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STEAMING AHEAD

FOSTERING CRITICAL
THINKING, PROBLEM-
SOLVING AND CREATIVITY



STEAM
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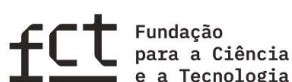
STEAMING AHEAD: Fostering Critical Thinking, Problem-Solving and Creativity.

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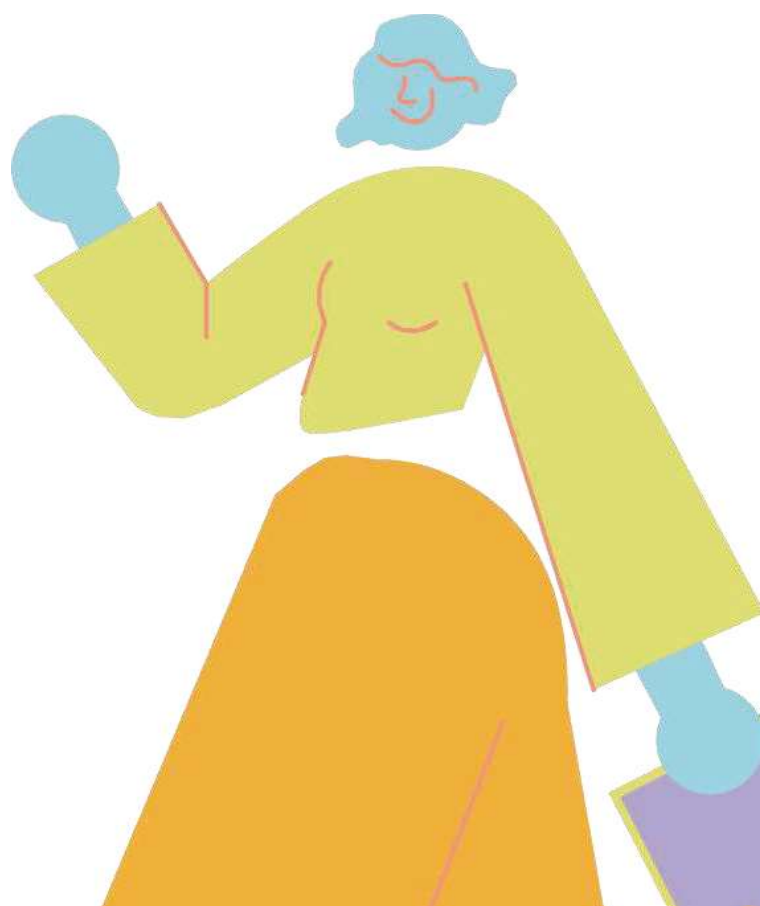
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IX. Innovating Pedagogical Practices in Elementary Schools through Educational Robotics

REFEPESEC – an internship teacher training project

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Introduction

The increasing influence of digital technologies in schools, as well as how Digital Natives see them, emphasise the significance of educating children about technology careers while simultaneously emphasising the development of cross-cutting abilities for full citizenship, providing them with opportunities to develop the 21st-century skills needed to thrive in the modern workplace (eMedia. (2019, NYAS, <http://www.nyas.org>).

Using Educational Robotics in collaborative learning environments, in an interdisciplinary approach, can promote abilities including computational thinking, ICT skills, critical thinking, and social skills like, communication, and collaboration, between others. It also allows the integration of students' knowledge with STEAM subjects (eMedia, 2019, NYAS, www.nyas.org). The integration of Educational Robotics into the teaching and learning process can create a conducive environment for meaningful learning, using the creative, critical, and collaborative abilities of students (Perignat & Katz-Buonincontro, 2019). Additionally, it promotes interdisciplinarity, establishing connections between various STEAM disciplines and students' prior knowledge (Athanasiou et al., 2019; Kuhl et al., 2019).

Participation in Educational Robotics activities also positively influences refuting gender stereotypes, particularly in engineering professions, and contributes to achieving success. Consequently, the teachers, especially the internships, must be trained to incorporate Educational Robotics into their educational practices, making learning more meaningful,

and playful, in line with the competence profile preponed in the national regulations, namely the Essential Learnings and Skill Profile of the Students (MEC, 2017; MEC, 2018). In this sense, the Educational Robotics in the Training of Educators and Teachers Project (REFEPESEC), located in the College of Education of the Polytechnic University of Coimbra, has been conceived as a program that pursues to solve this issue while also attempting to democratise the access to these technologies through low-cost Educational Robotics platforms.

Innovating pedagogical practices in elementary school

In this context, different pedagogical projects have been developed in various elementary school classes where future teachers are doing their internships. In this specific case, we would like to highlight a pedagogical experience carried out in a 2nd grade class, made up of 20 students, by a group of three trainees, from the master's degree in preschool education and Primary School Teaching, anchored in the Educational Robotics Project at the Polytechnic Institute of Coimbra.

This activity was designed to achieve the essential learning that had been recommended, and involved linking various curricular areas and promoting multidisciplinary activities within the scope of STEAM activities. The didactic sequence was themed "The Chocolate Cycle" and emerged from the student's interest and curiosity. In addition, this theme served as a centre of interest to address, at first, the professions related to Chocolate production and, later, to introduce other daily professions and their respective social services. This three-week project had as its main objective to provide significant and interdisciplinary learning of the various components of the Primary School curriculum, using Educational Robotics.

This learning was related to location and orientation in space, comparing objects with different magnitudes (mass), in mathematics; vocabulary, understanding written texts, classifying words according to the number of syllables, identifying the characteristics of a narrative text (Portuguese language), observation and identifying different types and constituents of plants (natural sciences) and recognizing institutions and services (social sciences). In addition to these, the aim was to develop reading and writing skills, as well as artistic expression, namely creativity and expression, and physical education.

