D 1.2 FRAMEWORK

[Deliverable 1.2]

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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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DOCUMENT REVISION HISTORY

Version Number	Date	Description	Author
V 0.1	15/05/2016	Document is created	Julian Angel-Fernandez
V 0.2	15/06/2016	Comments on design process	Ivo Gueorguiev and Pavel
V 0.3	11/07/2016	Comments on design process	Annalise Duca
V 0.4	20/07/2016	Comments on design process and literature	Nikoleta Yiannoutsou
V 0.5	23/07/2016	Comments on design process and literature	Carina Girvan
V 0.6	15/09/2016	Comments on the whole document	Lara Lammer

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1 EXECUTIVE SUMMARY

1.1 ROLE/PURPOSE/OBJECTIVE OF THE DELIVERABLE

This deliverable describes the specific objective of the framework, which is to help people create robotic activities. To achieve this, the framework introduces a macro-process that later is adapted to each one of the stakeholders' needs (i.e. teachers, organizers of educational activities, and educational researchers) identified in the D1.1. In this first version of the framework just two processes are developed (i) designing a pedagogical activity and (ii) implementing a conference.

1.2 RELATIONSHIP TO OTHER ER4STEM DELIVERABLES

This deliverable continues the study done in the D1.1: obtain a better understanding on how the framework will leverage activities in educational robotics. Deliverables 2.1 and 3.1 provided ideas on the processes for the activities covered in each deliverable. On the other hand D4.1 provides the tools and methodologies that are used in the framework. This activity plan has been used as inspiration for the design macro-phase of pedagogical activities. D 6.3 will provide relevant information that will use to improve and developed processes to achieve ER4STEM's goals.

1.3 STRUCTURE OF THE DOCUMENT

This document is organized as follows. Chapter 2 introduces the topics covered in this document. Chapter 3 presents some of the works in educational robotics, which bring an idea of the current and further trend in this area. With this understanding, chapter 4 introduces ER4STEM framework while chapters 5 and 6 present the first version of pedagogical activities and preparation for conferences, respectively. Finally, chapter 7 provides a summary of the work, conclusion and following steps.

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2 INTRODUCTION

The domain of robotics represents a multi-disciplinary and highly innovative field encompassing engineering, design as well as social sciences. It does not only cover mechanical, electronic and computer engineering, but also involves other fields such as mathematics, as psychology (e.g. human behavior and attitudes), biology, arts, and science. These broad connections to different fields and the complexity of the technology influence many people including educational robotics stakeholders in a threatening way, especially the huge amount of information that is found about robotics including all pre-required knowledge.

The problem is that many teachers or other laypersons in robotics do not master or do not have any previous knowledge in these fields, and this often results in them being reluctant to use robots. At the same time, the complexity of robotic technology is overwhelming, especially if the use of it needs to be aligned with other goals, like designing an educational robotics activity where other considerations are added to this complexity, such as how to teach, how to approach the children, and even more important how to use the robots. Trying to solve all of these factors is not an easy task. Therefore, the idea of the ER4STEM framework processes described in this document is to guide different stakeholders through the design, improvement and implementation of educational activities using robots. The macro-process used as a base to generate these processes is depicted in the Figure 1. Using it as a base and considering the diverse needs of the stakeholders identified (See D 1.1), the process derived from the macro-process must be helpful, easy to follow, and improve the quality of the activities.

To achieve these objectives a theoretical study and empirical work were done. The theoretical study included the review of diverse works on educational robots to get a better understanding on trends, uses and activities of robotic platforms in education (See chapter 3). On the other hand, the empirical work is a work on process and it involves diverse activities done on ER4STEM. These activities have been documented in D 2.1 and D 3.1, and they have been supported by the artifacts created in WP4 and reported in D 4.1. Beside activities implementation, they have been evaluated. The results and insight of the evaluation will feed the framework suggesting tendencies that could be followed to achieve specific results.

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3 RELATED WORK

The use of robotics in education is not a new trend, neither are the benefits that it has for students' learning. Most important, there is an agreement among educational researchers that robotics is a perfect tool to design activities based on constructivism, which is a methodology that advocates on learning through interacting with the world. The use constructivism, or methodologies derived from it, is documented by Altin and Pedaste [1] who identified the methodologies used in diverse educational robotic activities. They found that most methodologies used in educational robotics are discovery learning, collaborative learning, problem solving, project-based learning, competition-based learning and compulsory learning. Although there are differences in these methodologies, they are based on constructivism. This chapter, rather focusing on the methodologies used in educational robotics, focuses on the activities done in educational robotics, the domain and the use of the robotic platform. Getting a better understanding of current uses of robotic platforms in education and determining possible trends on the use of robotics in education let to create processes that will cover current and further tendencies. Moreover, having a better picture of the domains where robotics are used, let us to clarify and come with better suggestions for further activities that cover all kids.

Stager [2] presents four case studies that he implemented using the robotic platform MicroWorlds EX. The first case introduced was a ballerina that was developed by a five year-old girl. The researcher explained the girl how to use pushbuttons to control ballerina movements. So the kid decided to use two pushbuttons to control the ballerina's spin direction. This development took three morning sessions to be completed. The second project was a teddy bear, which was developed by a group of students, who worked for four consecutive mornings. The whole group decided to work on objects that could be found at a state fair and one group decided to bring a teddy bear to life. The third was a phonograph which was developed by a 15-year-old boy who had disabilities and had poor records in school. The final case is connected to adult professional development, where the researcher's target audience was educators. The researcher used a similar methodology that he uses when he is working with children. The researcher also suggested five ways that robots could be used in teaching. (i) *Robotics as a discipline,* which is the traditional approach used in universities. (ii) *Teaching specific STEM concepts* such as physics, programming, etc. (iii) *Thematic units*, where participants model real life systems. (iv) *Curricular themes,* where the robotic activities are specifically connected to topics in a formal curriculum. (v) *Freestyle,* where participants use robotics and other materials to create objects.

Riedo et al. present their own developed platform Thymio II [3]. They explain the weaknesses of the existing platforms (i.e. Bee-bot, Lego and Arduino) as motivation to create their own platform, which they call Thymio II. To test the final version of the robotic platform, they offered five different workshops during the Robotics festival 2013. The first workshop was designed to let kids play with pre-programmed robot's behaviors and then kids were asked to deduce some rules about robot's behaviors. During this workshop, computers were used by the participants. The second workshop, again without the use of computers, kids with previous experience with Thymio II were asked to form groups and solve six different tasks. In the third workshop kids were taught how to program Thymio using the Visual Programming Language (VPL) and then they received diverse tasks to be solved. The fourth workshop was similar to third but the only difference was the use of textual programming instead of VPL. The final workshop was developed to give a complex task to the participants. Their results showed that participants were pleased with the workshops and they felt that they had learnt things that could use iterations.

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Based on their experience on Robocup Junior, Stoeckelmayr et al. [4] decided to create workshops for kindergarten students. Using the Bee-Bot platform, they created ten lessons about 55 minutes long each. They asked kids to take pictures and record the artifacts that kids were doing along the lessons. The four first lessons focused on introducing the world of research, robots and how to use the cameras to report their work. The next two were focused on introduction and exploration of the platform. In the next three lessons participants had to solve some problems in groups, but no information was given about how the groups were informed. The final session was focused on the conclusions from the work done during the lessons. Their findings suggest that participants were interested in programming and robots and were looking forward to a sequel of the project.

Church et al. [5] present four activities with Lego Mindstorms to teach physics. The first activity they called *testing speed vs acceleration of drag cars.* In this activity students were asked to determine what is most important in a drag car: speed or acceleration. The second is *simple harmonic motion*, where the students were asked to use Lego microcontroller and the ultrasonic sensor to investigate changes in vertical motion of an oscillation spring. The third is a *ten second timer,* where students were asked to create a pendulum system. Moreover they should use the microcontroller and sound sensor to count 10 seconds based on the pendulum's movement and generating a sound when the time had elapsed. The final activity was *microphone sound reduction.* In this activity students had to create experiments to investigate the sound's variables (e.g. wave length). Their anecdotal results suggest that the students were really interested in the activities, where they were trying to analyze and improve each one of their artifacts.

