# STE(A)M Education in Kindergarten- The Case of the eTwinning Project "Captain Jim, Lassi and her Puppies - a STE(A)M Story"

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## Abstract

This article describes the planning and implementation of a STEAM program in 6 european kindergarten schools, as part of a collaboration project in the online platform “eTwinning”. The aim was the collaboration between teachers and children in a collaboration design, at the center of which was the decoding of coded routes using a bee bot or a SAMI (First Kids Coding and Robotics) and the completion with a simple experiment related to Physics, Mechanics, Technology, Art and Mathematics (STEAM). In this design participated 6 teachers and 120 children of 3 countries, Greece, Portugal and Spain.

**Key words**: STEAM education, Preschool

## *1. Introduction*

Last two decades in education show that it is more efficient to concentrate on students’ interests and experiences from a young age, to build on already existing knowledge and provide opportunities for involvement in scientific and mathematical practices, in order to maintain their interest. In other words, in the school context, students learn to investigate questions for the world around them through their everyday lives, the same way scientists do (Beatty, 2011).

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Teachers equipped with modern digital tools and appropriate practices, methods and techniques, provide new learning, social and cognitive experiences. In the category of digital tools is included a programmable toy, part of the educational robotics. Educational robotics is applied through the STEM educational method (Science, Technology, Engineering, Mathematics), to create a complete robotics construction by combining Science, Technology, Engineering and Mathematics practices. Students by interacting with the creation of such a construction, obtain new skills and develop their creativity, team-spirit and imagination.

Among STEM's positive outcomes are problem-solving and reasoning skills, faith in one's skills, innovation, inventiveness and digital literacy (Morrison, 2006; NRC, 2010). Collaboration consists of a basic skill for the 21st century and an essential STEM skill for the preparation of future workforce (NRC, 2010). Involvement in collaboration, formation of teams, collaboration between peers and providing help to others, is an efficient practice for the education of young children and supports each student's involvement in the classroom, boosting learning (Beatty, 2011; Hunter, 2014).

This paper presents preschool students' participation in a collaborative STEAM program, during which they were involved in real-life problem solving and had the opportunity to explore, experiment as little scientists and build together their knowledge through interesting, meaningful, game-like activities.

## *2. STE(A)M Education in Preschool*

### *2.1 STE(A)M Education*

In Recent decades, the National Science Foundation introduced STEM as an acronym for Science, Technology,Engineering & Mathematics, which is used as the definition of STEM education and as a general description of every educational policy referring to one or more of the STEM fields (Bybee, 2010). STEM education may be defined as a complete approach of curriculum and teaching, as it eliminates the borders between individual subjects and considers them as a "whole", taking into account that modern problems are much more complicated and multidimensional to be processed by only one science (Morrison & Bartlett, 2009).

In general, 21st century skills, such as adaptability, problem-solving, complex communication, systematic and logical thinking, inventiveness and technological literacy are developed through STEM education. Students' learning experience is enriched due to STEM's dynamic approach, as students solve problems of their interest and come to conclusions building their knowledge on previous principles implemented through Physics, Technology, Engineering and Mathematics (Roberts, 2012). Teachers with the use of collaborative activities can motivate children by focusing on their

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interests, encouraging them to collaborate and making use of their creativity. According to Creative Little Scientist's findings, creativity in STEM may be defined as "the creation of logical ideas and strategies as a person or a community and the production of reasonable explanations and strategies according to the available data" (Agogi et al, 2014 , p. 8).

In recent years, a shift is noted, from STEM methodology to its improved version, STEAM, adding an "A", which refers to Arts. This shift has provoked great interest in the research community.

### *2.2 Educational Robotics*

Educational robotics emerged in the 1980s, in the spirit of using technologies in the educational process, through Logo's educational stream. It is based on the principles of artificial intelligence and consists of an innovative teaching approach, based on a learning method that uses programming systems and exploits learning processes with complex assignments (project-based learning). As a teaching approach it is based on Piaget's constructivism (1974) and the basic principles of constructionism expressed by Papert (1991). Part of educational robotics applications is being approached by sociopolitical learning theories, as human collaboration is required (Κόμης, 2004).

Educational robotics is a powerful tool for designing STEM activities, being characterized by interdisciplinarity. It is addressed to every age, from young children to adults with the aim of inducting everyone involved in the scientific act and developing technical skills. This approach allows the learner to use educational technologies in order to design a plan, find solutions to problems and compare views with others in a group (Depover et al., 2010). It contributes to the enhancement of skills important in STEM education, such as coding, spatial skills, measuring with nonstandard units, interpretation of charts, analyzing of connections and relations and problem solving (Coxon, 2012; Kazakoff et al, 2013; Solomon, Vasilyeva, Huttenlocher, & Levine, 2015).

