula and the content of the curriculum is documented in Activity plan aligned to the stated learning objectives. Commitment from all ERW stakeholders is obtained and the ERW is prepared in terms of space, team, materials and evaluation (see 0 Prepare for ERW Delivery Sub-process).

Within the next phase, an ERW is delivered, while the team is performing continuous evaluation (see 0 Deliver ERW Sub-process). The process ends with an analysis and this way, the evaluation results enter the next cycle in order to improve the future educational robotics workshops.

Figure 2 ERW Implementation ProcessThose phases follow the basic content structure on a macro level of the ER4STEM project framework, and namely level two – implementation and level four – improvement (where the process gives evaluation guidelines, crucial for the improvement of the workshop, regardless of research purposes). The “Prepare ERW delivery” and “Deliver ERW” steps are presented in more details as sub-processes. Each process step contains overall the following properties:

- *Entry criteria*: criteria which determines when the respective step can be started.
- *Inputs*: materials, results from other steps and other items that are needed for the proper execution of the corresponding steps.
- *Outputs*: results, produced during the corresponding steps.
- *Exit criteria*: criteria, which determines whether the respective step could be considered completed.

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The process description included in this report incorporates changes and improvements made throughout Y2 and serves as an updated version of the process already published in D2.1 in Y2. Although the updates do not change the process's structure, they reflect on two very important issues 1) the need for closer cooperation with teachers/tutors for the workshops and educational materials' organization and preparation and 2) alignment of the workshops content to the curricula of other disciplines, included but not limited to since, technology, engineering and mathematics domains.

Other important changes were associated with the related artefacts and methods. More specifically the changes were:

- In Y2, a new improved version of the Workshops Activity Plans was used. This version of the activity plans provided more explicit links to the targeted skills and recommendations and how they can be addressed by the incorporated activity blocks. The activity plans used in Y2 will be described in details in D4.2 Operational Release of Activity Plans. The generic educational robotics curriculum framework, presented in this deliverable is built upon and follows the activity plans' structure from year 2.
- In Y2, improvements in the evaluation method and tools were introduced. Those improvements are described in further detail in D6.4 Evaluation and Analysis of 2nd Project Year.

ERW Implementation Process Description

The ERW Implementation process, presented in Figure 2 ERW Implementation Process starts with an Initiation phase. At this stage, the major objective is to make aware all relevant stakeholders and to establish the generic learning objectives on a contextual level. Once the stakeholders are committed to the ERW, we enter in Preparation phase in which an individual curriculum is tailored from the ER4STEM generic curricula and the content of the curriculum is documented in Activity plan aligned to the stated learning objectives. Commitment from all ERW stakeholders is obtained and the ERW is prepared in terms of space, team, materials and evaluation (see 0 Prepare for ERW Delivery Sub-process).

Within the next phase, an ERW is delivered, while the team is performing continuous evaluation (see 0 Deliver ERW Sub-process). The process ends with an analysis and this way, the evaluation results enter the next cycle in order to improve the future educational robotics workshops.

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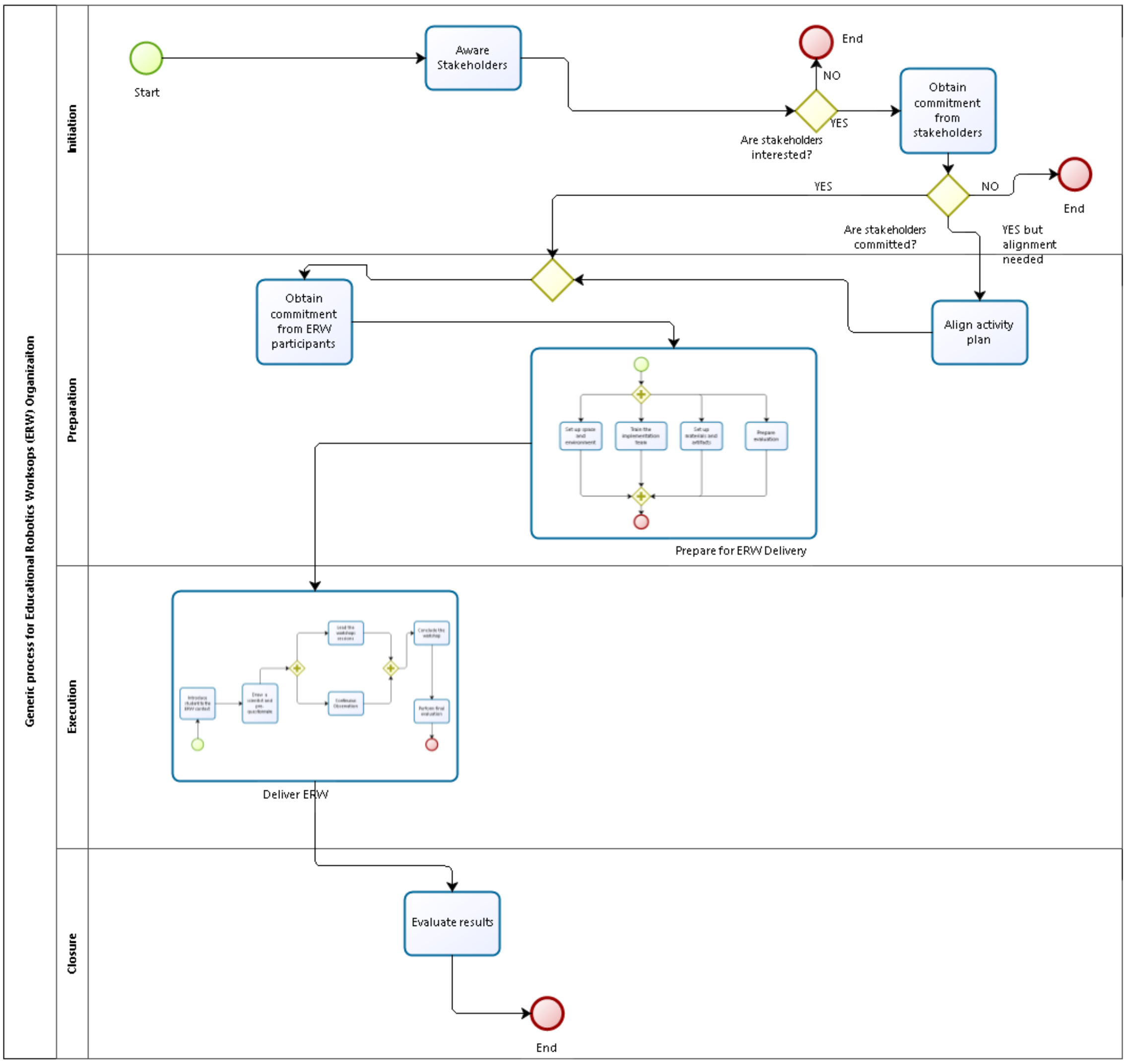
Figure 2 ERW Implementation Process



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PROCESS ELEMENTS

INITIATION PHASE

AWARE STAKEHOLDERS

Description

A representative/representatives of the Implementation Team takes actions for raising awareness within the target groups about the benefits of integrating ER in the educational process. One or several awareness activities could be performed within this step:

- Distribution of awareness materials via electronic channels such as e-mail, social media, broadcasting.
- Consultations with teachers on specific subjects related to science, technology, engineering and mathematics, how their disciplines can be supported through educational robotics.
- Close cooperation with teachers and educators, if possible, in order to tailor the educational content presented in the workshop, to the student's needs. This means putting stronger focus on some concepts included already in the activity plans or the formulation of an entirely new activity plan and educational content.
- Participation in different educational events, such as workshops, conferences, meetings and others.
- Direct meetings with relevant stakeholders.
- Others.

Entry criteria

ERW is designed and prepared

Inputs

- Information and demonstration materials - video, printed materials, multimedia presentations, robots or robotic kits ready for demonstration, analysed data from previously implemented ERWs.
- Curricula of the targeted disciplines related to science, technology, engineering and mathematics.
- References from teachers, including material already covered throughout the school year in the official school curricula.
- Representatives from implementation team to be involved in this process are selected and the relevant materials are provided. Target groups are identified, as well as relevant educational events.

Outputs

- A list of relevant stakeholders, who are interested in participating in ERWs.
- Analysis how the ERWs correspond to the curricula related to other disciplines related to science, technology, engineering and mathematics.

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- General requirements about the implementation of ERW communicated to the interested parties.

Exit criteria

Stakeholders are interested in participating in and contributing to ERWs.

ARE STAKEHOLDERS INTERESTED?

