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ROBOTICS AS A TOOL FOR INTERDISCIPLINARY LEARNING – TRAINING FOR PRIMARY SCHOOL TEACHERS

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Abstract. This paper explores the integration of educational robotics into primary school teaching through a teacher training seminar. During the seminar, various robotics kits were presented along with a sample educational scenario, demonstrating how robotics can be used to support active learning and problem-solving in the classroom. The results highlight the potential of robotics as a tool for enhancing student engagement, fostering creativity, and promoting STEM skills in primary education. The contribution of this work lies in providing practical guidance to teachers on how to adopt robotics in their teaching practice.

Key Words: *Educational Robotics, Interdisciplinary Teaching, Active Learning, Innovative Teaching Practices, Teacher Professional Development*

Introduction

Educational robotics has emerged as a dynamic tool for fostering active learning, creativity, and problem-solving skills across different stages of education. In primary schools, robotics can be integrated into subjects such as science, mathematics, and technology, providing students with hands-on opportunities to connect theory with practice. At later stages of education, robotics activities can further support teamwork, computational thinking, and interdisciplinary learning. The focus of this paper is on teacher training at the primary school level, highlighting how educators can effectively integrate robotics into classroom practice through practical workshops, the use of robotics kits, and the development of structured educational scenarios.

To put these ideas into practice, a teacher training seminar was designed and implemented, focusing on the practical integration of robotics into primary school teaching. A four-hour training course aimed at teachers of the initial stage of primary education was held on March 15, 2025, in a Greek primary school. The seminar introduced participants to various robotics kits and an educational scenario, demonstrating how robotics can be integrated into everyday teaching practice.

The topic „How robotics can support the educational process through an interdisciplinary approach" reflects the desire to modernize the learning environment and adapt it to the requirements of modern society. The training was structured to combine presentation of specific tools with discussion of pedagogical strategies and theoretical foundations.

According to the Government Gazette No. 10522/Δ1 published by the Greek government's educational policy institute, in primary education, computer science is taught for 1 hour per week in all grades 1 to 6. In recent years, the program has been enriched and now robotics will be taught alongside the computer science course. The ministry has already equipped the schools with robotics kits. It is noteworthy that apart from the curriculum, no textbook has been published on this subject.

The aim of this project is to utilize the robotics kits that the Ministry of Education has made available to schools, in the learning process, while training teachers in new technologies. Educational scenarios and activities have been specifically selected that are in line with the curriculum and that combine an interdisciplinary approach. The aim is to use robotics to help students understand various concepts in subjects such as Mathematics, Physics, Biology and others.

Part One: Introducing Educational Tools

In the first part of the training, participants were introduced to various educational platforms and tools suitable for primary school students. Specifically, teachers explored Bee-Bot, LEGO Education WeDo 2.0, and LEGO SPIKE Prime.

Bee-Bot is a simple, floor-based robot designed for the early years of primary education (Grades 1–2). It allows students to program basic sequences of movements using directional buttons, supporting the development of algorithmic thinking, spatial awareness, and early problem-solving skills. Teachers need only basic digital literacy to apply it, while students require no prior knowledge beyond understanding simple commands.

LEGO Education WeDo 2.0 is aimed at slightly older students (Grades 3–4). It combines hands-on construction with block-based programming, enabling children to build functional models and program them to respond to different inputs. This platform fosters creativity, logical reasoning, and teamwork, while requiring teachers to be familiar with basic programming concepts and classroom management of group projects.

LEGO SPIKE Prime is more advanced and suitable for upper primary grades (Grades 5–6). It offers a wider range of sensors and motors, along with both block-based and text-based programming options. This allows students to engage in more complex tasks, such as building interactive systems and solving open-ended STEM challenges. To effectively use SPIKE Prime, teachers benefit from deeper understanding of programming logic and confidence in guiding exploratory, project-based learning.

These distinctions underline that not all platforms are equally suitable for every age group. Rather, each tool has specific strengths that align with the developmental stage, prior knowledge, and learning needs of students, as well as the digital readiness of teachers.

Their pedagogical value was also presented – from developing logical thinking and problem-solving skills to encouraging collaboration and creativity. Attention was focused not only on the technical characteristics, but also on the methods of integration into the learning process: use of game scenarios, group work, and gradual complication of tasks.

Part Two: Applying Interdisciplinary Scenarios

After the theoretical foundation, the participants moved on to practical activities. They implemented two ready-made interdisciplinary scenarios that demonstrated how robotics can naturally fit into the primary school curriculum.

The first scenario was designed for mathematics lessons in Grade 4. Using a programmable robot moving along a circular path, participants were guided to calculate the perimeter of a circle. The activity combined hands-on exploration with abstract reasoning, helping students link mathematical formulas with observable, concrete movement. Teachers of mathematics found this approach particularly useful as it transforms a theoretical concept into a tangible experience.

The second scenario focused on physics concepts suitable for Grade 6. Participants explored the relationship between speed and torque by experimenting with gear combinations on a robotics platform. Through observation and measurement, they were able to understand how mechanical systems function and how forces interact. This activity was especially relevant for teachers of physics or natural sciences, but it also demonstrated how robotics can serve as a bridge between STEM subjects.

It is important to note that these scenarios were not presented as a separate subject called “Robotics”, but as integrated activities within the standard curriculum. The aim was to show teachers how robotics can enrich the teaching of core subjects, while also developing transversal skills such as problem-solving, collaboration, and digital literacy. These activities showed how the same robotic platform can be used in different disciplines, motivating students to actively participate in the learning process.