Educational robotics used in preschools are BeeBot and First Kids Coding and Robotics. Beebot is a "smart bee", a programmable floor robot, specially designed to be used by children of preschool and early primary school age. Programming is done with the use of buttons on-board and may be programmed to move around in space accurately, moving in front or backwards and turning left and right. With its friendly and simple layout, Beebot is an ideal starting point for teaching about control, direction and programming language to younger children. Beebot was introduced and used as a programmable toy in preschool children in the research of Pekarova (2008), Komi and Misirli (2016) and Katrimbouza and Misirli (2014). By playing with and programming the Beebot, preschool children get familiar with programming strategies and are able to build algorithmic type sequences in a wide number of

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controls, both at practical application and at game level.

Sammy is a cute robot from Kids First Coding & Robotics, that teaches programming principles and helps develop STEM skills in preschool children and won the Planning Award "Golden Pin 2018", one of the most important awards regarding product planning, nominated to the educational kit KIDS FIRST CODING & ROBOTICS. There is no need for a tablet, smartphone or computer for its programming. Programs are created simply by laying down a series of control cards that create the algorithmic "path". As the robot walks over the control cards, a sensor at the bottom of the robot reads the cards one by one and loads the program. As a next step, the robot is being placed at a track you have created and runs the loaded program. You may program the robot to run towards different directions, to activate the gear, switch on the LED lights, reproduce sounds and respond to different energy cards. The built-in gear allows the construction of simple robotic constructions with arms or other moving parts that respond to the instructions of the program. Handling both robots is based on autocorrection, as they offer children the opportunity to correct their incorrect choices by using the trial and error method.

### *2.3 Use of ICT*

The term of ICT or Information and Communication Technology, according to Siraj-Blatchford και Siraj-Blatchford, includes "everything that allows us to get information, to communicate with each other or have an impact on our environment using digital or electronic tools" (Bolstad, 2004). Preschool children use indistinctly digital tools and the Internet and usually have their first internet experiences at their home (Teuwens, 2011). Marsh et al. (2005) came to the conclusion that 53% of children from ages 2-6 use a computer at home daily. McKenney and Voogt (2010) explain that children nowadays use ICT even before being able to read and write.

Siraj-Blatchford και Whitebread (Bolstad, 2004) highlighted the importance of developing technological literacy skills in young children, as ICT has become part of the children's learning environment that takes place throughout their entire academic route. Patterson (Bolstad 2004) states that the use of ICT aims to enrich the learning environment, while according to researchers, educational software and supervisory material complete and amplify each other during the educational process (Haugland, 1992, Mioduser, Tur-Kaspa & Leitner, 2000). Finally, according to Papert, computers consist of potentially powerful means for experiential learning, with meaningful activities that boost the development of positive feelings and the enhancement and maintenance of learning motivation (Hogenbirk, et al. 2006). The use of ICT in education is of significant importance for the development of critical thinking in children, for the change of teaching and learning practices and communication and for the support of collaboration and exploratory learning (Bruce, 2008). Finally, the use of ICT in the form of spontaneous games in the classroom, constitute the catalyst for

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children to interact efficiently (Clements & Samara, 2003). The use of various web 2.0 tools, such as padlet, googledocs, support the cooperative learning, allowing students to work in teams inside the classroom, but also cooperate with students from other countries, exchanging views and creating knowledge, which is more stable and sustainable in the long-term (Hogenbirk, et al. 2006; Panagiotakopoulos et al, 2003).

However, use of ICT must be based on a concrete understanding of the aims, the practices and the social context of preschool education (O'Rourke & Harrison, 2004; Sheridan et al, 2003). This requires teachers' familiarization with various tools and their possibilities, along with the knowledge of modern learning theories and the way they can be linked to the use of ICT (Bolstad, 2004).

### *2.4 eTwinning Program*

According to the European Commission (2013), eTwinning program constitutes a successful European innovation based on ICT and contributes to the modernization of the training and education in the EU. ETwinning started in 2005 with the aim of fraternizing European schools in a non-formal way, which allows teachers to collaborate without any significant commitment as for their way of collaboration in the long-term. Nowadays, eTwinning constitutes a vast, very energetic teachers' community, in which they can implement collaborative programs, communicate, interact and participate in various activities of professional development.