Gates

- **NO**
- **YES**

OBTAIN COMMITMENT FROM STAKEHOLDERS

Description

Representatives of the Implementation Team meet decision makers from the organization that will host/ organize the ERWs. Both parties discuss and agree on important aspects of the ERW delivery such as:

- ERW objectives and expected results related to the targeted discipline and curricula.
- Space and student's info.
- Technical requirements and necessary equipment.
- Content of written consent forms and evaluation procedure.

Entry criteria

The relevant stakeholder is interested to organize/contribute to an ERW, which is aligned with the general curricula of other disciplines elated to science, technology, engineering and mathematics.

Inputs

- ERW Activity plan;
- Written consent forms for parents, students and school;
- Information/ demonstration materials and presentations.

Outputs

- Alignment of the ERW Activity Plan to the specific objectives and curricula.
- Alignment of Written Consent Forms, if needed.
- Official agreement between implementation organization and hosting organization (if necessary).
- List of participants.
- Signed consent forms from parents, students and educational organization.

Exit criteria

Commitment to organize/contribute to the ERWs.

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ARE STAKEHOLDERS COMMITTED?

Gates

YES, but alignment needed

YES

NO

PREPARATION PHASE

ALIGN ACTIVITY PLAN

Description

The Implementation Team aligns, if possible and necessary, the ERW Activity Plan and/or Written Consent Forms to the needs and requirements of the stated objectives, curricula of other disciplines related to science, technology, engineering and mathematics or teachers' requirements. The needs and requirements may include:

- Specific educational objectives. For instance, objectives might need to be changed because students are already advanced in some of the topics covered by ERW or in case that the curricula on other disciplines require additional topics to be included in the workshop in order to meet educational objectives derived from other fields and subjects in science, technology, engineering and mathematics domains.
- Technical constraints derived from the environment. For example, the host organization does not have enough computers available or the computers might be running on a different operation system.
- Organizational requirements. For example, the host organization requires different social orchestration, such as number of students per class, specific criteria for setting up the teams or the available time slots are different from the originally planned time slots in the ERW activity plan.

The Implementation Team in cooperation with local teachers/tutors changes the original Workshop Activity Plan and/or Written Consent Forms, if possible, in order to satisfy the agreed on requirements provided by the hosting organization. Bi-directional traceability between the changed (aligned) Activity Plan/Written Consent Forms and related activities, materials and artefacts is ensured.

Entry criteria

Changes to the Activity Plan are requested and agreed on

Inputs

- Original ERW Activity Plan.
- Original Written Consent Forms.

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- Information Materials.
- Alignment of requirements to the ERW Activity Plan.
- Alignment of requirements to the Written Consent Forms.

Outputs

- Aligned Activity Plan, including clear instruction how the implemented changes will affect the activities, materials and artefacts.
- Aligned written consent forms.
- Aligned information materials.

Exit criteria

Commitment to the Aligned Activity Plan and/or Written Consent Forms is obtained by all relevant stakeholders

OBTAIN COMMITMENT FROM ERW PARTICIPANTS

Description

The Implementation Team distributes information brochures and Written Consent Forms among the participants (students and their families) and answers any questions and comments that come from the participants or their parents.

Local teachers/tutors or scientists are committed to contribute to the ERWs and to learn how to implement them.

Majority of the participants in the ERW sign written consent forms and are familiar with the study and the purpose of data collection and have understanding on how their identity and their data will be protected.

Entry criteria

Obtained commitment to the Activity plan from the ERW organizers/ host

Inputs

- List of participants;
- Written Consent Forms Templates - for organizer/ host, for the participants and their parents.
- Information materials for the workshop, the project and the study.

Outputs

- Signed Written Consent Forms - by hosting organization, by parents and students.
- Updated list of participants with marked preferences for video or audio recording, agreement to participate in EC open data initiative, disagreement to participate in the specific ERW process and any other information, relevant to the ERW implementation.

Exit criteria

All participants and relevant stakeholders provided signed written consent forms. Updated list of participants is developed.

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PREPARE FOR ERW DELIVERY

Go to details of the sub-process

Description

The Implementation Team prepares the workshop delivery

Entry Criteria

Commitment from all relevant stakeholders is obtained and the Activity plan is aligned as needed.

Inputs

- Aligned Activity Plan including clear instructions how the implemented changes will affect the activities, materials and artefacts.
- Updated list of participants with marked preferences for video or audio recording, agreement to participate in EC open data initiative, disagreement to participate in the specific ERW process and any other information, relevant to the ERW implementation.
- Evaluation templates.
- Evaluation method.

Outputs

- Materials and artefacts prepared.
- Space and ICT environment ensured.
- Implementation team trained.
- Evaluation materials printed.

Exit Criteria

Outputs are finalized and ready

EXECUTION PHASE

DELIVER ERW

Go to details of the sub-process

Description

The Implementation team, ideally in cooperation with local teachers/tutors or scientists executes the ERW following the specific Activity plan and observation/ assessment method, taking into account a target group on which the observation will focus.

Entry Criteria

Workshop prepared

Inputs

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- Activity plan.
- Materials and artefacts.
- Space and ICT environment.
- Implementation team (tutors) trained.
- Observation/ Assessment methods and tools.
- Tools, equipment and spare parts.

Outputs

- Educational results.
- Collected and processed artefacts and observation/ assessment forms.
- Reflections on ERW and improvement suggestions from implementation team and contributing teachers/tutors or scientists.

Exit Criteria

ERW finalized

CLOSURE PHASE

EVALUATE RESULTS

Description

The implementation team or external expert evaluates achieved educational results according to the educational objectives in the Activity plan and observation/ assessment methodology. Members of the Implementation Team document good practices and issues that were observed and any ideas for improvements that were generated by the relevant stakeholders. Information includes:

- Source (who identified the issue).
- Observation (description of the issue).
- Cause (what caused the issue, if it can be readily identified).
- Suggested improvement (how to solve the problem).

Entry criteria

Delivered workshop

Inputs

- Evaluation method.
- Collected and filed in evaluation documents and educational artefacts.
- Tutor reflections and observations in raw format.
- Improvement suggestions.

Outputs

- Evaluation forms and sheets are filled in by participants and are collected, organized, anonymized and scanned to be further stored in the workshop data base.
- Signed written consent forms are processed and organized into folders.
- Other relevant artefacts of learning, such as code, mind maps, midpoint reflections, etc., are collected.

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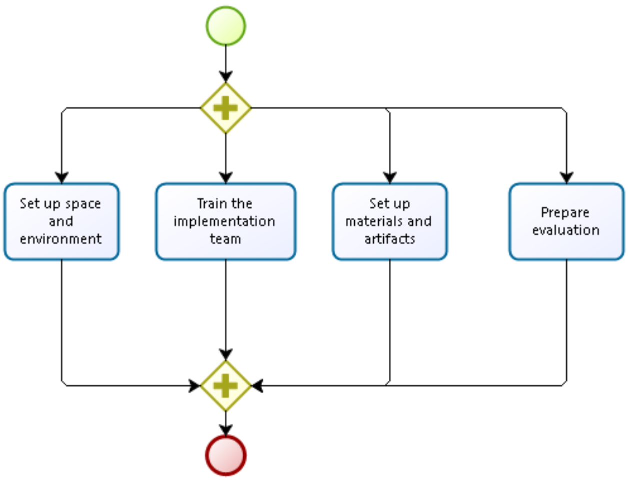
- Tutor documents, such as tutor observations and tutor reflections are completed;
- Video or audio interviews with preferably the target group from the study, are performed, transcribed and encrypted.
- Sensitive data, such as participant key, name labels, certificates, photos, videos, etc., is encrypted and stored on an external hard drive.
- Suggestions for improvement and reflections on the workshop are taken into consideration and filed.

Exit criteria

Evaluated results.

Prepare for ERW Delivery Sub-process

Figure 3 Prepare for ERW delivery sub-process



PROCESS ELEMENTS

SET UP SPACE AND ENVIRONMENT

Description

The Implementation team checks the hall/s where the ERW will take place and ensures that the facilities and equipment correspond to the requirements of the ERW defined in the Action plan. When applicable, the Implementation team installs the necessary software on the computers that will be used by the students and tests it to make sure that the software is properly set up.

Entry criteria

Commitment from all relevant stakeholders obtained and the Activity plan is aligned as needed

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Inputs

- Aligned Activity Plan including clear instructions how to further involve local teachers/tutors or scientists and how the implemented changes will affect the activities, materials and artefacts.