Williams et al. [6] offered a summer camp to teach physical science and scientific inquiry to middle school students. The camp ran for two and half hours each day for a period of two weeks. It was done during the summer of 2006. They enrolled 21 participants for this summer camp. They grouped the participants in small group and for each group were assigned a facilitator. The challenges done during this period included Mars Rover Challenges, Tugof-war Challenge, and Creature Bot Challenge. They provided Lego Mindstorms robotics kit and Robolab programming environment. As part of day activity each group had the possibility to share ideas with other groups. To assess participants' knowledge they did a pre and post-test. The test included question about Newton's law of motion, which were created by their team. For the scientific inquiry they used the material created by Harvard graduate school of education. Additionally, they used facilitator interviews and reflection to get a better understanding. Their results suggest that robots have an impact in physics but not in scientific inquiry learning.

Ashdown and Doria described an activity to teach Doppler Effect in a school [7]. They did an activity where first the phenomenon is explained to the students, and then they proceed to give required definitions to understand the effect. To give a practical application of the effect, the students are asked to create a set up where the effect is evident. They highlight that letting students to think about the experiment, let them to think about the concept. Moreover teachers observed students getting engaged in the activity.

Alimisis and Boulougaris explore possibilities to use robots to foster students graphing abilities [8]. They suggest that understanding physical graphics could be difficult for students because they cannot make the connection between the physical variables and how they are connected. They mention diverse approaches to teach abilities to create physical graphics, which are mostly virtual activities. They suggest that doing these virtual activities students loose the possibility to get engaged with real objects, and intrinsic errors introduced by diverse factors (e.g. friction). To verify if robots have an impact in graphing skills, they designed an activity based on constructivism. Groups of five students

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were created to build a robot from scratch using the Lego Mindstroms NXT Kit. The students had to make the robot move forward and backward in a constant speed, acceleration or deceleration. Teacher was asked just to provide basic support to students regarding the technology used. Also it was given worksheets with open/questions to each group. The activity was carried out in four sessions of two hours each. To evaluate student progress they decided to use free questions rather than multiple choices, which has been identified to have disparities [9]. Two tests were done, one before the sessions and one after. The results showed an improvement on understanding of kinematic concepts.

Hussain et al. [10] wanted to replicate the experience done by the Peruvian government that at the end of 90’s, which introduced Lego in schools around Peru. Peruvian researcher found a significant impact on the students learning. However the authors suggest that those findings cannot be generalized mainly because most of the students in Peru did not had any previous experience with computers, which could not be stated in Sweden. So they wanted to see if there is any impact on the use of Lego Dacta material by the pupils. They did a study for one year with two groups, control and test. The test group worked in groups of 3-4 pupils each time they work with the robotic kit. They used quantitative (e.g. test in mathematics and problem solving) and qualitative (e.g. observations, interview and inquiry) methods to evaluate the study. Their results show that students used two different methods to learn when they were interacting with the kits. One way to learn was by trial and error, and the other was cooperative. Also they found out that girls were more often willing to follow instructions while boys were not. They also found that there was not much improvement in logic skills, but there was an improvement in cooperative work. Also they did not observe any difference between young and old learners in the ability to build, program or handle Lego material. They also provided some suggestions based on their patterns observed in the lessons. (i) It is necessary a large space to let the students to spread and work on diverse solution. (ii) Working groups should not be big. (iii) The task must be relevant and realistic to solve.

Sullivan et al. used as programming software called Creative Hybrid Environment for Robotic Programming (CHERP), which is a tangible and graphical computer language. Students can create programs using interlocking wooden block or on screen programs. They implemented a curriculum using the positive technological development framework [11]. The curriculum was design to be used in a pre-kindergarten classed as central topic the engineering design process. The curriculum involved about ten hours of work over the course of five days. All activities were focused on creating tools for assisting recycling process. Therefore, participants during these activities followed the engineering design process to create this objects. The activities were: (i) introduction to engineering design process and engineering; (ii) introduction to robot (iii); introduction to programming; (iv) culmination of the project: Robot recyclers. In addition, participants received handbooks to plan, design and refine their robotic construction and programs. Their results show that all participants were able to create functional robots. Also each group had individual help from an adult to ensure that the final project was accomplished. Also their results showed that after the week children had a better understanding about what an engineer is and the objects they create. Moreover participants showed an improvement in participants’ programming.

Sullivan and Bers studied how robotics and computer programming could be used in pre-kindergarten to second grade classrooms and what children could learn from them [12]. They developed an eight week curriculum focus on teaching foundations of robotics and programming concepts. They used the robotic platform KIWI, which was specifically design for young children (four years and up). KIWI platform is programmed using the Creative Hybrid environment for computer Programming (CHERP) and it does not require any computer to be programmed. The curriculum was focus on introducing robotics and programming. There were a total of eight activities, each one with duration of one hour. During these activities, students were introduced to diverse sensors (e.g. light sensors) and programming concepts (e.g. conditionals and cycles). As a final project, the researchers asked the students to draw their neighborhood's map and program the robot to move along it. The projects for older children had a higher level of difficulty respect the young ones. The results suggest that children, even the youngest, were able to program correctly their robots. Also, the results suggest that pre-kinder students had difficult with sequential thinking. The researchers believed that this could be due young children working memory and capacity to remember parts of a story is still under development.

Robotics platforms have been not just used as tools to be used by teachers in the classrooms. They have been also started to being suggested as autonomous agents that could motivate students in the classroom through real interactions. Werfel, in his position paper, introduced the idea of using robots as teachable agents in classrooms [13]. He suggests that the act of teaching requires a deep understanding of the material, with could be beneficial to students, who would require the creation of underlying connections to teach a specific topic. This approach has been used with virtual agents, but he believes that better results could be obtained through the use of robots due their physical embodiment. He gives some examples where robots physical embodiment has shown a positive impact in comparison virtual agents.

Continuing on the same line, Walker and Burleson use a Speed Dating method to stablish needs that users perceive when they interact with teachable robots [14]. To do this they focused on geometry and used iRobot to create 24 scenarios. Their scenarios are crated on the assumption that people can interact with the robot through gestures and speech. They asked participants to play one of the following roles: robot, peer tutor, classroom teacher, and peer tutor helper. They asked the peer tutor to teach the robot a particular concept with the help of the classroom teacher. They results show that students complain when not enough support or too much feedback were given. Researchers identify that motion is important to them, because it helps break the monotony of class. More important participants highlight the importance to visualize geometrical concepts in the real world and the interested on interact with the robot in pet-like way.

Once again the importance of robots' embodiment is used as motivation to create a tutor system. Serholt et al. [15] decided to focus on geography because they considered that this topic has not been explored enough in educational robotics. Therefore, they envisioned a robot taking the role of a tutor while students use a touchscreen table to do their task. They idea was to focus on teachers' rather than students' requirement because they consider (i) teachers could or not accept this type of technology in their classrooms. And (ii) teachers have experience knowing possible barriers that could come during the adoption of robots in classrooms. Therefore researchers conducted interviews to teachers from Portugal, England, Scotland, and Sweden. The interviews show that teachers do not want administrative overhead, generated by trying to manage the time that each student interacts with the robot. Also teachers suggest that the robot should be able to understand the classroom situation and collaborate with the teacher. Moreover teacher would prefer that the assessment responsibility remains with the teacher.

Kanda et al. evaluated the impact of a social robot as a tutor in a robotic activity [16]. They offered an eight sessions of two hours, where participants learnt about programming and basic aspects of robotics. In the last lesson participants' learning achievement is measured via test. The robot tutor was implemented with diverse behaviors, which could fall into manage or social categories. Manage behaviors are related to behaviors that are used to control the activity, while social behaviors are

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used to motivate and interact with the participants. Their results showed that robot's social behavior in the first classes motivated students to work more but this motivation decayed through the classes.

Brown and Howard studied the impact of verbal cues given by a robot into participants' performance in diverse math test [17]. To test if there is any positive impact, they did an experiment with a control and test group. They results suggest that the presence of verbal cues reduce the time required to complete the test, and make more enjoyable the test.

The works presented in this chapter show the multi-displicinarity in educational robotics. Moreover, the activities done in each one of these works let us to determine the current and further tendencies to generate processes that are suitable to generate activities with robotics. To summarize the works and get a better picture of the use and domain of robotics in education has been created Table 1. Three types of roles were used in it, which are suggested by Mubin et al. [18]. These roles are (i) as tool, when the robotic platform is used as teaching aids, where students would be building, creating and programming robots; (ii) As a peer, the robot could have spontaneous collaboration with the kids or been a kid receiver; (iii) As a tutor, the robot is going to support children learning, and in some cases motivating kids to continue with the activity. In Table 1 could be observed there is a multidisciplinary of topics that have been taught or is intended to be taught with robotics, which range from mathematics to geography. When robotics platforms are used as tool, the predominant platforms are the ones provided by Lego. Also it could be seen a tendency to look for possible requirements that a social robot would require in case the robotic platform is used as tutor in a classroom.