Schools are supported both at a national level (National Support Service) and at a European level (CSS). NSS provides training, help, support and advice to teachers and controls the progress of their projects. Among the benefits of eTwinning is the easy enrollment and search for partners, the sense of a community, the practical and secure platform for the development of collaborative projects, the motive of acknowledgement with the national and European eTwinning quality label, the support from the national agencies, the lack of bureaucracy, the joy of communication with children of the same age but different origin and the opportunity to combine multiple teaching methods in the classroom (eun.org, 2017). Teaching methods of the constructivist theory, such as Project Based Learning (PBL) and Inquiry Based Learning (IBL) are being applied in eTwinning projects (Clemente, 2016; Τσιάτσος, 2015).

Participating in eTwinning projects help students το develop a range of skills include many of those 21st Century Skills such as collaboration, communication, teamwork, interest and understanding of new technologies, problem solving, critical thinking, creativity, initiative, decision taking, mathematical competence and basic competences in science and technology, digital competence, learning to learn, social and civic competences, sense of initiative and entrepreneurship and cultural awareness and expression (Gilleran, 2019; Gilleran & Kearney, 2014).

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## *3. The project "Captain Jim, Lassi and her puppies - a STE (A) M story"*

The project "Captain Jim, Lassi and her puppies - a STE(A)M story" started in October 2019, with the participation of 6 schools from 3 different countries. The basic principles of STEM education: ICT, educational robotics and the capabilities provided by the eTwinning program were used to design, develop and implement a program that combined collaborative strategy with a focus on problem solving, educational robotics and STEAM methodology in the context of a technology-supported learning environment in primary education, in particular, the proposed conceptual framework was attempted in relation to the change of Collaboration Skills, the engagement of students and skills STEM (STEM Skills) and educational robotics. I collaborate, signal I work with someone else and so kindergarten teachers and students were actively involved in the learning process.

This project was performed by 6 schools from Greece, Portugal and Spain, with 6 kindergarten teachers and 120 students. The Kindergarten of Neochorouda with the Kindergarten of Pardilho of Portugal, were the founders of the program and collaborated with the 6th Kindergarten of Oreokastro, the 6th Kindergarten of Katerini and the Kindergarten of San Julian from Spain.

### *3.1 Aims*

As STEM is the teaching of subjects within the STEM umbrella, the integrated teaching between those subjects, and the skills such as collaboration, problem solving, critical thinking and creativity were the main aims through this program.

More specifically aims of the project has been:

- a solid understanding of basic science and mathematics so participation and excellence in these core subjects should be promoted.
- opportunities to expose kids to interdisciplinary approaches in their learning.
- connections between subjects and the transfer of knowledge and skills across disciplines.
- opportunities to learn and practice skills of communication, collaboration, project based work and enterprise in order kids to be successful workers in the future.

Collaborative schools were orientated to provide these experiences, and the STEM lens provides an authentic way to do so.

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### *3.1 Procedure*

The project was completed in three phases:

**The phase of rescue missions.** The first rescue missions began in November, with each school assigning a rescue mission to Lassi and her puppies each week. The mission included for each school a game through an excel file, a game in an online tool, a coded path for a robot and at the end an experiment related to Natural Science. All partners had to complete all missions. In February, the school missions were completed.

1. **The phase of diffusion.** In March, we were planning to complete the program when we were threatened by the Covid-19 pandemic and the closure of schools in all European countries. In a wave of interaction, it was decided to collaboratively make a wish padlet and end it with a distance science festival.
2. **The phase of evaluation**. The project was completed with an evaluation by all involved teachers, students and parents.

Entering the project, teachers were informed with a complete calendar plan for the progress of the program. Each teacher had to organize a complete integrated treasure hunt and complete all the missions assigned by all the cooperating schools. He had to inform parents and children about the progress of the program, receive certificates of participation from all children and proceed to update the eTwinning platform. The update of the platform included the uploading of the assigned mission of each school and the uploading of photos and videos, where the children completed the missions.

### *3.2 Activites*

**A. Phase of Rescue Missions - Challenges**

The first phase was completed in 4 months, where children and parents were informed about the program and its requirements. In the phase of rescue missions-challenges, children from all countries were called with minimal guidance to solve problems, to decode the route with their robot and work in pairs (infant-toddler) to complete the required construction. The children gradually came to first acquaintance with the bee bot, and work in groups. In a second phase they became acquainted with Sami (First Kids Coding and Robotics) who had higher handling requirements.