Outputs

- Space and ICT environment.
- Access to an appropriate workshop hall guarantied.
- Workshop desks, power supplies and other special tools/equipment ensured.
- ICT equipment ensured and set up as needed.

Exit criteria

Space and ICT requirements fulfilled.

TRAIN THE IMPLEMENTATION TEAM

Description

All members of the implementation team, local teachers/tutors and participating scientists are trained how to facilitate the ERW. If necessary, the team can decide to simulate the workshop and all activities in it. Any specifics of the particular workshop are discussed and actions are planned.

Entry criteria

Commitment from all relevant stakeholders obtained and the Activity plan is aligned as needed.

Inputs

- Aligned Activity Plan including clear instructions how the implemented changes will affect the activities, materials and artefacts.
- Updated list of participants with marked preferences for video recording, agreement to participate in open data pilot, disagreement to participate in the specific ERW and any other information relevant to the ERW implementation.
- Evaluation templates.
- Evaluation method and protocol.

Outputs

- Implementation team, local teachers/tutors and participating scientists trained on:
  - Scenario.
  - Space and students' information.
  - Social orchestration.
  - Student productions and artefacts of learning.
  - Sequence and description of activities.
  - Evaluation procedures, interviews, reflections, observations and sensitive data.

Exit criteria

Implementation team is capable to execute the workshop

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SET UP MATERIALS AND ARTIFACTS

Description

The implementation team prepare the materials and artefacts for the ERW taking into account any specific requirements for the particular workshop. The activities can include:

- Disassembly/assembly of components of the robotic kits.
- Testing each kit/robot to ensure that it functions properly.
- Modification of students and teachers' guides.
- Others.

Integrity (e.g. right versions) of the materials and artefacts ensured.

Entry criteria

Commitment from all relevant stakeholders obtained and the Activity plan is aligned as needed.

Inputs

- Aligned Activity plan including clear instructions how the implemented changes will affect the activities, materials and artefacts.

Outputs

- Materials and artefacts prepared:
    - Digital artefact.
    - Robotic artefact.
    - Student's workbook and manual.
    - Teacher's instruction book and manual.

Exit criteria

Materials and artefacts ready.

PREPARE EVALUATION

Description

The implementation team prints the evaluation forms and ensures equipment for conducting the evaluation during the ERW delivery.

Entry criteria

Commitment from all relevant stakeholders obtained and the Activity plan is aligned as needed.

Inputs

- Evaluation templates.
- Evaluation method and protocol; Updated list of participants with marked preferences for video recording, agreement to participate in open data pilot, disagreement to participate in the specific ERW and any other information relevant to the ERW implementation.

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Outputs

- Evaluation materials printed:
    - Draw a scientist form.
    - Pre-questionnaire form.
    - Post-questionnaire form.
    - Observation notes template.
    - Reflection sheet form.
- Focus group for observation and interviews identified.
- Evaluation equipment ready:
    - Camera.
    - Audio/ video recorder.

Exit criteria

Evaluation prepared.

Deliver ERW Sub-process

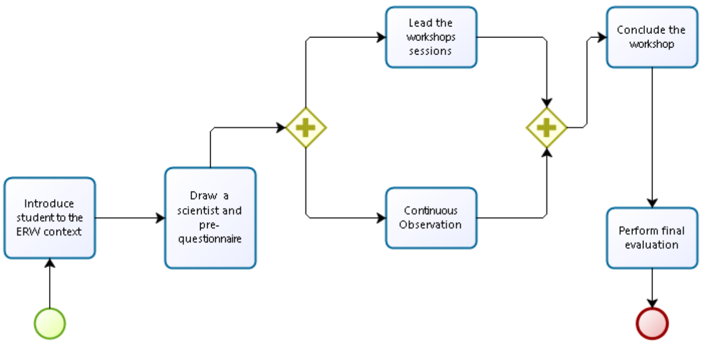

Figure 4 Deliver ERW sub-process

PROCESS ELEMENTS

INTRODUCE STUDENT TO THE ERW CONTEXT

Description

The researcher introduces the implementation team, explain the ERW objectives, describe the ERW agenda and provides safety instructions. Explain that video/audio recording equipment will be/is set up in the room and why.

Entry criteria

ERW has started

Inputs

- Aligned activity plan;
- If conducted in a school, informed consent given by the school to carry out the research.
- Informed consent to collect and store data given by parents.

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- Informed consent to collect and store data given by students.
- Informed consent to collect and store data given by tutors.
- Signed consent forms stored safely.
- Each student has randomly allocated a student number.

Outputs

- Tutors introduce themselves, the project, the workshop and the study - students are aware of the workshop context and about the study, they will take part in.
- Students are introduced to the evaluation methods, which will be applied during the workshops.
- Students understand that they do not have to consent to take part in the evaluation and that this will not result in any negative consequence for them.
- Students know that they can withdraw from the study at any time, without giving any explanation and this will not result in any negative consequence for them
- Students receive and understand safety instructions for participating in the ERW.

Exit criteria

Introduction done

DRAW A SCIENTIST AND PRE-QUESTIONNAIRE

Description

The implementation team asks students to draw a scientist at work according their notions and to fill in the pre-questionnaire form.

- Draw a scientist at work must be done before the first experience.
- Pre-questionnaire (online or paper copy) collects background information on students and requires their student number.

Entry criteria

Introduction done and students are aware about the ERW objectives.

Inputs

- Draw a scientist sheet.
- Pre-questionnaire evaluation form.
- Drawing or writing tools.
- Participant numbers stickers or other way to mark participants' work.

Outputs

- Filled in draw a scientist and pre-questionnaire sheets.

Exit criteria

Implementation team collected students’ sheets: draw a scientist and pre-questionnaire

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LEAD THE WORKSHOPS SESSIONS

Description

Following the Activity Plan, the implementation team informs students about robotic behaviours, the role of creator-programmer in giving desired functionalities and characteristics to a robotic device. Students are introduced to available parts, sensors, motors. Students create/ assemble robot devices from available parts or consider functionalities/ characteristics of pre-assembled available robotic devices. Students experiment with different values and settings and observe the results during the workshop. Students create programs for controlling the robotic devices. If robotic devices are pre-assembled, the students focus on programming and debugging their own programs. Implementation team leads the students in researching connections with other scientific domains - mathematics, engineering, biology, chemistry etc.

Entry criteria

Collected filled in draw a scientist and pre-questionnaire sheets

Inputs

- Activity plan.
- Scenarios.
- Tested and assembled/ disassembled robotic kits.
- Installed programs and applications on student computers.
- Provided guides and instructions.

Outputs

- Pictures and videos (if applicable) of the workshop, the artefacts of learning, etc.
- Assembled robot devices.
- Collect the code that each team produced.
- Observation.
- Mid-point reflections conducted in a format suitable to the case.
- Other artefacts - research description, project design description, problem description etc.

Exit criteria

Collected artefacts of students' work

CONTINUOUS OBSERVATION

Description

The implementation team follows assessment method and tools together with blank sheets of questionnaires and interview questions. The observation is implemented during the whole duration of the workshop. The observation can include one or more of the following elements:

- Interview with focus group(s) (implemented by implementation team).
- Peer assessment.

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- Artefacts of learning (code, robots, plans, reflection, etc.).
- Observation notes (filled by the implementation team).
- Reflection sheet (filled by each member of implementation team).

Entry criteria

Designed and developed assessment method and tools.

Inputs

- Developed assessment method.
- Printed supporting documents for tutors (observation forms, interview questions, evaluation protocol, etc.).
- Signed written consent forms - by the host/ organizer of the workshop, parents, students;
- Awareness of the participants in the assessment/ observation, its goals, the evaluation protocol, data and identity protection policies.
- Implementation team is trained how to perform the observation-related activities.

Outputs

- Target group is observed and interesting moments, phrases, reactions are recorded; if audio or video equipment is used for recording, the equipment is also monitored, and observations are timestamped according to the recording.
- Tutor documents, such as tutor observations and tutor reflections are completed and stored in the workshop database.
- Observation is accompanied by evaluation forms and other evaluation-related documents and activities.
- If permitted, audio or video recordings are made.
- Conducted short "interviews" with groups, ask questions and if possible, record them to support the evaluation. Each team could write instead a short team reflection on what they have done so far in the format of a blog post. The team's response is discussed within the team (not a sub-set of the team) and is as honest as possible.

Exit criteria

Collected and filed all observation sheets and tools

CONCLUDE THE WORKSHOP

Description

The implementation team gives students feedback about the workshop, gives last minute advice, internet connections for more information and provides important conclusions. The implementation team collects all observation/ assessment sheets and announces the end of the workshop.