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Table 1 Summary of the works studied.

Work	Publication Year	Country	Domain	Platform; Role	Programming Language
Stager [2]	2010	USA	Programming and mechanics	Lego; Tool	Lego environment
Riedo et al. [3]	2013	Swiss	Programming	Thymio II; Tool	Thymio's Software
Stoeckelmayr et al. [4]	2011	Austria	Programming and Technology	Bee-Bot; Tool	Not required
Church et al. [5]	2010	USA	Physics	Lego Mindstorms: Tool	Lego environment
Williams et al. [6]	2007	USA	Physics and scientific inquiry	Lego Mindstorms; Tool	Robolab programming environment
Ashdown and Doria [7]	2012	USA	Physics	Lego Mindstorms NTX; Tool	Not specified
Alimisis and Boulougaris [8]	2014	Greece	Physics	Lego Mindstorms NTX; Tool	Lego education program
Hussain et al. [10]	2006	Sweden	Mathematics	Lego Dacta; Tool	Not specified
Walker and Burleson [14]	2012	USA	Geometry	iRobot; Peer	Not specified
Kanda et al. [16]	2012	Japan	Programming and Robot construction	• Robovie-R3M; Tutor • Lego Mindstroms; Tool	Not specified
Sullivan et al. [19]	2013	USA	Engineering design process	Lego education WeDo; Tool	Creative Hybrid Environment for Robotic Programming (CHERP)
Walker and Burleson [14]	2012	USA	Geometry	iRobot; Tutor	Not specified

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Sullivan and Bers [12]	2016	USA	Programming	KIWI; Tool	Creative Hybrid Environment for Robotic Programming (CHERP)

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4 FRAMEWORK

The framework's main goal is to provide processes and tools that could help people (e.g. teachers and other organizers of educational activities) to design, implement and improve robotics activities for learners. To achieve this objective a macro process was created based on the use in research cycles and professional teaching and learning cycles [20]. The main aim is to conceive a suitable structure that is used in activities that involve the use of robots. The final result is depicted in Figure 1. This process is compound by four main macro phases: design or adaptation of an activity plan, implementation in real settings, activity's evaluation or assessment, and improvement of the activity plan. The first macro 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 macro 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. The fourth and last macro phase focuses on possible improvements of the activity plan based on information derived from the implementation in real settings, on reflections from the teachers, the students and the designers. Once the activity has been improved, the cycle should be continuing with adapting the activity for future groups.

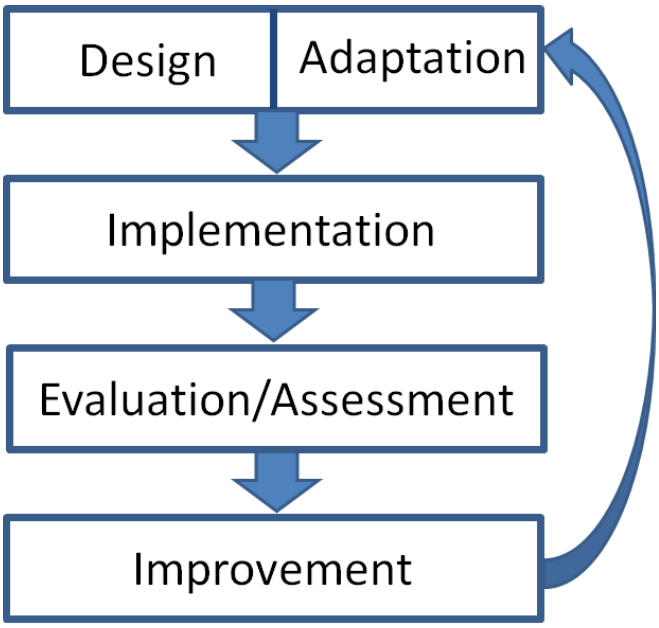

Figure 1 Framework's macro process definition

Using this macro process as reference, three specific processes that embraces the stakeholders' (i.e. teachers, organizers of educational activities, and educational researchers) needs, elaborated on in in the deliverable 1.1., have been identified. These three processes are: (i) conferences and competitions, (ii) research, and (iii) pedagogical activities. The process for conferences and competitions is created from the experience acquired during ECER 2016 and it will be improved after 2017 and 2018 editions. This process is fed by the work package three and it embraces the two main stakeholders: researchers and teachers. The research process is focused on experiments in educational robotics, which will provide diverse approaches to describe the experiment and measure the desired variables. This process is supported from the whole project's experience and contributed to mainly by the work packages four and six. Although this process is mainly designed to be used by researchers, it is also designed to address stakeholders who are not researchers but still would like to

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do an experiment in robotic education. Finally, the pedagogical activities process is conceived to help teachers and instructors to structure their pedagogical activities in a way that could have a better impact in their pedagogical practices and at the same time become available resources used by others. This process is supported by pedagogical approaches studied in the work package four and experiences acquired through the whole project.

All these processes are supported by a glossary and skills tree. The glossary and the skills tree are introduced as mediating artifacts [21] to facilitate the design process and the implementation of educational robotics in practice. Conole argues that exploitation of the full potential of the technologies in practice can be facilitated by mediating artifacts which consist of transferrable properties of learning activities with digital technologies that are not context bound. The glossary provides a vocabulary that is used in educational robotics. This vocabulary brings a common ground among all the newcomers in the field of educational robotics and let everyone to get a better understanding on the real meaning of the words used in a long the framework. On the other hand, the skills tree concept is a interconnected representation of skills that are acquired through the use of robotics. This concept helps (i) to realize the pre-requisites to acquire specific skills, (ii) calculate the required time based on amount of skills covered during the activity and (iii) be a bridge between the activity and curriculums. Due to the broad spectrum of robotics skills, these skills trees are going to be generated exploiting the existing community in educational robotics. The idea behind the skills tree is explained in the next section.

4.1 SKILLS TREE

Due to intrinsic interdisciplinarity in robotics, it could be difficult for someone without enough experience determine the precise skills that could be necessary for specific tasks or to obtain a new skill. To overcome this difficulty, we introduce the concept of skills tree, which consists of an interconnected representation of the robotics' skills. However creating this representation is time consuming and out of the scope of ER4STEM project. Therefore, it has been planned as an outcome for the second year to have a process that guides other experts to create their own skills tree and to contribute it to the community on a voluntary basis through the repository.

To construct the first version of the skills tree, it was followed a bottom up and a top down approach. The bottom up approach is grounded on a review of existing lesson plans with educational robotics that refer to specific skills and connect them to specific activities (See deliverable 4.1). The top down approach is based on bibliography about the skills developed or those that can be pursued when educational robotics are used. To do this study, it was consulted the following libraries: ieeexplore, acm and sciencedirect. Table 2 presents the keywords used in each one of these libraries. The review is summarized in Table 3. As it could be observed, the skills mentioned in these works are too general to know the specific skills that are used in robotic activities. For example, robotic activities have a positive impact in problem solving, would mean that these activities have a positive impact on all skills that are involve in problem solving? Or just a set of skills are improved? And more important all the activities have the same amount of improvement? As a consequence a deeper study on skills and how they are related to the activities should be done to help in the improvement of robotic activities. To constrain this study, it was decided to determine the skills require in the industry and based on the results developed trees for those skills.

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Table 2 keywords used in each library consulted

Library	Keywords used
ieeexplore	((skills or skill) and (robotic or robotics) and (school or k-12))
acm	((skills OR skill) AND (robotic OR robotics) AND (school OR k-12))
sciencedirect	((skills OR skill) AND (robotic OR robotics) AND (school OR k-12))

The study's results revels that six main skills are required in the industry. (i) *Problem solving* is a key aspect for admittance of a new employee in a company. Passive or technical knowledge is worthless if the person is not able to synthetize a new solution out of given facts. (ii) *High level problem solving* is the ability to see problems in context and on a high level of detail. People with this skill are able to propose products and future trends. (iii) *Specific knowledge* is the very detailed knowledge of a particular technology or knowledge area. (iv) *Creative thinking* is a very high ranked skill and must be accompanied with major amount of self-reflection in order to objectively evaluate new ideas and reject wrong ones. (v) *Efficiency* is related to the time required to finish a given task. It usually is considered with no procrastination. (vi) *Flexibility* to use various technologies and to adapt to a given problem is appreciated by employers very much. There may be many very focused employees who do not wish to switch to a different technology or learn acquire new skills.