The use of robotics brings together knowledge and skills from science, technology, engineering, arts, and mathematics into an integrated learning experience. Through design and creativity, students not only learn scientific principles, but also develop imagination and aesthetic thinking.

Adaptation of the 1st didactic scenario in the classroom

Description of the 1st educational scenario

1. Title of the lesson: Calculating the perimeter of a circle using robotics.

2. Subjects: Informatics, Mathematics – Geometry, Robotics

3. Objective of the lesson:

Students to understand and apply in practice the concept of "detour" through an interactive activity with educational robotics.

4. Interdisciplinary approach to learning:

In the proposed lesson, the most appropriate learning theory is constructivism, combined with elements of:

4.1. Constructivism

According to this theory, knowledge is not passively transmitted, but is actively constructed by the student based on previous knowledge and personal experience.

In this lesson:

- Students explore and build their own understanding of the concept of "circumference".
- Work with real objects (robot, wheels, measurements) to understand the mathematical concept through experience and experiment.

4.2. Inquiry-Based Learning

Students: Formulate questions; Make hypotheses; Conduct experiments; Analyze results; Draw their own conclusions;

4.3. Constructionism (Seymour Papert)

An extension of constructivism where learning occurs best when students create something concrete and visible (e.g., a robot, a project).

In this lesson: Use Lego Spike Prime to build a robot, Program and experiment, Learn by "doing"

4.4. Collaborative Learning

Students work in teams where they: Exchange ideas; Make decisions together; Learn through dialogue and collaboration;

5. Required materials and tools:

Lego Spike Prime Educational Robotics Kit, Ruler, Paper, Pen or pencil, Computer or tablet

6. Previous knowledge:

Computer science: Sequence of commands, Programming with blocks

Robotics: Wheel, Engine, Central controller, Connecting and controlling modules

Mathematics – Geometry: Radius, Diameter, Circumference formula: $C = 2.\pi.r$, the value of π

7. Duration: 3 class hours

8. Difficulty level: Low

9. Activity Description:

9.1. Students assemble a robotic vehicle equipped with wheels from the Spike Prime kit.

9.2. Using a ruler, measure the radius of one wheel.

9.3. Apply the formula $C = 2.\pi.r$ to calculate the circumference of the circle that describes one complete rotation of the wheel.

9.4. Program the robot to make exactly one full rotation of the wheels. Mark the robot's starting and ending positions on the paper.

9.5. Measure the actual distance traveled and compare it with the value calculated by the formula.

9.6. Repeat the same experiment with: Larger wheels and Smaller wheels

9.7. They observe how the distance traveled changes depending on the size of the wheel and how this confirms (or not) the theory.

9.8. They summarize the results and discuss in class:

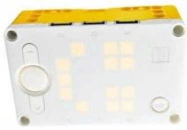
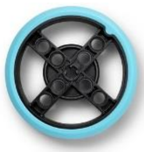
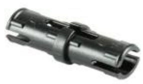
- What they learned
- What difficulties they encountered
- What conclusions they can draw

10. Expected results:

- Students will understand the meaning and practical application of the tour.
- They will develop skills in observation, measurement and inference.
- They will feel that mathematics is not just theory, but has a real connection with technology and everyday life.

Robotic Vehicle Construction and Programming

Table 1. Components from the Lego Spike Prime educational robotics kit

Central Unit x1	
Motors x2	
Wheels x2	
Connectors-nails x14	
Support Wheel x1	

Programming the robotic vehicle

The programming of the robotic vehicle was done using software provided free of charge by Lego Education. https://spike.legoeducation.com/prime/lobby/. The software is based on the philosophy of programming with tiles for easier use by young students, although it also supports the python programming language.

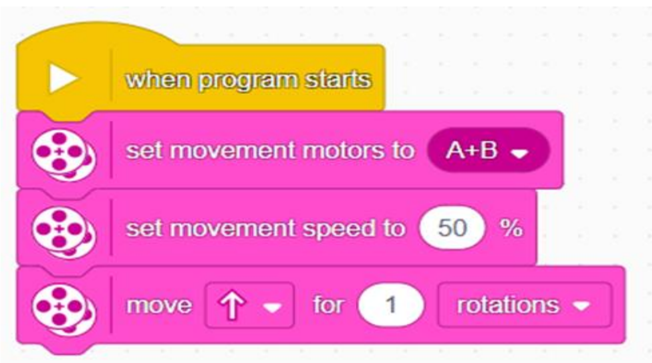


Figure 1. The code

Part Three: Discussion – Advantages and Challenges

In the final part, a discussion was held between the participants. Twelve teachers took part in the training, most of them teaching mathematics, science, and general primary education subjects. Approximately 75% of the participants successfully completed the proposed activities, while the rest needed additional support, mainly due to lack of prior experience with programming.

During the discussion, teachers raised questions about how to adapt robotics activities to different grade levels, how to manage time constraints within their existing curriculum, and what kind of further training would help them feel more confident. Some highlighted the difficulty of integrating robotics in schools without sufficient equipment, while others emphasized the challenge of balancing innovative methods with traditional teaching requirements.

Conclusion

The four-hour training proved that robotics is not just a technological innovation, but a powerful pedagogical tool that transforms the way we teach and learn. It allows for knowledge building through experience, stimulates critical thinking, and unites different disciplines into a holistic learning experience. Teachers expressed a desire to continue such initiatives, build a community for the exchange of good practices and apply what they have learned in their classrooms. Thus, robotics becomes not just a tool for learning, but a catalyst for pedagogical change.

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