Entry criteria

Collected workshop artefacts and observation sheets.

Inputs

- Developed assessment method.

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- Printed assessment tools and supporting documents for tutors (evaluation forms, draw a scientist sheets, interview questions, evaluation protocol sheets).
- Signed written consent forms - by the host/ organizer of the workshop, parents, students.
- Awareness of the participants in the assessment/ observation, its goals, the evaluation protocol, data and identity protection policies.
- Implementation team is trained how to perform the evaluation-related activities;
- Microphone and/or camera.
- Post-Questionnaire sheets printed out.

Outputs

- Evaluation forms and sheets are filled in by participants and are collected by tutors.
- Other relevant artefacts of learning, such as code, mind maps, midpoint reflections, etc., are collected.
- Tutor documents, such as tutor observations and tutor reflections are completed.
- Video or audio interviews with preferably the target group with minimum 2 students from the study are performed.

Exit criteria

Artefacts and observation sheets.

PERFORM FINAL EVALUATION

Description

The implementation team processes the collected and filed artefacts and observation sheets according to the evaluation protocol. According to the tutor experience and data (last if applicable), the implementation team suggests improvement actions. The Implementation team conducts interviews with the target group of students.

Entry criteria

Artefacts and observation sheets

Inputs

- Developed assessment method.
- Printed assessment tools and supporting documents for tutors (evaluation forms, draw a scientist sheets, interview questions, evaluation protocol sheets).
- Signed written consent forms - by the host/ organizer of the workshop, parents, students.
- Awareness of the participants in the assessment/ observation, its goals, the evaluation protocol, data and identity protection policies.
- Implementation team is trained how to perform the evaluation-related activities;
- Camera and/or microphone.

Outputs

Data Collection:

- Observations - video and audio recordings are used to finalise own observation notes.

Preparing Data:

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- Session information.
- Draw a scientist.
- Observations.

Artefacts of learning:

- Audio recordings of interviews.
- Workshop Information.
- Group information.
- Lesson Activity Plans (in English).
- Teaching materials: Handouts, worksheets, presentations, videos or any other material created for the purposes of teaching (in English).
- Paper-based questionnaires.
- Tutor reflections.

Make sure that:

- Student names are blanked out and participant keys are added where necessary.
- Translate; anonymise observation notes.
- Everything is translated in English and anonymised.
- Digitise any non-digital data (scan or take a high-quality photograph).
- Collate each group's work in a separate folder. The folder is labelled with the group's name.
- Transcribe (using template) and translate into English.
- Anonymise Translate free-text responses.
- Input all questionnaire responses in provided evaluation tools.
- Documents are archived and ready to be stored.

Exit criteria

Processed data.

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4 ER4STEM WORKSHOPS PROGRESS REVIEW

Within the period from October 2016 until July 2017, project partners organized 60 ERWs with 1570 participants, which is about 39 % of the planned 4050 students for the whole project implementation phase. For the period February 2016 – July 2017 in which WP2 was in implementation totally 108 ERWs with 2781 students or 68% of the planned students for the whole project were completed.

December 2016 and May 2017 were the months, in which the highest student participation in the workshops was recorded. Detailed information about the workshops is presented in Appendix 1 Quantitative data from the ERWs based on the Workshop Information Forms. The timeline of the ERWs implementation is illustrated in the Figure 5 and Figure 6.

Figure 5 Number of male and female students and number of workshops per month

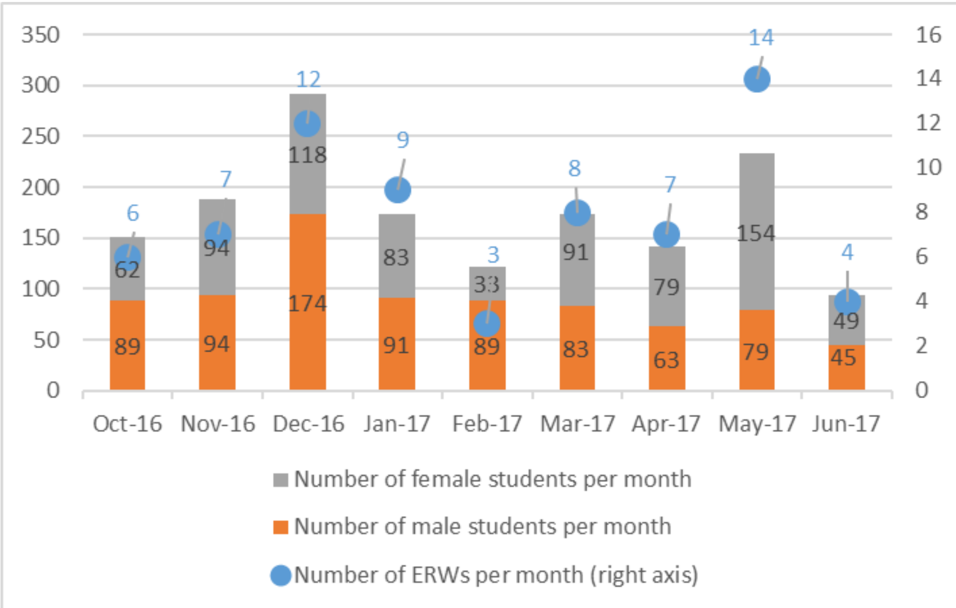

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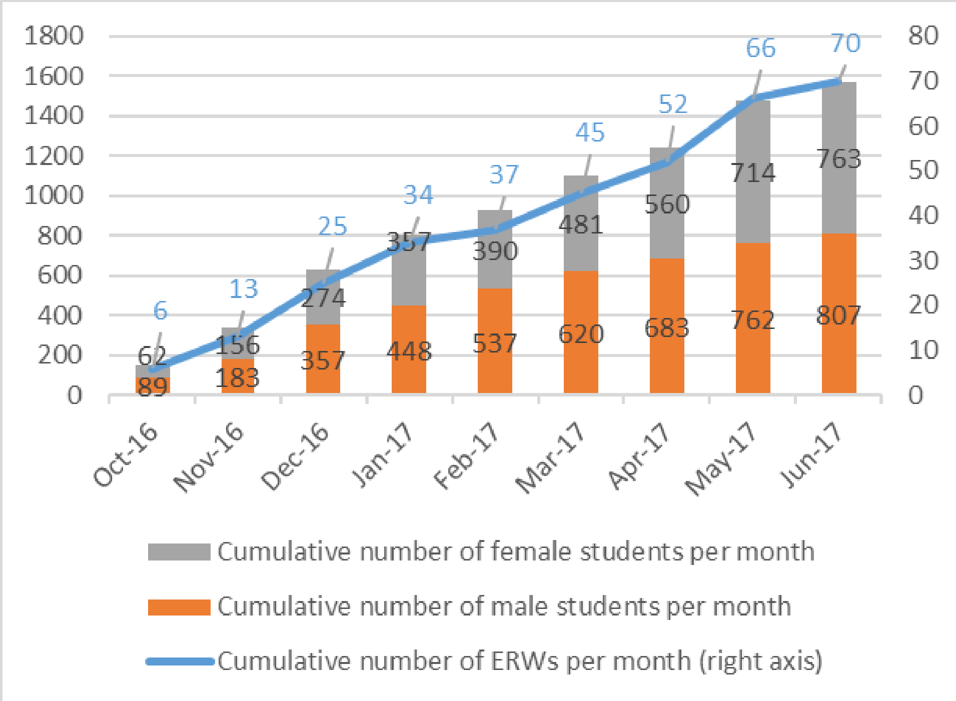
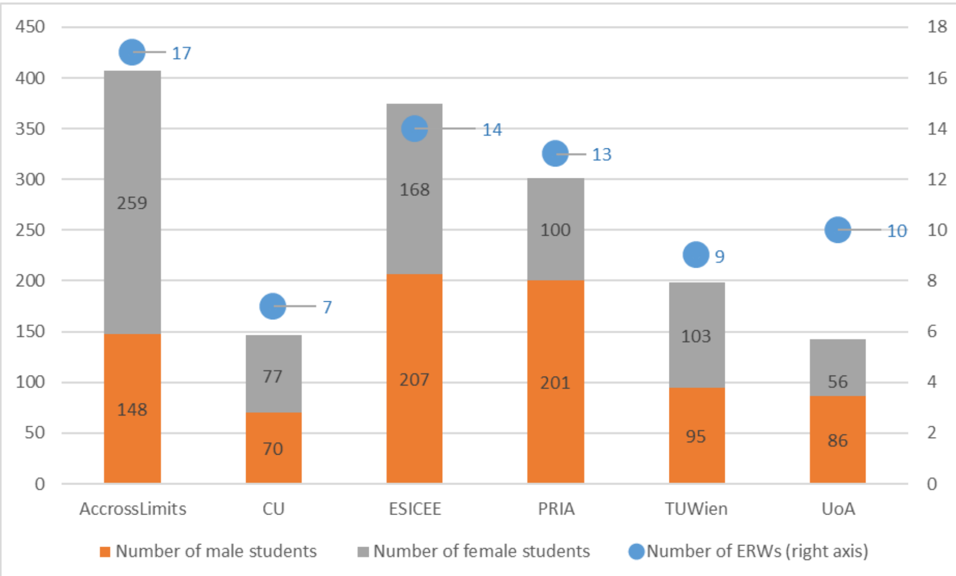
Figure 6 Cumulative number of male and female students and number of workshops per month