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Work Title	Skills mentioned	The skills are evaluated?	Instruments used to evaluate the skills	Description of the activity	Robotic platforms used
A Deeper Understanding of Technology is needed for workforce Readiness [22]	Researchers mention diverse studies on skills in USA, OECD and ATC21S. They mention that SCANS work divide skills in two groups: • **Competences:** Resources, interpersonal, information, systems and technology • **Foundations/fundamental:** Personal qualities, Thinking skills and basic skills	Not specified	Not specified	Researchers presented a case study done in the Academy of Informational Technology and Engineering High School. Although they not give any description of the activities done in the institution, they present the experience of different people involved in these activities. The researchers give an important point about students and teachers in the school, which are provided with PC tablet computers.	Not specified
Application of the Cognitive Apprenticeship framework to middle school robotics camp [23]	Engineering design skills and developed skills in engineering, science, and computational thinking	Yes. Researchers' results suggest participants had an improvement in their scientific reasoning.	Researchers used which included the STEM semantic survey (SSS [24]). They also implemented pre/post questionnaires using Piagetian' variables [25]	Researchers used the cognitive apprenticeship and Carnegie Mellon to create their activities. They divided the activities in two parts: moon mission and pantheon. The activities took place	Lego Mindstorms

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				for two weeks with three to four hours per day.	
Developing technological knowledge and programming skills of secondary schools students through the educational robotics projects [26]	Programming skills	No	Not Apply	Researchers created a six session activity, each session lasted five hours. During the first two sessions, participants get all the theoretical background, which includes robotics and constructionism topics. In the next three sessions participants have hands on robotics kits, and in the last session the projects were presented.	Lego Mindstorms NTX and WeDO
Evaluating the impact of educational robotics on pupil's technical and social skills and science related attitudes [27]	Technical skills: • general programming and/or robotics • computer science • textual programming • mathematics and scientific investigation Science related attitudes and interest Social and Soft skills: • self-efficacy in robotics • problem solving • teamwork attitudes • social skills	Yes, Researchers did two groups: control and experiment. The experiment group was mainly kids that participate in Robocup Junior. Their results suggest a positive effect of robotics in mathematics and scientific	Researchers used a pre and post questionnaire with 129 questions from diverse assessment tools, such as multiple choice and Likert-scale. They divided the questionnaires in four parts as follows: • Demographic and background • Technical skills • Science related	The activities were based on preparation for Robocup Junior	Lego Mindstorms and kits to participate in Robocup Junior

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		investigation, teamwork, and social skills	attitudes • Social and soft skills		
Fostering analogical reasoning and design skills through creating bio-inspired robotic model [28]	Analogical thinking skills	No	Not Apply	Students were asked to replicate some biological model using the kit provided. 14 sessions of two hours, where the following topics were given: Introduction to robotics; basics of construction and use of picocricket kit; sensors and control; DC motors and digital transmission; inquiry into a biological system; creation of robotic model; presentation and evaluation of the robotic model.	Picocricket kit
Robots for educations [29]	Teamwork, communication, and problem solving.	No	Not Apply	The authors presented diverse works that have shown a positive impact on the development of teamwork skills, communication skills, and problem solving skills.	Not Apply
Improving engineering	Science skills and basic skills determined	Yes.	Test before and after the	The researchers first	Not Apply

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skills in high school students: a partnership between university and K-12 teachers [30]	by engineering professors. These skills are: communications, reach to conclusions, find information, analyze situations, concept of function, develop of arguments, creation of hypothesis, derivatives, limits, tangencies, teamwork, scales and proportions.		intervention was done in all the schools that took place.	asked engineering professors to determine the weaknesses of engineering students. Once the weak points were stablished, they did a test in the schools that were participating in the research. Based on the results they created activities to be done in the schools to improve students skills in the areas determine as important. Then a second test to see if there was any improvement in the students.	
Acquisition of Physics content knowledge and scientific inquiry skills in a robotics summer camp [6]	Physics and scientific inquiry: planning and conducting investigation, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific argument	Yes. Researchers had two researches question: do student participant exit the summer robotic program with increased content knowledge? Do student participants exit the summer robotic program with better scientific	Pre- and post-test were done to assess participants. These test consisted in multiple chose items that was created by them. The questions were focus on newton's laws of motions. For the scientific inquiry they used the material created by Harvard graduate school of	Two week robotics summer camp. The participants were group in small group and each group had one facilitator. At the end of each day groups could share ideas among them.	Lego Mindstroms and Robolab programming environment

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		inquiry skills?	education		
A robotics based design activity to teach the Doppler effect [7]	Doppler effect	No, but researchers had a clear learning objectives, which are inform	Not Apply	The phenomenon is presented in an intriguing way. Then they defined frequency, wavelength, and velocity. Then students are asked to create a set up where they show their understanding of the phenomenon.	Lego Mindstorms NTX

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5 PEDAGOGICAL ACTIVITIES PROCESS

As it was mentioned in the previous chapter, the pedagogical activities process aims to stakeholders create, implement and improve robotic activities that are well structured and could be shared with others. To achieve this objective an instance of the macro process (Figure 1) has been created. This instance is shown in Figure 2. This process could start in two different ways. The first is when someone has an idea and wants to develop it. In this case the person starts with the macro phase Design. If the person wants to adapt an activity to their specific situation, they start the process on the adaptation macro-phase, which have two possible outcomes. One is to re-do the whole design of the activity, because the contexts are so different. The second, it is that the activity could be modified. Despite designers' starting point, in both cases the final result is an activity plan.

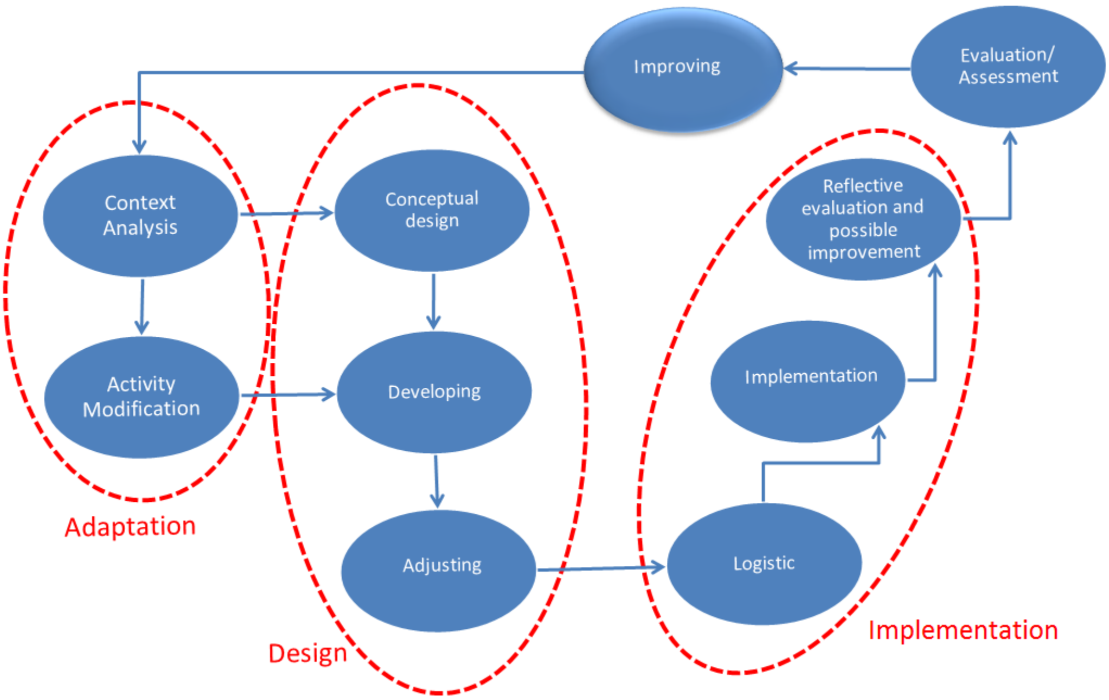

Figure 2 Pedagogical activities process

5.1 DESIGN

As Figure 2 suggests the instance of the meta-phase design is composed by three steps: conceptual design, development of the activity plan, and adjustment. These phases will lead stakeholders to materialize their ideas and produce material that is used during the implementation. The conceptual design focuses on conceiving an activity idea that integrates educational robotics in the teaching and learning process. Conceptual design can be inspired by specific topics to be taught or by characteristics of the available technologies. Usually conceptual design and development is a continuous movement between the above two ends. As a result of this phase, an activity plan [19] is filled out. The next phase consists of developing all the required materials to carry the activity such as handouts, software libraries or hardware. During the implementation of the activity, it is necessary to adjust possible aspects that are noticed during the development and that could improve the activity quality.

