Escape from Tolentino During an Earthquake Saving as Many Lives and Cultural Objects as You Can

Paola Pazzaglia and David Scaradozzi

Abstract In the last five years, the Italian Ministry of Education has placed its focus on digital skills, recognizing them as fundamental and indispensable for the growth of future citizens in the information age. It has thus backed projects aimed at developing computational thinking and digital creativity at school. One of the highest-funded of such projects is "*Più vicini al nostro territorio—Valorizziamo i monumenti di Tolentino … giocando con Scratch e App Inventor*" (Closer to our territory—appreciating the value of Tolentino's monuments … while playing on Scratch and App Inventor). In this paper we describe this project, its vertical path, and the results of the first activities, which have already taken place in a primary school. These results show the progression of the skills and competences defined in the National Operational Programme document "For school 2014–2020" (Axis I Education, Objective 10.2, Improving students' key competences), and those set out in the National Plan for Digital Education.

Keywords Digital competences · Coding · Educational robotics · STEM · Primary school · Nintendo labo

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1   Introduction

Many researchers have been investigating the use of coding and robots to support education. Studies have shown that robots can help students develop problem-solving abilities and learn computer programming, mathematics, and science. The educational approach, based mainly on developing logic and creativity in new generations from the first stages of education, is very promising. Introducing coding and robotic systems is fundamental to the achievement of these aims, if begun at an early stage of education. At primary school, coding and robot programming are fun, making them excellent tools for introducing children to ICT and helping them develop their logical and linguistic abilities. In the last five years, the Italian Ministry of Education has placed its focus on digital skills, recognizing them as fundamental and indispensable for the growth of future citizens in the information age. It has thus backed projects aimed at developing computational thinking and digital creativity at school. While considering how to engage girls and boys in an activity with the potential to motivate them to consider a future career in STEM-related fields, the authors drew on personal experience (see from [1–9]) and on findings in the literature of great results obtained using educational robotics (ER) for the same aim. First, Benitti [10] reviewed ER experiences from around the world. Her results show that there is great potential in ER methodologies and activities in K12 classrooms, but the full power of these research outcomes still needs to be thoroughly exploited. Mubin et al. [11] highlight the great effort that research still needs to make to produce appropriate curricula that include robotics. Veselovská and Mayerová [12], on the other hand, present a qualitatively assessed ER activity in the context of an ER curriculum at lower secondary school. Sanders [13] considers robotics to be the real integrated approach to STEM education: rather than these four subjects addressing it separately as a mere series of notions, they could come together to re-elaborate these notions as part of active learning. Moreover, the benefits of ER education can also come in the form of cyber-security [14], a STEM-related field that can empower future citizens of the digital world and protect today's boys and girls from the potential dangers of connected life. The authors have conducted coding and robotics teaching experiences in Italian schools since 2000–2001, when the first project was proposed. It was called "Building a robot" and a description of it can be found in [8]. This paper presents the project entitled "Più vicini al nostro territorio—Valorizziamo i monumenti di Tolentino … giocando con Scratch e App Inventor" (Closer to our territory—appreciating the value of Tolentino's monuments … while playing on Scratch and App Inventor). The main aim of this project is to encourage primary school students to experience the creative process, in spite of the earthquake, and to foster their literacy in their local heritage. The activities included the creation of a board game simulating Tolentino during an earthquake. Players have to escape from the town, saving as many lives and cultural objects as possible. In this paper we describe the project, the vertical path within it, and the results of the first activities, which have already taken place in a primary school. These results show the progression of the skills and competences

defined in the National Operational Programme document "For school 2014–2020" (Axis I Education, Objective 10.2, Improving students' key competences), and those set out in the National Plan for Digital Education.

2 Material and Methods

The following subsections provide an account of the project activities.

2.1 Underlying Pedagogical Approach

The pedagogical theory used for the design and execution of the activities in this project is constructionism. Its premise is that knowledge building is the natural consequence of creating and experimenting. Students are encouraged to observe their own actions directly and to analyze the consequent effects. They are asked to share ideas in a highly motivating context. Here, technology and innovative learning environments give students room to learn in their own distinct style. Drawing on Howard Gardner's theory of multiple intelligences, students are encouraged to acknowledge their own skills and abilities. This can help them to think about their future, in terms of both their studies and their careers. Problem-based learning (PBL), a learner-centered approach, was employed. After a short explanation of the fundamental aspects of the project, students were given challenges to search collaboratively for effective solutions. Thus, they were also involved in project-based learning and peer tutoring. All the activities were designed on the TMI model (Think, Make, Improve), as suggested by Martinez and Stager [15]. First, students try to figure out what a solution to the problem might look like (Think); second, they try to implement the solution by building and programming the board game (Make); third, they look at their artefacts closely and try to debug or improve them, by using different points of view or by sharing their ideas with others (Improve). The methodology adopted is learning by doing, in other words, learning from experience. According to Dewey, learning should not be passive, but rather relevant and practical. This hands-on approach allows students to learn through practical tasks, after which their experience must be accompanied by thinking over and reflecting. To be effective, this methodology needs students to reflect, revise and integrate the experience. For this reason, each lesson included a session of sharing, when each group shared its work with the others and reflected on it. Moreover, peer tutoring was applied during coding activities (with Scratch), during which students worked collaboratively with others, improved relationships and increased motivation.