A visual representation of the distribution of ERWs and the respective number of students by project partner could be seen in Figure 7. This distribution corresponds to the country in which the respective workshops were implemented. PRIA and TUWien implemented 22 workshops with 499 students in Austria, ESI CEE implemented 14 workshops with 375 students in Bulgaria, UoA implemented 10 workshops with 142 students in Greece, AcrossLimits implemented 17 workshops with 405 students in Malta and Cardiff University implemented 7 ERWs with 145 students in UK.

Figure 7 Number of male and female students and number of ERW per project partner



The ERWs were highly appreciated by the students. On average, the partners' workshops were rated by the students with 4 and 5 stars out of 5 possible (Figure 8).

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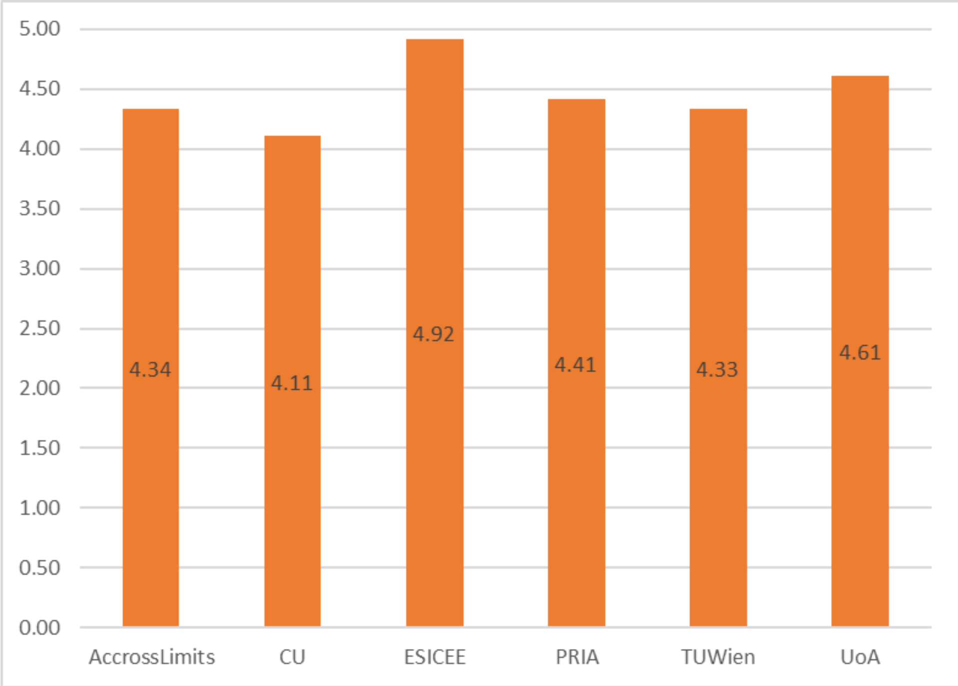
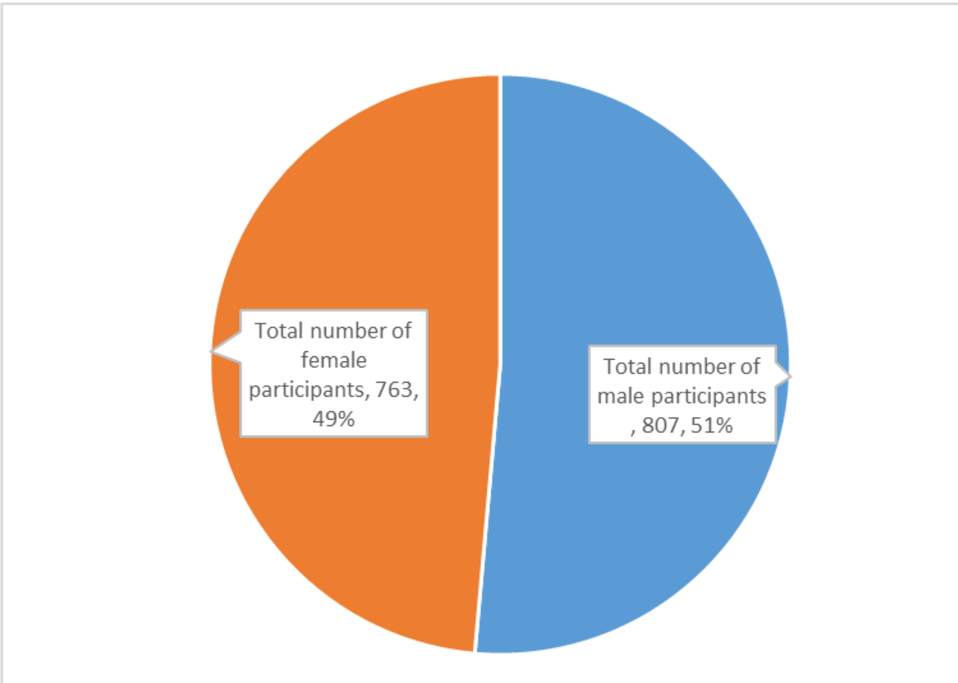
Figure 8 Average number of stars given by ERWs participants per project partner



The participants in the workshops were well balanced in terms of gender (Figure 9). Female participants were 49% of the total number of students and male participants were 51% of the total number of students. With a few exceptions, there were no significant deviations between the shares of female and male students based on variables such as implementing partner, robotics kit and programming languages, which yet makes the research rather unbiased in terms of gender in most of its aspects.

Figure 9 Number of male and female participants



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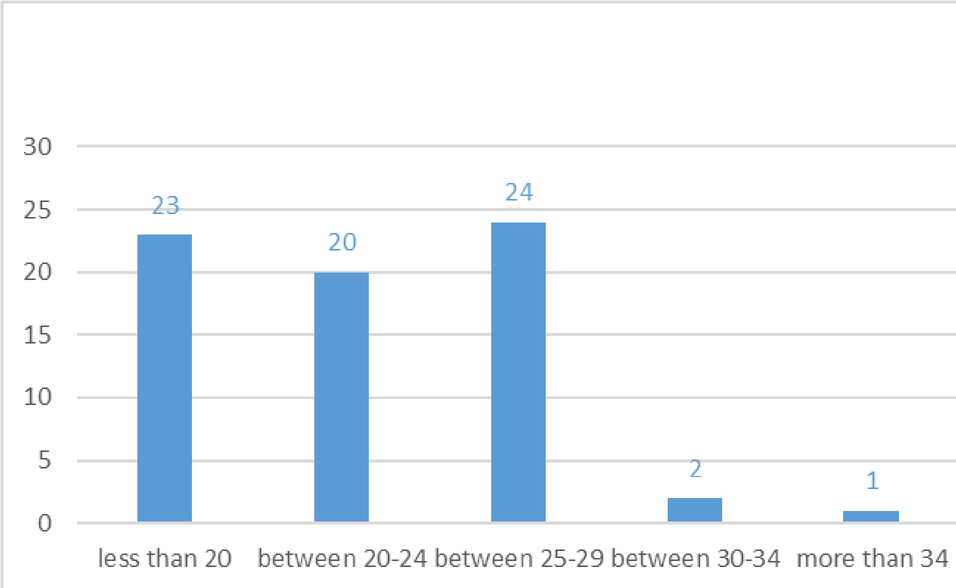
A number of participants ranging between 20 and 29 students was applicable for about 62% of the workshops, which closely corresponds to the typical number of students in the normal classes in general education schools (Figure 10).