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Conceptual Design

The conceptual design phase focuses on conceiving and specifying an activity idea about implementing educational robotics for teaching and learning. This specification is achieved through diverse steps, which are depicted in the Figure 3 and each one of the step is described in more detail below.

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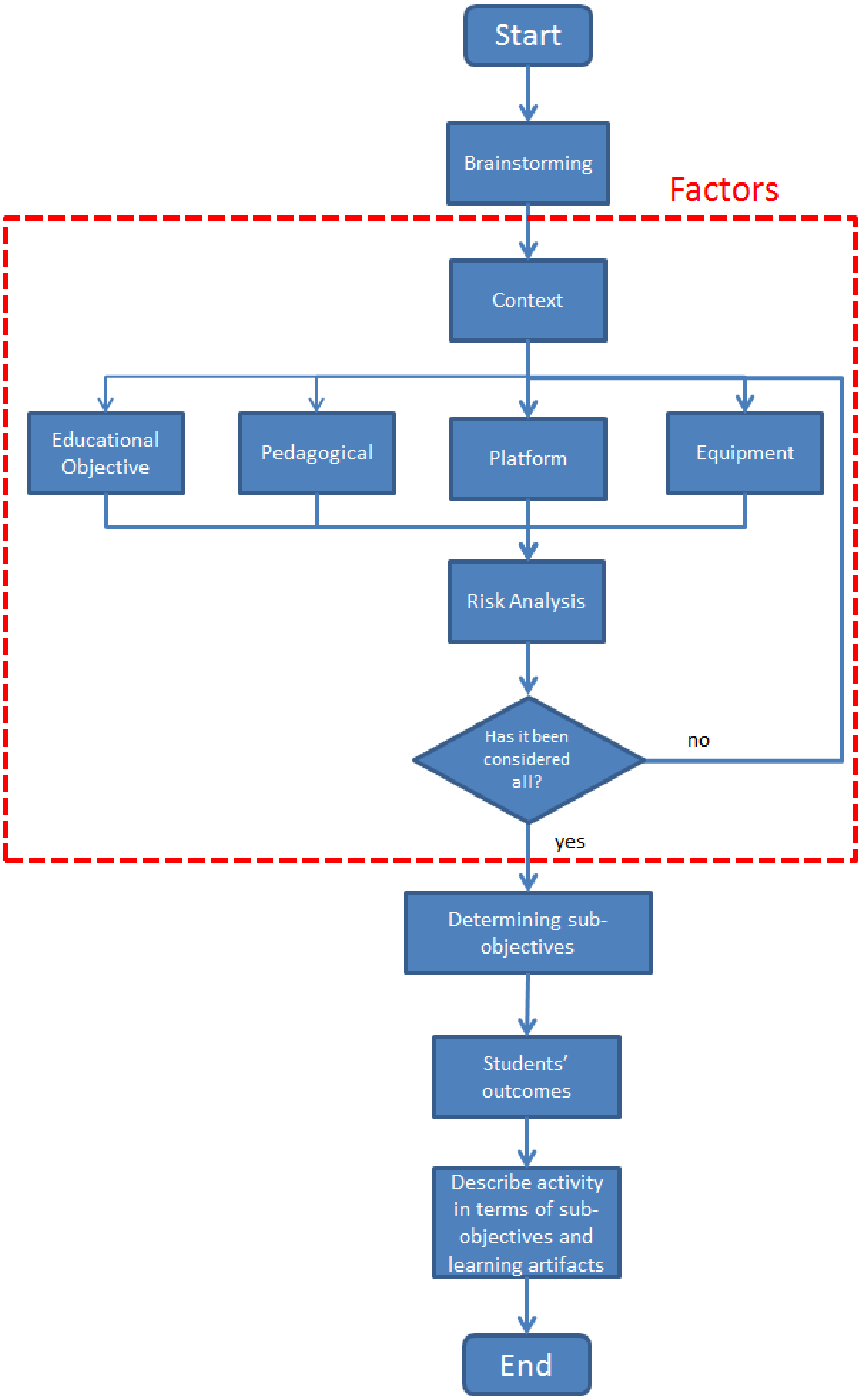

Figure 3 Conceptual design's flow diagram.

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BRAINSTROMING

In this step designers are going to come up with ideas for the activity without considering any possible constraints. The main objective of this step is to generate the activity's concept that is going to be developed in the next steps. To guide designers in the brainstorming the following questions are suggested:

- What am I going to teach? / What do I want my students to learn?
- What is difficult for my students to understand that could be better elaborated with robotics?
- What would be fun/ interesting for my students to learn with robotics?
- How can I use this robot to teach my students? (Inspired by specific technologies)
- What is special about this robotic kit and how can I use it for my teaching?
- Who are my target learners?

If the activity is going to be designed collaboratively by more than one person, it is advisable to let each member first do the brainstorming by their own and then do a meeting, where each member explains his ideas. In this way the team members would have time to think about the activity and organize their ideas to later share with the rest of the team.

DETERMINING THE FACTORS

In this step we are going to focus on the diverse factors involved in the design process of activity plans for teaching and learning with educational robotics. By identifying these factors we aim to support designers to perform a risk analysis in order to help them take into account the crucial aspects that should be addressed before starting the implementation of the activity. Through the study of diverse platforms' characteristics, related work, and consortium knowledge, there have been identified five factors that should be considered any time that a new activity is been designed: robotic platform, equipment and spaces, educational objectives, pedagogical approach, and context. These factors also correspond to diverse fields on the activity plan. Thus considering them would guide designer to fill the activity.

The *Robotic platform* is a factor that should be considered in order to determine the equipment (i.e. hardware and software), the characteristics of the space, skills and concepts that can be taught during the activity. For example, let's consider the Sphero Sprk plus [31] and Thymio II [32]. Sprk is a robotic ball developed by Sphero and it has gyroscope and accelerometer sensors. It is programmed through diverse applications that could be downloaded in smartphones and tablets, but also it could be also programmed via Chrome's extension. The programming is done via Bluetooth. Thymio II is a robotic platform with diverse sensor (e.g. accelerometer and distance sensors). It is programmed via USB or plugin a USB key in the computer to do it via wireless. Although these two platforms could be used to teach programming, their physical characteristics determine topics that could be also teach with them. For instance, Sprk could be used to teach concepts of rotation, friction and angles. On the other hand, Thymio II could be used to explain proximity sensor (i.e. infrared proximity sensors) and let participants draw. These subtle differences influence factors and could bring different learning outcomes.

Equipment and spaces factor is concern about the physical spaces (e.g. classrooms and computer rooms) and the equipment (e.g. computers, laptops and tablets) available in the institution. Continuing with the example of the two platforms already mentioned. Thymio II required access to

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computers' USB while Sprk requires Bluetooth modules, which could require having Bluetooth USB or tablets. These two different devices would require specific spaces, in which different approaches could be followed. *The educational objectives* factor is related to the main concepts that are going to be covered during each session. Depending on the stakeholder who is designing the activity, it helps to align the activity to specific curricula (e.g. teacher), or design an activity with concreate objectives, that could even be measured. They are also going to be influenced by the platform. Moreover, this factor is highly influenced also by *pedagogical approach* factor, which is related to stakeholders' teaching approach (e.g. discovery learning or collaborative learning). The last factor is the *context*, which influences all the previous factors and gives important information about the profile of the participants (e.g. students), the characteristics of the organization (i.e. school, museum) which hosts the activity, and country. This information could significantly change the educational objectives of the activities when participants do not have the same previous knowledge, or it could prioritize some spaces rather than others. Also it gives valuable information to understand where an activity was designed, so it would allow the adaptation to other contexts.