2.2   Tools and Materials

In the first module of the project, primary school students (aged 9–10) began to learn to code with Scratch 3, the free, easy-to-learn and visual programming language, and used Lego WeDo 2.0 for educational robotics activities. They went to school one afternoon a week to find out about the main principles of coding. They used their knowledge and applied their creativity to invent a board game that is both physical and virtual. The purpose of the game is to find out about the most important monuments in their town, Tolentino. Lessons were organized as hands-on learning laboratories in which students worked in teams of two or three sharing ideas and helping each other. The second part of the project started in October 2019 and is still in progress. Students from the lower secondary school are completing the board game using Scratch, APP Inventor and QR code.

2.3   Learning Objectives and Competences

The learning objectives and competences developed in the first part of the project were to: promote and develop computational thinking, coding and the use of digital technologies; encourage students' interest in STEM; improve soft skills, especially critical thinking, analyzing ability, problem-solving, planning skills, team working; reinforce logical reasoning; rediscover and enhance Tolentino's artistic and historical monuments.

2.4   Contents of the Activities

The activities included the creation of a board game simulating Tolentino during an earthquake. Players have to escape from the town, saving as many lives and cultural objects as possible. The module introduced the basic concepts of coding using Scratch. The teaching progression was:

- coding: introduction to Scratch: simple animations and experiments. Basic functions of Scratch and first sprite movements;
- coding: sequence of instructions and animations: drawing geometric shapes with Scratch. Starting with polygons (triangle, square …) students continued creating their own pictures;
- coding: cyclical repetition of instructions;
- coding and logic: synchronizing events: after the stories were created in analogical form (using paper, pen and storyboard), the children reproduced them with Scratch;

- robotics: basic principles of robotics; man–machine-robots: similarities and differences; building a robot using a Lego WeDo 2.0 kit and programming it with Scratch 3; programming challenges;
- robotics exercise: each group of children is asked to watch by a video captured during an earthquake and design and build a mechanism that reproduces the movement of the ground (undulation). Initially, some houses with weak foundations collapse, until the designed system is able to withstand powerful impacts generated by the WeDo engine;
- cultural heritage literacy: find information about Tolentino's most important monuments and their distinctive features;
- storytelling: be a tourist guide in Tolentino using Scratch;
- basic principles of gamification: how do you design a game? Brainstorming during which students discussed their points of view about a board game;
- creation of the board and markers from paper and recycled materials;
- final exhibition: students showed the board game to parents and teachers.

2.5 Expected Results

- Improving the learning process and school performance and motivating the students involved in the project.
- Developing new knowledge and competences in digital technologies, coding and computational thinking.
- Increased interest in STEM.
- Improved teamwork.
- Improved problem-solving and analytical skills.
- Learning the very basics of coding.
- Rediscovery and appreciation of Tolentino's most important monuments.
- Understanding how to behave during an earthquake.

3 Preliminary Results

The preliminary results are based on the activities described in Sect. 2, carried out over a given period of time. The proposed criteria turned out to be suitable for teaching new concepts to children, for attributing coherent purpose to building an application for tablets and a robot, and for teaching them the history of their town and the importance of the right behavior during an earthquake. Selected groups of professional operators were also invited to observe and to take part in the intermediate tests and experiments. Università Politecnica delle Marche will assess the activity by means of questionnaires [2, 5]. The first experimental project was carried out at Istituto Comprensivo "Lucatelli" in Tolentino, Italy. Primary School teacher Paola Pazzaglia, University professor David Scaradozzi, and Talent s.r.l. developer

Federico Camilletti developed the experimental project after their observation of primary school students. The project focused on increasing and pursuing logic and creativity as important educational skills in modern school. They were able to start the project.

The preliminary results are based on a comparison of the following items:

- higher marks (before and after the project) in some subjects, such as Italian, English, mathematics and science, showed the students had improved in those areas;
- the students' attitude, as they were always curious and grew more and more interested, especially when they understood the importance of working as a group to gain new skills while, at the same time, being able to deal with new problems;
- through systematic observation, it was possible to see an overall improvement in the EU competences, too (only those closely related to the project) (Figs. 1, 2 and 3).

Fig. 1 Children looking for information about Tolentino's monuments
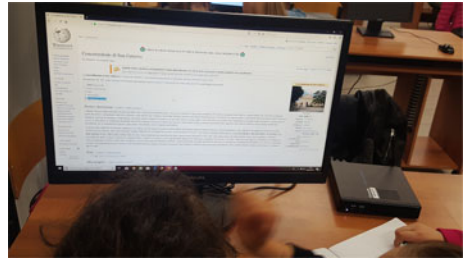
Fig. 2 One of the mechanisms children built using Lego WeDo 2.0 that reproduces the undulations of the earth
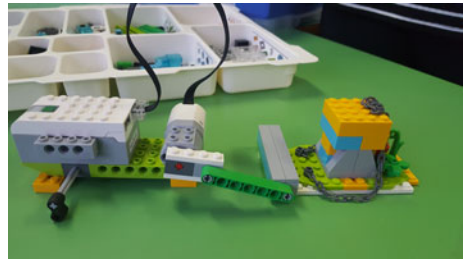
Fig. 3 The game's board

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