Figure 10 Distribution of number of ERWs by number of participants per ERW



Most of the students participated in ERW based on Dash a Dot robotics kits (26%), followed by students that participated in workshops based on Arduino robotics kit (15 %) and LEGO Mindstorms robotics kits (13%). The remaining participants in the workshops used Thymio II (11 %), Finch (11%), Slurtles (7%) Botball (5%), Hedgehog (5%), LEGO We Do (4%) and various electronics (2%) (Figure 11). With the exception of the ERWs based on Botball, the ERWs were generally gender balanced.

Finch, Slurtles and Hedgehog robotics kits were introduced for first time in Y2 and they proved to be successful in demonstrating the benefits of using ER for teaching other disciplines such as mathematics.

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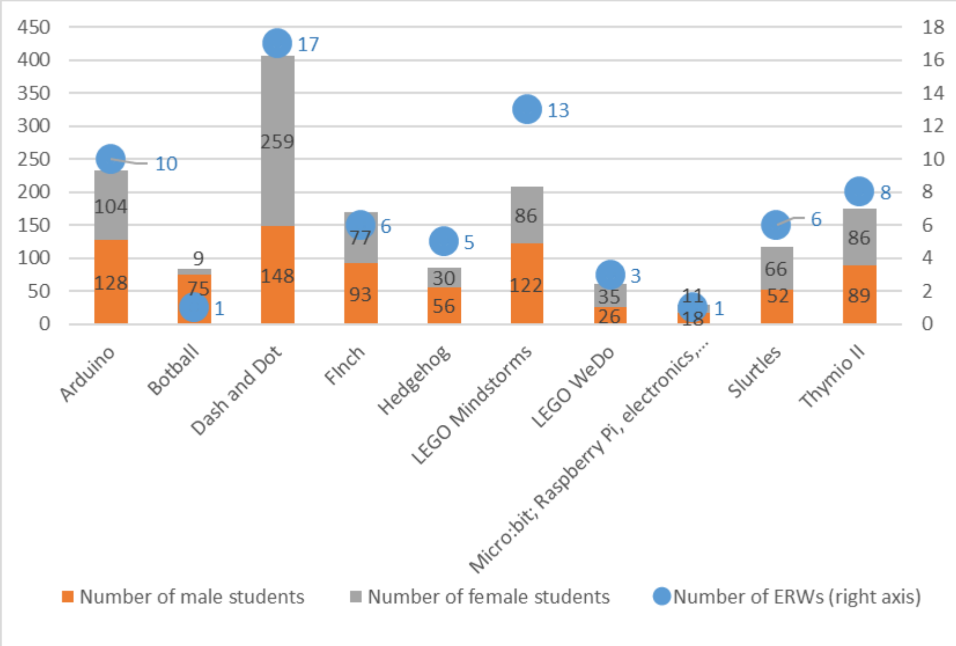
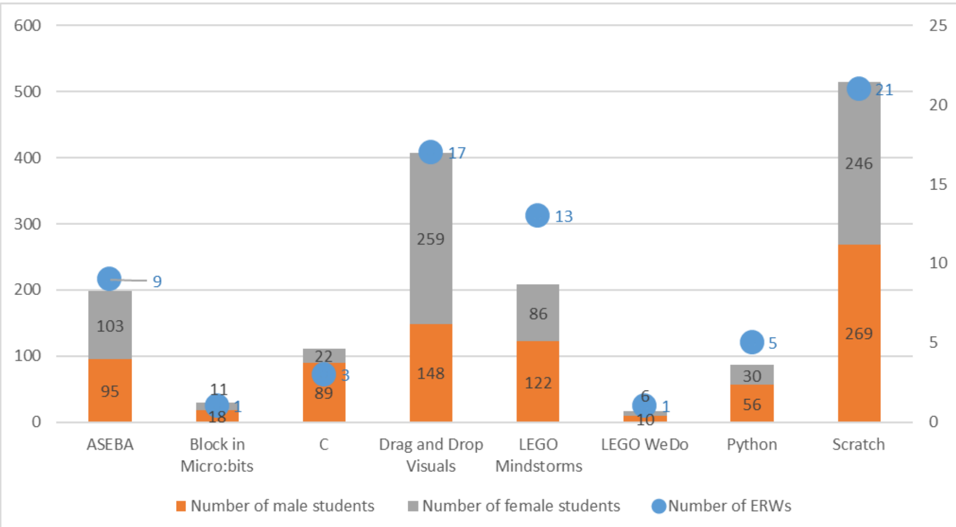
Figure 11 Number of male and female students and number of ERW per robotics kit



Distribution of ERWs based on programing languages correlates with the distribution of the robotics kits that were used for the same ERWs (Figure 12). To demonstrate, 17 workshops that applied Dot and Dash robotics kits, used Drag and Drop Visuals as a programming language Likewise, the LEGO Mindstorms based workshops applied the LEGO Mindstorms programing environment, Botball Link Controller based workshops applied the C programming language. The Thymio II based workshops incorporated ASEBRA. By the same foot, workshops conducted with the Lego We Do robotics kits applied the native Lego We Do graphic language. Scratch was an exception of this trend since it was used with Arduino, Slurtles and Finch robotics kits.

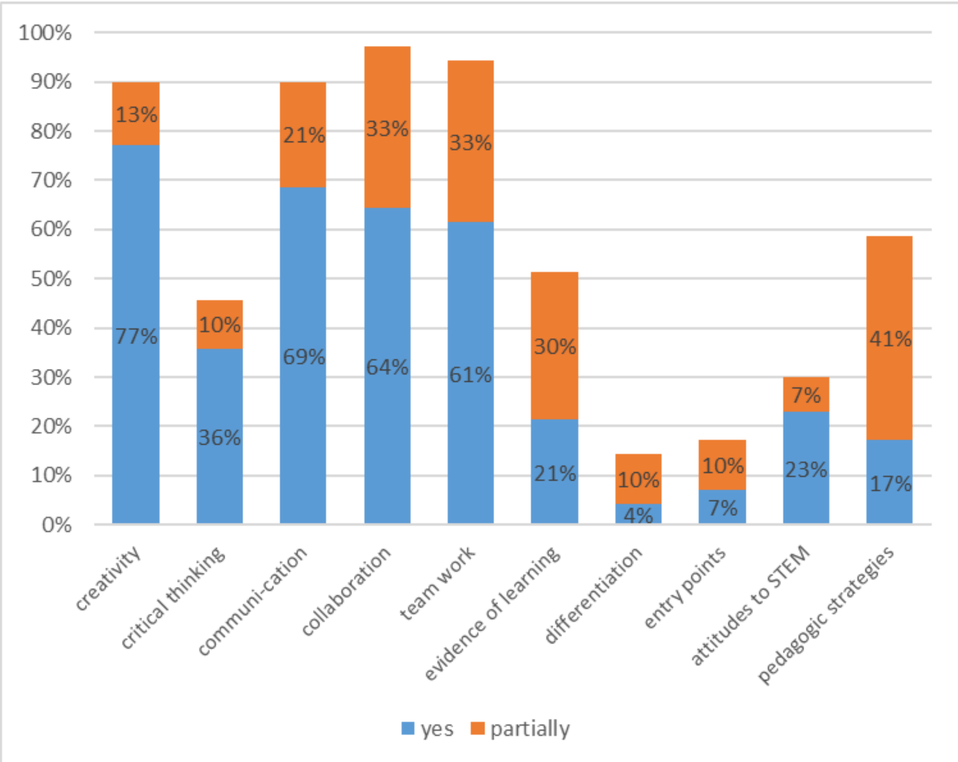
Figure 12 Number of male and female students and number of ERW per programming language



On can notice that the ERWs performed in Y2 used wider variety of robotics kits compared to the ERWs performed in Y1 that well corresponds to the key principle in the ER4STEM for delivering of ERWs for all children. The new robotics kits introduced in Y2 were Finch, Hedgehog and Slurtles. Finch and Slurtles were mostly used to demonstrate mathematical concepts that fits well to the ER4STEM principle to use educational robotics in order to support educational in other domains.

Based on the experience gained in Y1 in September 2016 at the beginning of Y2 during the project Y1 review meeting in Malta, the ER4STEM project partners agreed on using 21st century skills as a unit to encompass industry skills and soft-skills. Moreover, it was decided to develop a unit within the Framework on 21st century skills, which is sub-divided into section on teamwork and collaboration, communication, creativity and critical thinking. Following those key recommendations, the project partners mapped the Y2 workshops curriculum to 10 key recommendations. The ERWs curriculum was mostly connected to four of them, namely creativity, communication and teamwork, as those four skills were among the most frequently targeted by the ER4STEM partners' year 2 activity plans.

Figure 13 Share of the workshop that cover the Y1 recommendations in terms of 21st century skills



Source: ERWs planning, monitoring and control tool.