To have a clear idea how these factors are related among them, it is possible to think that robotic platform, educational objectives, equipment and spaces, and pedagogical approach are located in the edge of a pyramid, one factor for each edge. Context is a factor that also affects the other four factors. Therefore it is visualized as a ball that covers the pyramid. The Figure 4 depicts this idea.

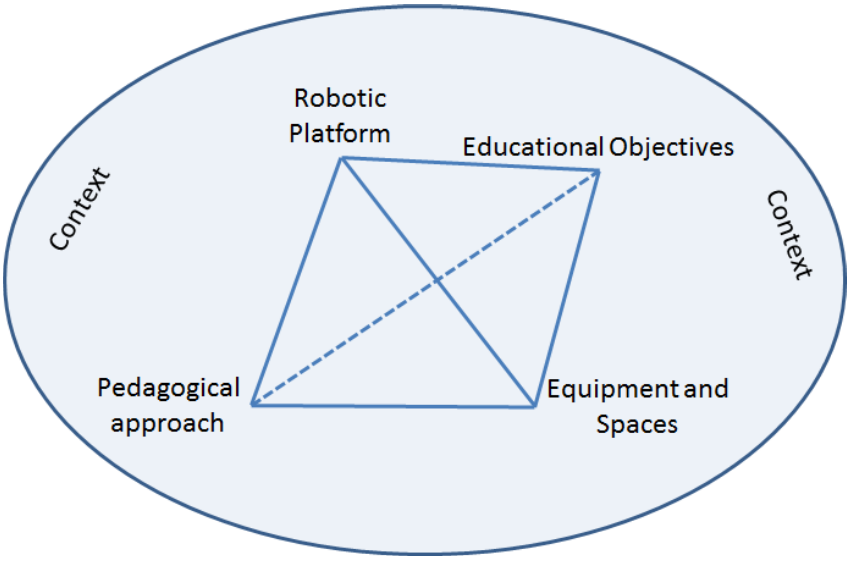

Figure 4 Factors that should be considered during the design of a pedagogical activity

To further illustrate how these five factors are used to identify crucial aspects for the design and implementation of the activities we analyzed them into a set of questions to be considered by the designer. Such as it is suggested in Figure 3 the first factor to consider is the context. The questions in this factor are:

- The group of participants is just conformed by males, females or both?
- How old are the participants?
- What is the maximum number of participants that you are able to manage?
- What is the cultural background of the participants?
- Is expected to have participants with disabilities?

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The questions marked with ▪ bullet are present in the activity plan. The same notation is going to be used for question in other factors. Once the context's questions have been answered, it is open to the designer to decide which factor start. The following are the questions for each factor:

Educational objectives:

- ▪ What is the domain of the activity? (e.g. Mathematics)
- ▪ What is the skill or skills that are going to be covered in the activity?
- ▪ Is any previous knowledge required?
- ▪ How are you going to assess the participants' evolution?

Robotic Platform:

- Which are the robotic platforms available in the organization?
- Are you able to buy new robotic platforms?
- What is required to use the robotic platform? (e.g. batteries)
- How many robotic platforms do you have?
- What can you teach with each one of the robotic platform enlisted?
- What are the roles that could be portrayed by the robotic platform? (e.g. tool, tutor or peer)
- Does the robotic platform need to be assembled? How many times could be assembled the robotic platform? How many ways the robotic platform could be assembled?
- How many robotic platforms are fully operational?
- How many spare parts are available?
- Which is the recommended age for the platform?
- How is the robotic platform programmed?

Equipment and space:

- What is the equipment that is available in you institution?
- How many of each of this equipment exists in your institution?
- What is the procedure to have access to this equipment?
- How many computers rooms are available in the institution?
- How many people use these computer rooms?
- How many people could fit in the computer room?
- Are there laptops/tables available?
- How many hours could you have access to the computer rooms or laptops?
- How can you access to the computer rooms or laptops?
- Can you modify the room's organization?
- Where is going to be done the activity?

Pedagogical approach:

- What is going to be your role in the activity?
- What are the materials that you are going to give to the students?
- What is going to be the process followed by the students?
- How are you going to manage students' difficulties during the activity?
- What is the social orchestration/s you are going to use? (Working in groups? Working individually? Switching between different modes?)
- If the participants are going to work in groups, how these are going to be established?

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- Are you expecting interaction between the participants?
- How are you going to manage the different learning pace of the participants?

Risk Analysis

Once all the factors have been considered is necessary to determine if there is any inconsistency among these factors. For example, the use of collaborative approach could require modifying the distribution of the tables in the room. However, not all computer rooms allow the redistribution of tables. This could bring stakeholders to rethink the approach to be used in the activity: changing the pedagogical approach or looking for a different space. Table 3 presents small example of questions and a template that could be used to look for incongruences or risks. The table includes a column for comments, which let stakeholders to add possible solutions or threats. These comments would let, in the future, to have a better understanding on the decisions made during the design, which sometimes could be forgotten after some time.

Table 3 Example of questions that could be used to determine incongruences.

Equipment and Space – Context		
Question	**Yes/No**	**Comments**
Is the equipment (e.g. platform and computers) sufficient for participants?		
Can you make sure that the equipment (e.g. robotic platform and computers) will be available for the duration of the activity?		
Equipment and Space – Pedagogical Approach		
Question	**Yes/No**	**Comments**
Can you re-organize the space to facilitate your pedagogical approach (e.g. group work? Interaction during construction etc)?		
Do you consider that all the available equipment could be used in the desired methodology?		
Equipment and Space – Robotic Platform		
Question	**Yes/No**	**Comments**
Does the robotic platform require specific software to be installed?		
If the answer to the last question was yes, can you install the program or is already installed?		
Do you have all the necessary components to program the robot? (e.g. USB cables)		
If your answer to the last question was no, do you have budget to buy the additional components?		
Robotic Platform – Educational Objectives		
Question	**Yes/No**	**Comments**
Can the platform Support all the aspects of the activity you have in mind?		
Does the specific platform support the stated objectives?		
Robotic Platform – Context		
Question	**Yes/No**	**Comments**
Can you book the robots for the amount of hours that you are going to use them?		
Is the platform safe for the participants?		
Do you have enough robotic platforms for all the		

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groups?		
If you have to buy materials, do you have enough budget to purchase them?		
The robotic platform shape is not considered as vulgar or offensive by the institution, country or community.		
Is the robotic platform advisable for the participants' age?		

DETERMINING SUB-OBJECTIVES

With a clear idea about the activity, it is necessary to establish objective/s for each session of the activity. For example, suppose that the activities are going to be related to programming and the final objective of one session is the use of cycles. With this objective now it is possible to determine sub-objectives that should be achieved during the session. Continuing with the previous example, the use of for cycles would require children to: (i) recognize variables, (ii) use variables, (iii) recognizing conditional, and (iv) use conditionals. Two methods could be used to determine all the sub-objectives: (i) the use of the skills tree and (ii) manually. Using the skills tree is the simplest method, because it provides a clear connection among the skills in robotics and gives a visual representation them. Once the skills are identified, designers could establish their desire sub-objectives. On the other hand, the template depicted in Table 4 is suggested to the manual method. The main objective is to specify measurable and concise sub-objectives that should be reached by the participants. Therefore it is advised to write just one concise sub-objective in the post-requisite field. For example the objective to program is not measurable or specific, and more important achieving this objective would have more than one specific objective (e.g. understand variables and conditionals). Regarding the method used to create all the sub-objectives, designers at this point should realize if all the sub-objectives could be reached in the session's time. In case that it could not be accomplished, the activity should be adjusted to the time constraints.

Table 4 Sub-objectives information

Sub-Objective			**Pre-requisites**	**Post-requisites**
ID	**Short name**	**Description**		
SO 1	Sub-objective 1			• SO 1
SO 2	Sub-objective 2		• SO 1	• S0 2
SO 3	Sub-objective 3		• SO 1 • SO 2	• SO 3

PARTICIPANTS' OUTCOMES

After establishing the order of sub-goals is necessary to determine what outcomes are expected after achieving each one of the sub-objectives. The outcomes are divided in four parts artifact, code, and robot actions. Table 5 provides a template for this step. As it could be seen the left part of the template is the sub-objective ID, which was established in the previous step. The next three columns correspond to the following outcomes:

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- *Artifact* is any creation done by the participants. It includes building the robot, writing a diary, writing a report, just to mention few.
- *Code* is computational writings done in specific programming language. This outcome does not necessarily produce any action in the robot. For example a code outcome could be the function/method read_file, which does not make the robot move.
- *Robot action* is an expected action that the robot should do. These actions could be as simple as move forward, to more advance as avoid obstacle.