1st Rescue Mission: Greece and the Neohorouda's Preschool started in November with the first rescue mission of Lassi and her puppies. Through a treasure hunt in an excel file, Captain Jim announced that he had lost Lassi and her puppies and urged children from all schools to search the excel file pages to find the lost puppies. On these pages were the main monuments and the main points of interest of the village of Neochorouda, where the children had to tour to reach the Kindergarten of Neochorouda, who told them that they did not have the puppies and that they had to look elsewhere. There the children received a link

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https://learningapps.org/display?v=p50yk7w4519 that led them to an online math game, where they had to match pictures to shapes. At the end of this mission, they were given a map with arrows on the map, as a code for their robot. The children had to decode the code, and lead their robot to the end of the mission. At the end of the mission they found a note from Lassi, informing them that she had been abducted by the evil Cruella on a high mountain. She had only pipe wire, bags and napkins with her and needed a parachute. And she asked the children to make her parachutes with simple materials, asking for their skills in engineering (Image 1).


***Image1.*** *1st Rescue Mission*

2nd Rescue Mission: Next week the 6th Preschool of Oreokastro in turn made a treasure hunt with an excel file. In the excel pages the children were looking for Lassi and her puppies among coloured shapes and they had to find the right shapes, in order to reach the end, to find the coloured Lassi, who told them that by clicking on her image they would proceed to next level. A memory game (https://learningapps.org/display?v=pojat40y319) was the next step, with the completion of which they found the coded map, which they had to decode and drive their robot to the end of the mission. At the end of the map, Lassi informs them that Captain Jim had lost his keys to a sewer and they were looking for a tool to pull them out. She asked the children if they had any ideas to help her and gave them a worksheet to make assumptions and draw conclusions about which objects were attracted by magnets, which was the tool they were looking for (Image 2).

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***Image 2:*** *2nd Rescue Mission*

3rd Rescue Mission:The next treasure hunt was created by Portugal and Pardilho's Preschool and started with a great math game via learningapps.com https://learningapps.org/display?v=p5fe7cop319, where it got kids to count, numbers, multiply (counting animal feet). At the end of the game, the children found a link https://www.jigsawplanet.com/?rc=play&pid=0b4eae3ba7ba that led them to the Azores and a coded map to be decoded. Decoding the map and driving their robot to the end of the mission, they learned that Lassi was stranded in the Azores and that she needed a catapult to get out of there. Existing materials were a tongue depressor, rubber bands, a teaspoon and a small piece of aluminum foil (Image 3).

***Image 3:*** *3rd Rescue Mission*

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Christmas Rescue Mission: As Christmas was coming, a poll was conducted on the twinspace platform on the subject of the Christmas Rescue. The team as a whole agreed on the choice of Crystallization with borax. So, the children had to solve the first coded map, and lead their robot to the end, where they found a message from Mrs. Santa Claus, who gave them a link to solve an online puzzle https://www.jigsawplanet.com/? rc = play & pid = 092056a0453d. Completing the puzzle, the children found the message of Mrs. Santa Claus that she lost her ornaments and that she needed the children to renew her Christmas tree ornaments, making crystallized ornaments with tongue depressor and borax (Image 4).

***Image 4:*** *Christmas Rescue Mission*

4th Rescue Mission: The fourth treasure hunt was prepared by the 1st division of the 6th Preschool of Katerini at the beginning of January. The excel file included winter sports, inviting children to find Lassi and her puppies among winter sports, they finally found her pulling a sleigh among other puppies. At the end of the first phase, the children went to a page of learningapps.com https://learningapps.org/display?v=ps74j2y3k20, where they had to match sport and athlete and finally found the map to decode. Decoding the map, there was a message informing the children that Lassi had been abducted by a bad man and calling on the children to guess the reason for the abduction and to build a helicopter in pairs (Image 5).

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***Image 5:*** *4th Rescue Mission*

5th Rescue Mission: The fifth treasure hunt was carried out by the 2nd division of the 6th Preschool of Katerini. The game started with an excel file in the pages of which the children, solving riddles, browsed among animals that were falling into hibernation to discover the lost Lassi, on the last page. There Lassi was linked to a https://learningapps.org/display?v=pojat40y319 link that sent children to find lost puppies on a web page, listing hibernating animals, from smallest to largest and one link https://learningapps.org/display?v=pokik5ssk19 where children had to match objects at the right time. Upon completion of the games they received a map.