It is important to be noted that most of the workshops were delivered to students with not more than 3 years of difference between the youngest and the oldest participant. Yet, two of workshops reported had, respectively 11 and 7 years of difference between the youngest and oldest participant. (For more information, refer to Appendix 1 Quantitative data from the ERWs based on the Workshop Information Forms)

All data in this section is based on the workshop information forms. Some of the indicators could have different values when they are reported in Section 4 ER4STEM Workshops Progress Review and in Deliverable 6.3 since the data in those reports is based on the written consent forms and other evaluation artefacts. One should take into account that not all students that had signed written consent forms participated in the workshops and that there were students that had not signed written consent forms but participated in the workshops.

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5 CONCLUSION / OUTLOOK

During the second year of project execution, the project partners were able to successfully design, implement and evaluate ERWs carried out within 70 workshops with 1570 students in five countries, while implementing key improvements, such as:

- Modifying the ERWs implementation process that takes into account the STEM elated curricula and involve local teachers and tutors.
- Three new educational robotics technologies were implemented in the workshops including Finch, Slurtles and Hedgehog.
- Introduction of improved Activity Plans including activity blocks oriented towards STEM.
- Introduction of new improved evaluation methods and tools.
- Focus on 21st century skills.

Within the first two years, the project team was able to reach 68% of the total number of students planned to be covered in the whole project. Based on that fact we do not envisage significant risks for the successful completion of WP2 Educational Robotics Workshops.

In the third project year the curricula for the already implemented workshops will be improved, based on the evaluation results, the lessons learned, the changes in the activity plans and the new workshops which are about to be designed and implemented.

The project partners will have the opportunity to work with students and groups that had participated in the ERWs during the Y1 and Y2 year of project implementation and to observe their attitude towards educational robotics, science and STEM in general, which would be a significant input for this research, as well as the field of educational robotics in general. This will further allow tracking schools' motivation to conduct and support the organization of educational robotics workshops.

With the intention to involve more local teachers, pedagogues and researchers in the educational robotics workshops' content design and adaptation, year 3 looks promising in terms of availability for students and suitable for various ability levels, regardless of age.

For the competitions and educational robotics workshops, conducted in an out-of-school context, the lessons learned throughout these two years will be put into practice with the hopes to attract more participants and to try and ensure multiple points of entry for students as well as broaden the activities outside the in-school context.

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6 GLOSSARY / ABBREVIATIONS

AcrossLimits	AcrossLimits, Malta
EC	European Commission
ER	Educational Robotics
ER4STEM	Educational Robotics for Science, Technology, Engineering, and Mathematics
ERW	Educational Robotics Workshop
ESI CEE	European Software Institute Center Eastern Europe, Bulgaria
Implementation Team	All members of the team that implements the workshop including but not limited to facilitators, teachers, researchers, evaluators and others.
PRIA	Practical Robotics Institute Austria, Austria
Local teacher/tutor or scientists	Teacher/tutor or scientists form hosting organizations, school or club.
REA	Research Executive Agency
Relevant Stakeholder	A stakeholder that is involvement in specific ERWs activities.
STE(A)M	Science, Technology, Engineering, Art, and Mathematics
STEM	Science, Technology, Engineering, and Mathematics
TUWien	Vienna University of Technology, Austria
UoA	University of Athens Educational Technology Lab, Greece

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APPENDIX 1 QUANTITATIVE DATA FROM THE ERWS BASED ON THE WORKSHOP INFORMATION FORMS

ERW No	Code	Partner name	Dates from	Dates to	Number of sessions	Number of lead tutors	Number of other tutors/mentors	Age of students from	Age of students to	Total number of students	Number of male students	Number of female students	Group size from	Group size to	Total number of groups	Robotics kits used	Programming languages used
1	AL-2-2-CAT	AccrossLimits	3/27/2017	3/28/2017	2	2	1	10	13	23	9	14	2	3	11	Dash and Dot	Drag and Drop Visuals
2	AL-2-1-CAT	AccrossLimits	3/23/2017	3/24/2017	2	2	1	11	12	26	10	16	2	4	10	Dash and Dot	Drag and Drop Visuals
3	AL-2-3-CAT	AccrossLimits	3/29/2017	3/30/2017	2	2	0	12	13	27	8	19	2	3	11	Dash and Dot	Drag and Drop Visuals
4	AL-2-8-FRA	AccrossLimits	5/2/2017	5/4/2017	2	2	0	11	12	26	0	26	2	3	11	Dash and Dot	Drag and Drop Visuals
5	AL-2-9-FRA	AccrossLimits	5/5/2017	5/8/2017	2	2	0	11	12	24	0	24	2	3	11	Dash and Dot	Drag and Drop Visuals
6	AL-2-10-FRA	AccrossLimits	5/11/2017	5/12/2017	2	2	0	11	12	26	0	26	2	4	12	Dash and Dot	Drag and Drop Visuals
7	AL-2-6-JOS	AccrossLimits	4/25/2017	4/28/2017	2	2	0	11	13	23	0	23	2	3	10	Dash and Dot	Drag and Drop Visuals
8	AL-2-7-JOS	AccrossLimits	5/17/2017	5/18/2017	2	2	0	11	12	25	0	25	2	3	12	Dash and Dot	Drag and Drop Visuals
9	AL-2-4-VER	AccrossLimits	4/5/2017	4/6/2017	2	2	1	12	14	15	8	7	2	3	7	Dash and Dot	Drag and Drop Visuals
10	AL-2-2-VER	AccrossLimits	3/23/2017	3/24/2017	2	2	0	12	13	16	12	4	2	2	8	Dash and Dot	Drag and Drop Visuals

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ERW No	Code	Partner name	Dates from	Dates to	Number of sessions	Number of lead tutors	Number of other tutors/mentors	Age of students from	Age of students to	Total number of students	Number of male students	Number of female students	Group size from	Group size to	Total number of groups	Robotics kits used	Programming languages used
11	AL-1-13-StFrancesMsidaB	AccrossLimits	12/5/2016	12/6/2016	2	2	0	9	10	27	15	12	2	3	10	Dash and Dot	Drag and Drop Visuals
12	AL-1-8-AugustineA	AccrossLimits	10/24/2016	10/25/2016	2	2	0	9	10	24	24	0	2	3	11	Dash and Dot	Drag and Drop Visuals
13	AL-1-9-AugustineB	AccrossLimits	10/27/2016	10/28/2016	2	2	0	9	10	25	25	0	2	3	12	Dash and Dot	Drag and Drop Visuals
14	AL-1-7-DorothyA	AccrossLimits	10/17/2016	10/18/2016	2	2	1	9	11	25	0	25	2	3	11	Dash and Dot	Drag and Drop Visuals
15	AL-1-12-StFrancesMsidaA	AccrossLimits	11/28/2016	11/29/2016	2	2	0	9	11	26	13	13	2	3	10	Dash and Dot	Drag and Drop Visuals
16	AL-1-11-NicholasB	AccrossLimits	11/16/2016	11/17/2016	2	2	0	9	11	26	8	18	2	3	12	Dash and Dot	Drag and Drop Visuals
17	AL-1-10-NicholasA	AccrossLimits	11/14/2016	11/15/2016	2	2	0	9	10	23	16	7	2	3	11	Dash and Dot	Drag and Drop Visuals
18	PRIA-2-A3-02-AB	PRIA	10/3/2016	1/9/2017	2	1	0	13	14	16	14	2	1	3	15	LEGO Mindstorms	LEGO Mindstorms
19	PRIA-2-A3-03-AM	PRIA	12/5/2016	12/5/2016	1	1	1	14	16	19	11	8	2	3	7	Hedgehog	Python
20	PRIA-2-A3-01-ECERWS	PRIA	2/2/2017	2/3/2017	2	1	2	9	19	84	75	9	3	15	15	Botball	C
21	PRIA-2-A2-07-MG	PRIA	5/10/2017	5/15/2017	1	1	0	10	14	10	7	3	2	2	5	Hedgehog	Python
22	PRIA-2-A2-02-MG	PRIA	1/9/2017	1/23/2017	2	1	0	13	15	16	14	2	2	3	7	Hedgehog	Python
23	PRIA-2-A2-05-AS	PRIA	1/30/2017	1/30/2017	1	1	1	12	14	26	16	10	3	4	8	Hedgehog	Python