After these three columns have been filled, designers could start describing the actions that will be done to achieve each outcome. It is important to notice that the actions should be aligned with the desired pedagogical methodology. Once the actions have been enlisted, the designers are advised to give an estimate time for each action, which should be done base on participants' previous knowledge and designer experience. Designers are also encouraged to determine possible actions for the fast finishers. Some possibilities would let those participants to help others or additional challenges. This estimation would help designers to establish a base line time for the activity, which will be corrected after activity's implementation.

Table 5 Activity description template. Where artifacts is creations done by the participant, code is the lines of code written (e.g. function or methods), and robot action is the physical movements done by the robotics platform.

Sub-objective ID	Outcome			Sequence of Steps	Time
	Artifact	Program	Robot Action		
SO 1	Robot part 1				
SO 2		Program 1	Action 1		

Developing and Adjusting

These two final phases focus on developing all the necessary material for the activity and refining the activity description based on the weaknesses found during the development. To achieve this, the developing phase is done using the activity plan as a reference. Two main aspects in the activity plan should be spotted: first the pre-requisites for the activity, participants' knowledge and activity's goal, and second the desired outcomes. The first aspect gives information about tools and software libraries that should be provided to the participants. For example, consider the situation where a bipedal robotic platform NAO is going to be use. This robotic platform provides all the necessary libraries to make walk, hiding the control to move all the robot's joints. However if the objective of the activity is to give an understanding about the walking control, the walking libraries are not given to the participants. The second is related on what information (e.g. books and booklet) that could let participants to accomplish the outcomes specified in the activity plan. During the developing it important to spot possible difficulties that participants could face during the activity and make the necessary correction on the activity's design, which could be including additional steps or new outcomes, because during the design is possible to misjudge the activity's difficult. Once the developing, which could have included modification in the activity plan, the designer is advised to go through the activity plan and look for possible improvements.

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6 PREPARATIONS FOR A CONFERENCE PROCESS

The preparations of a conference process cover a wide range of activities which range from determining the scope to the website. This chapter introduces the first version of preparation for a conference process. The main objective of this process is to help teachers to organize conferences that involve school students. The process here presented was created from the experience lived during the organization of ECER 2016 (More information can be found in D 3.1) and it follows the same structure of the macro process (Figure 1). The instance of this macro process can be observed in Figure 5. As other ER4STEM's processes, this process can start from two different ways. One is when a new concept for the conference wants to be developed or when a new version of a conference is going to be done. The next section provides more information about each phase.

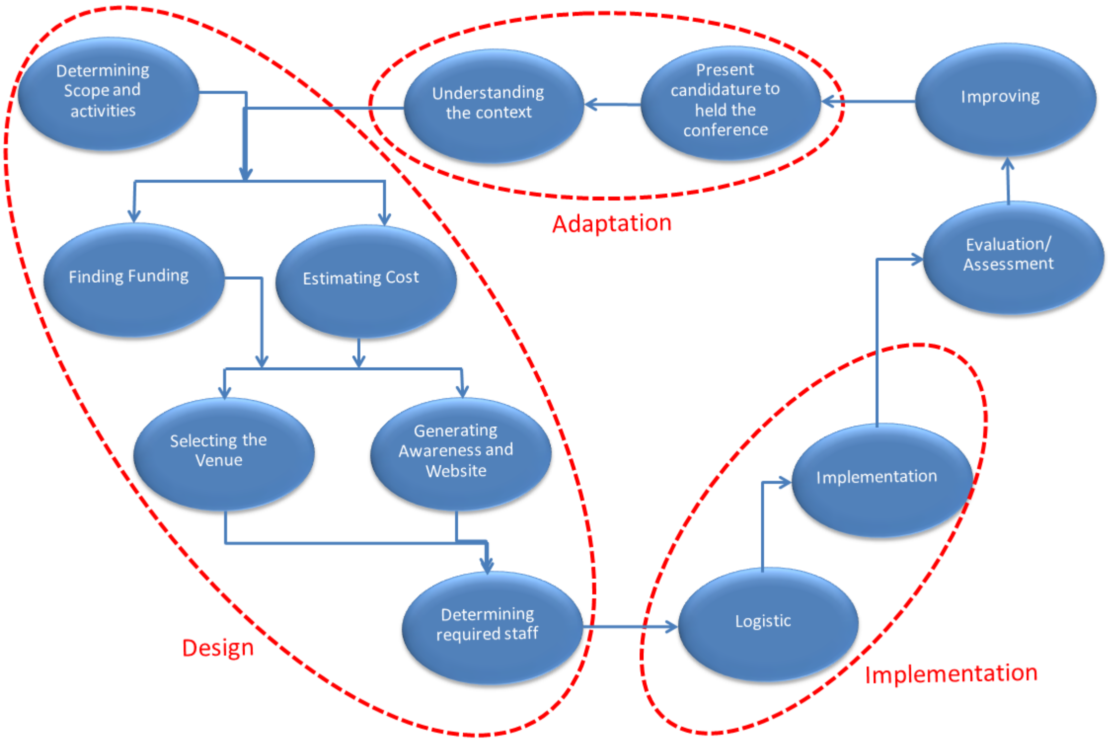

Figure 5 Preparations for a conference process

6.1 DESIGN

Determining Scope and Activities

Scope and activities of a conference or competition need to be defined at first because they influence the planning of the event. An event can be composed of one type of activity or of several types. Examples for activities are:

- *Talks by researchers*: Actual researchers present their research in a way that is comprehensible and maybe entertaining for the young audience.

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- *Talks and papers by participants*: The students submit papers likewise to an actual researcher conference and if accepted, they present their work to the other attendants of the conference. The talks of the students can be arranged according to the topics they cover in their papers.
- *Showcases*: Showcases are less formal than a talk. They can be presented for instance by sponsors or other companies that would like to show their achievements to the young audience.
- *Competitions*: One or several competitions can be part of a conference. The contestants can be individual persons or teams. Various worldwide competition programs exist for which a local conference can act as a regional competition.

Finding Funding

Evidently, a conference or a competition requires a certain amount of budget for covering costs. The three major possibilities of obtaining funding for a conference or competition are as follows:

- *Grants*: Looking for grants is recommended as a wide range of grants exist that support various activities connected with education. Once obtained, a grant represents a secure way of funding. However, grants require a certain preliminary lead time as formulating a proposal might commonly take considerable efforts. Also, there is often quite some competition regarding certain calls. It is recommended to regularly look for grants on EU, national and regional level to make sure not to miss an opportunity.
- *Sponsoring*: The concept of sponsoring is widespread among organizers of conferences and competitions. Sponsors have to see some kind of benefit from sponsoring such an event. Regarding student conferences and competitions in STEM, two types of sponsors can be identified: (i) STEM companies that are aware of their societal responsibilities in conjunction with the need for talented young future employees, and (ii) companies that are interested in young people as possible customers of their products (e.g. driving schools).
- *Participation fees*: Demanding a participation fee from all participants is another way for obtaining funding. However, one has to keep in mind that the participants are school students and therefore the fee cannot be very high.
- *Selling objects*: Depending on the legal status of the host organisation, it might be possible to create some funding by selling souvenirs (e.g. t-shirts) or other objects to the participants.

Estimating Costs

The costs depend very much on the planned activities and the available resources and environment for carrying out these activities. Possible costs are:

- *Rent of venue*: A venue is needed for the conference/competition. A school or university can be an appropriate place for hosting such an event without rental costs. If not available, then some costs for renting a venue need to be taken into account.
- *Administrative costs*: Name tags for all participants are advisable. T-shirts as souvenir for the participants are recommended for increasing the personal identification with the event but also create some PR later when worn. However, the t-shirts cause considerable costs, which is also because t-shirts in enough sizes should be available (if not known before). If not sold directly at the event, money for the t-shirts could be obtained from participation fees. Further costs might be due to printing documents or necessary office items.