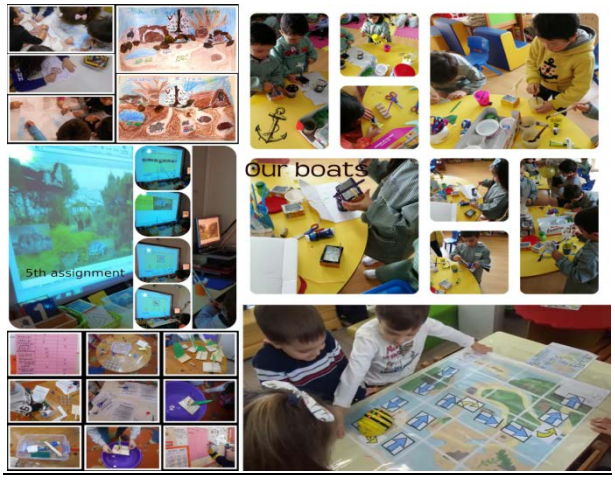


***Image 6:*** *5th Rescue Mission*

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Decoding the map and discovering the route for their robot, the children discovered that the puppies were stranded on a mountain and needed a raft to escape using the river. It had plastic bottles, straws, a tongue depressor and a piece of paper. So, they asked for the help of the children, so that they could escape safely (Image 6).

6th Rescue Mission: The last mission was assigned to the team from the Preschool of San Julian, Spain, in February. The last treasure hunt began in the San Julian classroom, where children roamed the corners of the Kindergarten, trying to find out where Lassi was hiding. Through the tour, the children discovered that he was playing in a corner of the Kindergarten and received the map to be decoded. Decoding the map and guiding their robot to the end, it was transported with a link https://learningapps.org/display?v=pxq9wy22520 to a memory game and the mission was completed by injecting pastry colours into gelatine (Image 7).


***Image 7:*** *6th Rescue Mission*

In March, experiencing the global threat of COVID 19 and the lock down, in a climate of support, a padlet was prepared where parents and children from all schools sent messages of support and love.

**B. Diffusion phase**

In the second phase of diffusion, the initial planning was to hold a science festival in the classrooms of all schools. Parents and children in the classroom, in the form of a small party, would be invited to present simple experiments. With the covid-19 epidemic and the closure of all schools, the planning was redesigned and the science

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fair was held online from every child's home.

Experiments with simple materials were assigned to parents and children electronically, videotaped and sent by parents, creating a three-volume project with almost 100 experiments from three European countries, presented and implemented by children at home.

Volume 1

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Volume 2

https://www.canva.com/design/DAD8HLGiwBo/ys1FdKN_efIClCZqxv90uQ/view

Volume 3

https://www.canva.com/design/DAD8HLGiwBo/ys1FdKN_efIClCZqxv90uQ/view

**C. Evaluation phase**

In the last phase, parents, children and educators from all countries were invited to write about their experience and evaluate the program http://www.tricider.com/brainstorming/2aDuGOarhlp, giving excellent feedback on the program.

## 4. *Conclusions*

Many experiential activities were carried out and many online tools were used to complete the rescue missions assigned by each school. The program started in October 2019. In November, the first rescue missions began and were completed in March. Each school, each week, assigns a rescue mission to Lassi and her puppies. The mission included for each school a game through an excel file, a game on an online tool, a coded path for bee bot, or Sami (First Kid Coding and Robotics) and finally experimenting with a Natural Science. The children used many online tools, both individually and in groups, as well as remotely with their families.

The project encouraged children and teachers in schools in Greece and Portugal and Spain to meet, communicate through new technologies, collaborate and create, gaining educational experiences and developing mental, social, physical and emotional skills. The project was successfully integrated into the curriculum and was interdisciplinary with the rest of the subjects. On a weekly basis, they participated through Twinspace in many challenges, problem solving and creation of many STEAM constructions, helping each other, through many collaborative experiences. They made assumptions and predictions and often their answers required the use of online tools such as wordwall.net or learningapps.org. The children came in contact with cultures of other countries and gained respect for them. Through this program we have been able to improve our problem-solving ability through perseverance, concentration, cooperation,

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commitment and vigilance. In the end, due to the given situation of Covid-19, they became involved through asynchronous training, in forms of asynchronous communication.

Little students used web 2.0 tools and created collaborative digital content as part of their work on this eTwinning project. The advantages of these tools focus not only on the easy communication and cooperation between the participants regardless of the geographical distance they have, but also on activating the children in the approach of learning in new innovative ways. The project was evaluated by children, parents and teachers and everyone was pleased with their active participation. It also found very positive recipients in local institutions and the wider community, where it was presented and published on personal educational and school websites and in the wider school environment.

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