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ERW No	Code	Partner name	Dates from	Dates to	Number of sessions	Number of lead tutors	Number of other tutors/mentors	Age of students from	Age of students to	Total number of students	Number of male students	Number of female students	Group size from	Group size to	Total number of groups	Robotics kits used	Programming languages used
24	PRIA-2-A2-03-AM	PRIA	12/22/2016	12/22/2016	1	1	1	11	13	21	12	9	2	3	9	LEGO Mindstorms	LEGO Mindstorms
25	PRIA-2-A2-06-MA	PRIA	1/31/2017	1/31/2017	1	1	0	12	14	21	4	17	2	3	9	LEGO Mindstorms	LEGO Mindstorms
26	PRIA-2-A2-04-MA	PRIA	1/27/2017	1/27/2017	1	1	0	12	14	15	9	6	2	3	7	LEGO Mindstorms	LEGO Mindstorms
27	PRIA-2-A2-01-MG	PRIA	1/20/2017	1/27/2017	1	1	0	12	13	15	8	7	2	3	7	Hedgehog	Python
28	PRIA-2-A1-03-VA	PRIA	12/20/2016	12/21/2016	2	1	0	7	9	18	11	7	2	3	8	LEGO Mindstorms	LEGO Mindstorms
29	PRIA-2-A1-01-VA	PRIA	1/10/2017	1/13/2017	2	1	0	9	11	18	5	13	2	3	8	LEGO Mindstorms	LEGO Mindstorms
30	PRIA-2-A1-02-VV	PRIA	11/24/2016	12/1/2016	3	1	2	7	9	22	15	7	2	3	7	LEGO Mindstorms	LEGO Mindstorms
31	TU-Wien-2017-02-01	TUWien	2/1/2017	2/1/2017	2	1	2	13	14	23	6	17	2	12	9	LEGO WeDo	ASEBA
32	TU-Wien-2017-03-06	TUWien	3/6/2017	3/7/2017	2	1	2	6	10	24	14	10	2	11	10	Thymio II	ASEBA
33	TU-Wien-2017-06-13	TUWien	6/13/2017	6/13/2017	2	1	2	14	16	26	14	12	2	12	10	Thymio II	ASEBA
34	TU-Wien-2017-01-26	TUWien	1/25/2017	1/26/2017	1	1	2	6	7	24	9	15	2	13	10	Thymio II	ASEBA

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ERW No	Code	Partner name	Dates from	Dates to	Number of sessions	Number of lead tutors	Number of other tutors/mentors	Age of students from	Age of students to	Total number of students	Number of male students	Number of female students	Group size from	Group size to	Total number of groups	Robotics kits used	Programming languages used
35	TU-Wien-2017-03-30	TUWien	3/30/2017	3/30/2017	2	1	2	14	18	23	15	8	2	11	7	Thymio II	ASEBA
36	TU-Wien-2017-01-31	TUWien	1/30/2017	1/31/2017	2	1	2	6	7	23	12	11	2	12	8	Thymio II	ASEBA
37	TU-Wien-2017-02-02	TUWien	2/2/2017	2/2/2017	2	1	2	13	15	15	8	7	2	15	7	Thymio II	ASEBA
38	TU-Wien-2017-04-19	TUWien	4/19/2017	4/28/2017	2	1	2	9	11	20	9	11	2	10	9	Thymio II	ASEBA
39	TU-Wien-2017-02-23	TUWien	2/23/2017	3/2/2017	2	1	2	8	11	20	8	12	2	8	7	Thymio II	ASEBA
40	UoA421	UoA	5/18/2017	6/2/2017	4	1	0	10	11	22	10	12	3	4	6	LEGO WeDo	Scratch
41	UoA422	UoA	5/5/2017	5/24/2017	3	1	0	11	12	16	10	6	4	4	4	LEGO WeDo	LEGO WeDo
42	UoA423a	UoA	3/31/2017	5/8/2017	4	1	1	13	14	10	6	4	2	3	4	LEGO Mindstorms	LEGO Mindstorms
43	UoA423b	UoA	5/15/2017	5/26/2017	4	1	1	13	15	5	5	0	2	4	2	LEGO Mindstorms	LEGO Mindstorms
44	UoA424a	UoA	5/5/2017	5/24/2017	3	1	0	14	15	12	4	8	3	3	4	Arduino	C
45	UoA424b	UoA	5/5/2017	5/24/2017	2	1	0	14	15	15	10	5	3	3	5	Arduino	C
46	UoA425	UoA	3/20/2017	4/10/2017	2	1	0	12	15	15	14	1	2	3	5	LEGO Mindstorms	LEGO Mindstorms
47	UoA426	UoA	5/4/2017	5/8/2017	3	1	0	15	16	17	11	6	3	4	5	LEGO Mindstorms	LEGO Mindstorms

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ERW No	Code	Partner name	Dates from	Dates to	Number of sessions	Number of lead tutors	Number of other tutors/mentors	Age of students from	Age of students to	Total number of students	Number of male students	Number of female students	Group size from	Group size to	Total number of groups	Robotics kits used	Programming languages used
48	UoA427a	UoA	3/22/2017	3/29/2017	2	1	1	13	15	15	7	8	3	3	5	LEGO Mindstorms	LEGO Mindstorms
49	UoA427b	UoA	5/2/2017	5/9/2017	2	1	1	13	15	15	9	6	3	3	5	LEGO Mindstorms	LEGO Mindstorms
50	PRW2-2-125-4v	ESICEE	11/21/2016	11/28/2016	2	2	1	9	11	30	14	16	3	5	7	Finch	Scratch
51	PRW2-2-125-4g	ESICEE	11/24/2016	12/1/2016	2	2	1	9	11	27	15	12	1	5	7	Finch	Scratch
52	PRW2-2-125-4e	ESICEE	11/25/2016	12/2/2016	2	2	1	9	10	30	21	9	2	5	7	Finch	Scratch
53	PRW2-2-125-4d	ESICEE	11/11/2016	11/18/2016	2	2	1	9	10	29	14	15	2	5	7	Finch	Scratch
54	PRW2-2-125-4b	ESICEE	11/22/2016	11/29/2016	2	2	1	9	11	26	12	14	3	4	7	Finch	Scratch
55	PRW2-2-125-4a	ESICEE	11/10/2016	11/17/2016	2	2	1	9	11	28	17	11	3	5	7	Finch	Scratch
56	PRW2-2-125-3V	ESICEE	10/6/2016	10/10/2016	2	3	1	8	10	26	15	11	3	5	7	Arduino	Scratch
57	PRW2-2-125-3G	ESICEE	7/10/2016	12/10/2016	2	3	1	8	9	28	15	13	3	5	7	Arduino	Scratch
58	PRW2-2-125-3E	ESICEE	5/12/2016	12/12/2016	2	3	2	9	9	27	15	12	3	4	7	Arduino	Scratch
59	PRW2-2-125-3D	ESICEE	10/24/2016	12/13/2016	2	3	1	8	10	27	13	14	2	4	7	Arduino	Scratch
60	PRW2-2-125-3b	ESICEE	10/4/2016	10/10/2016	2	2	1	8	9	26	13	13	3	5	6	Arduino	Scratch
61	PRW2-2-125-3a	ESICEE	10/3/2016	10/11/2016	2	3	1	8	9	25	12	13	3	4	7	Arduino	Scratch
62	PRW2-2-125-6e	ESICEE	10/19/2016	12/6/2016	3	3	1	11	12	25	16	9	2	4	7	Arduino	Scratch

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63	PRW2-2-125-Kyustendil	ESICEE	12/5/2016	12/5/2016	1	2	2	11	12	21	15	6	4	7	4	Arduino	Scratch
64	621_NWETSS_1	CU	5/5/2017	5/29/2017	4	1	1	13	14	15	7	8	1	2	19	Slurtles	Scratch
65	621_NWETSS_2	CU	5/5/2017	5/29/2017	4	1	1	12	14	17	10	7	1	2	17	Slurtles	Scratch
66	622_MIHS_1	CU	3/7/2017	4/6/2017	6	1	1	11	12	21	9	12	1	2	21	Slurtles	Scratch
67	622_MIHA_2	CU	7/2/2017	6/8/2017	6	1	1	11	12	22	10	12	1	3	11	Slurtles	Scratch
68	625_OFPS_1	CU	3/17/2017	4/30/2017	5	1	0	8	10	19	5	14	1	3	9	Slurtles	Scratch
69	622_MIHA_3	CU	6/20/2017	6/18/2017	5	1	1	11	12	24	11	13	1	4	11	Slurtles	Scratch
70	624_CA_1	CU	3/20/2017	4/3/2017	3	2	1	9	11	29	18	11	2	4	13	Micro:bit; Raspberry Pi, electronics, Felt and sewing kit	Block in Micro:bits

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