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- *Equipment for competition*: If the activity encompasses a competition, equipment for the competition setup might be required. E.g. in the botball program, a specific game table is needed.
- *Spare parts for participants*: The host organisation might want to supply the participants with spare parts in case some equipment (e.g. a servo) breaks. The participants can buy these spare parts but evidently a selection of spare parts is needed.
- *Travel costs*: Maybe travel is involved for staff members or persons giving a talk.

Selecting the Venue

A venue is required that is suitable for the planned activities and number of participants. Depending on the activities, the venue should offer:

- *Working spaces*: Tables and chairs for teams that participate in a competition. It is advisable to have sturdy tables in case the teams handle equipment with metal parts. Plugs and WIFI might be required as well.
- *Place for presentations, talks and awards*: An auditorium or a big lecture hall is suitable for these activities. Maybe also bigger classrooms might be suitable.

Schools and universities are suitable venues for conferences and competitions. Moreover, their usage might be free of charge as such an event represents an effective PR-activity for them.

Generating Awareness and Website

An awareness campaign might be needed to promote the event. Various target groups exist for such an awareness campaign:

- *Participants*: The campaign should make the event attractive for possible participants that might submit a paper or form a team for a competition.
- *Sponsors*: The funding might be enhanced by sponsoring if the event is introduced to companies or other entities.
- *Multipliers*: Some entities or persons might not be involved directly in the event but might spread the word to attract other entities or people towards the event.
- *Visitors*: Especially younger school students are possible visitors that might become future participants of the event.

The awareness campaign can encompass various activities:

- *Website*: Having a website for the event is crucial as it represents the core information platform.
- *Online calendars*: The event can be registered at certain online calendars and therefore be found.
- *E-Mails to schools*: Schools are the “working” place of the target group. Winning the teachers means winning the students.
- *Booths at fairs*: The event can be made public at other fairs that target a young audience. Flyers are required.

The website represents the central place for information about the event. Its purposes are as follows:

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- Advertisement/Information: The website is the first place to gather specific information about the event. It should therefore offer clear information on the purpose of the event.
- Registration: The website can be used as tool for registration.
- Paper submission: If not directly embedded in the website, then at least a link should be provided that leads to a paper submission tool (e.g. Open conference tool, Easychair).

Determining required Staff

In order to successfully carry out a conference or competition, a certain amount of staff members is required on site as follows:

- *Registration desk*: The registration desk welcomes newly arriving participants and acts as general information or various enquiries. At least 2 people are recommended for the registration desk during the intensive times (start of the conference).
- *Technical support*: Technical support is of importance for competitions if spare parts are available. Also, the technical support should be able to answer certain technical questions. 1 person should suffice.
- *Moderation*: Moderation is needed in the sessions when papers are presented but also for introducing speakers as well as during a competition. As the audience is composed of school students, the moderator needs to know how to address such an audience. Especially during competitions, the moderator can greatly enhance the atmosphere.
- *Judges for competitions*: Any competition requires judges that know the rules and stay objective.

The staff can be composed of:

- Staff of the host organisation
- *Teachers*: Commonly teachers accompany the student teams at student conferences/competitions. They might be willing to take over some tasks.

Volunteers: If the venue is a school, students of that school might act as volunteers.

6.2 IMPLEMENTATION

Logistics

Being onsite the day before the start of the event is of utmost importance to make sure the preparations can be finished. It takes a few hours to setup the conference rooms in an appropriate way. E.g. this involves placing the working tables and equipping them with plugs or setting up the game tables for the competitions. For sure there will be still trouble shooting required during the conference but the main preparations need to be finished before the event starts.

Implementation

Implementing the conference means carrying out the previously planned activities. A detailed schedule helps keeping the participants oriented and the activities in order. Figure 6 shows the schedule of ECER 2016.

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	Monday, 11. April 2016	Tuesday, 12. April 2016	Wednesday, 13. April 2016	Thursday, 14. April 2016	Friday, 15. April 2016
8:00-8:50	Registration (Exnersaal)	Open Practice for Botball, PRIA Open, KIPR-Aerial (Exenrsaal) Registration (Exnersaal)	Open Practice for Botball and Underwater (Exnersaal) PRIA-Open and KIPR-Aerial Seeding Rounds (Exnersaal)	Registration for RiE (Aula EG) Open Practie for KIPR-Aerial, PRIA-Open and Underwater (Exnersaal)	PRIA-Open and KIPR-Aerioal Open Practice
8:50-9:40	Open Practice for Botball, Open, Aerial (Exnersaal)	Onsite Presentations for Botball-Teams (H128 - PRIA-Lab) Underwater-Workshop and Open Pracitce (H127 - PRIA-Lab)		Welcome Introd. and Keynote Prof. Petrovic´ (HS 1)	Keynote DI Lammer (HS1) Botball Open Practice (Exnersaal) PRIA-Open and KIPR-Aerial Finals (Exnersaal)
9:40-9:50					Break
9:50-10:40				Techn. Session 1 (9:50 - 10:40, HS1) Poster-Pres. 1 and Coffe-Break (10:40-11:10 CCNA-Room) Techn. Session 3 (11:10-12:20, HS1)	Techn. Session 5 (9:50-11:00, HS1) Techn. Session 6 (11:10-12:20, HS1)
10:40-11:30					
11:30-12:20		Student Talks 1 - Software Developement and Autonomous Projects (HS1)	Student Talks 2 - Best Practices and Mechanical Engineering (HS 1)		
12:20-12:30	Lunch / Break	Lunch / Break	Lunch / Break	Lunch / Break	Lunch / Break
12:30-13:20					
13:20-14:10	Onsite Presentations for Botball-Teams (H128 - PRIA-Lab) Open Practice for Botball, Open, Aerial (Exnersaal)	Botball Seeding Rounds (Exnersaal) Open Practice for PRIA-OPEN, KIPR-Aerial (Exnersaal) Underwater-Workshop and Open Pracitce (H127 - PRIA-Lab)	Botball - Double Elimination Rounds (Exnersaal) Open Practice for KIPR-Aerial, Underwater, PRIA-Open (Exnersaal)	ECER-Student Talks at RiE2016 (HS1)	Techn. Session 7 (HS1) Botball Alliances and Finals (Exnersaal)
14:10-15:00				Techn. Session 3 (14:10-15:40, HS1) Poster-Pres. 2 and Coffee Break (15:40-16:00, CCNARoom) Open Practie for Botball (Exnersaal)	
15:00-15:10					Closing
15:10-16:00	ER4STEM Teachers Confernece (H244)				
16:00-16:50				Techn. Session 4 (HS 1)	
16:50-17:00					
17:00-18:00					Awards Ceremony (HS1)
18:05-18:40	Openening Ceremony, Dr. Gottfried Koppensteiner, Pria and Invited Talk, Prof. Pavel Petrovič Comenius University in Bratislava(HS1)	Invited Student Talks (HS1), Hovering Steward (HTL Rennweg) and RobBox 3.0 (Florian Kristof)		Christoph Krofitsch, PRIA "low-cost robotics controller hedgehog-lite" Reinhard Grabler, PRIA "underwater robotics" (HS1)	

Figure 6 Detailed schedule of ECER 2016

It is recommended to stick to the plan as good as possible as otherwise confusions or unhappiness might arise. E.g. if students show up at a certain time for presenting their competition robot but then their presentation is delayed and they have to wait, they might feel as having lost precious time for improving their robot.

One also needs to keep in mind that the participants are (mostly) not yet adults, which means hosting such an event comes with the responsibility for ensuring the safety of the young people. The situation is made a lot easier if the students are accompanied by their own teachers. This releases the staff of the host from the direct responsibility as this is the job of the accompanying teachers.

As PR is always important for such an event, it is recommended to take pictures and create videos. Those can be used for reporting about the event but also for advertising the issues of the coming years.

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

7 CONCLUSION / OUTLOOK

This document has presented a theoretical study done to get a better understanding on current status of robotics in education. In this study was detected use, trends and domains where robotics are used in education as aspects to be considered in the framework. A macro-process is presented as a base to create the processes that will be part of the framework. Using this macro-process and from the experience learnt on the activities done during the project's first year, it is reported the first version of pedagogical activities and preparations for a conferences processes. These processes are going to be improved based on their uses on the following years and the findings obtained from the data analysis (WP 6). Additionally to support these processes, skills trees will be developed.

8 GLOSSARY / ABBREVIATIONS

EC	European Commission
ER4STEM	Educational Robotics for STEM
REA	Research Executive Agency
STEM	Science, Technology, Engineering, and Mathematics

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