Objectives and skills to be developed

Throughout the project, it was intended that the students acquire various learnings in the various components of the curriculum, of which we highlight:

- Promote students' autonomy, active participation, and creativity.
- Encourage collaborative work.
- Stimulate students' curiosity and interest.

- Categorise living beings according to observable similarities and differences (plants: root type, stem type, leaf shape, deciduous/persistent leaf, flower color, fruit and seed);
- Identify the constituents of plants.
- Relate institutions and services that contribute to the well-being of populations with their respective activities and functions;
- Develop spatial orientation in students;
- Program the robot to reach a certain position;
- Create low-complexity algorithms to solve specific challenges and problems;
- Understand the concepts of mass and volume;
- Compare the mass of different objects;
- Compare the volume of different objects;
- Promoting the taste for physical activity;
- Encourage moments of oral communication;
- Identify the characteristics of a narrative text;
- Speak clearly and articulate words appropriately;
- Read with correct articulation, intonation, and speed appropriate to the meaning of the texts. (MEC,2018; MEC. 2021).

Interdisciplinary educational practices

Based on the learning recommended in the curricular documents guiding educational practice, this project seeks to achieve integrated practices involving the connection and articulation of the various curricular subjects.

The first day was dedicated to contextualising the project. In this sense, a sensorial activity was promoted, in which the students, with their eyes closed, had to taste food (white chocolate, milk chocolate, or black chocolate) and guess the theme of the new project. Then, the narrative text “What fruit is this?”, previously prepared by the trainee teachers, was distributed, to fill gaps in the text, throughout its reading. For a better understanding, an interpretation form was created, with questions about the text and tasks related to the constitution and characteristics of the cacao tree.

Subsequently, the book “The Chocolate Cycle” by Cristina Quental and Mariana Magalhães was read, to know the various stages of the chocolate production line in a factory. In this sense, an activity of plastic expression was promoted, in which the students had to cut and color representative images of the chocolate production process, ordering them according to the story presented.

The second day was dedicated to oral and written interpretation of an excerpt from the book presented. To introduce the professions, an order was received with a chocolate cake, which served as the basis for a big group conversation about the various professions involved in the production and marketing of chocolate, namely the farmer, the carrier, the factory operator, the distributor, the merchant, among others. In addition, the pastry chef who made it, the postman who delivered the cake at the school, and the teacher who received it were introduced. Therefore, it was possible to broaden the student's knowledge,

approaching other professions and their respective services, performing tasks proposed in the “Study of the Environment” guidebook.

To reinforce the division’s sense of sharing, the students were asked about the division of the cake, so that all the elements of the class had an equal slice. Then, the class was asked to work on some words from the story, reading and writing their syllables, and, finally, classifying them according to the number of syllables (monosyllable, disyllable, trisyllable, and polysyllable), which were recorded on the board and their daily notebook.

The third day was dedicated to the presentation of texts prepared at home with the families, based on some guiding questions about the profession they would like to play in the future. Subsequently, research was carried out on the computers, to create a concept map about chocolate. Thus, each group was responsible for collecting different information about chocolate, namely about its production, its types of chocolate and ingredients, its nutritional value, and, also, foods from the daily diet that contained chocolate, in the end, each group presented their findings to the class.

Subsequently, a game about the professions was played and, at first, one of the students had to guess a profession presented, through clues given by the class. In a second moment, each student, using mime, had to perform gestures associated with a particular profession, so that the other colleagues could guess it.

On the fourth day, the concept of mass was introduced through the “Hypatiamat Mass” Applet, in a big group dynamic, and then, for a better understanding of the content, the mass of several objects was measured with the assistance of a dish scale.

Based on the foods mentioned in the concept map and its nutritional table, each student had the opportunity to measure the amount of sugar in each food. To reinforce this learning, tasks were carried out in the Math manual and workbook.



Image 17. Measurement the amount of sugar in food.

To integrate Educational Robotics, the trainee teachers made it possible for all the students to have contact with the robot Mind Designer, in groups of five elements, in a game about professions. Therefore, each student should guess the profession related to the clues contained in some cards, programming the robot to reach, initially, the image of the profession and, later, the respective service.



Image 18. Profession game with the robot Mind Designer.



Image 19. Comparison of the mass of various objects

On the fifth day, a playful activity was promoted, to compare the mass of different daily objects. Initially, for every two objects, students had to reflect and fill in a table of estimates, marking: heavier, lighter, or balanced. After their estimate, the objects were placed on the scales, confirming the veracity of their conceptions.

To encourage students to engage in physical activity, the game of the “scarf bar” adapted to the context was promoted, that is, instead of giving numbers to the players, professions were assigned. With this activity was intended for students to associate the profession assigned with the service provided by the trainee teacher, reinforcing the acquired knowledge.

To motivate the students, an activity involving ICT was promoted through a game on the Kahoot platform related to the story of the book “The Chocolate Cycle” and the information collected in the realisation of the concept map.

On the sixth day, the concept of volume was introduced, and an activity was carried out to compare the volume of different containers, filling them with sugar. Thus, for every two numbered containers, students had to fill in a table of estimates, marking: greater volume, lesser volume, or equal volume. After their estimates, the sugar was placed in the numbered containers, confirming the veracity of their conceptions. Given the students' difficulties with this content, it was necessary to carry out tasks in the Math manual and the workbook.



Image 20. Comparison of the volume of different containers

To reinforce the learning about the three fundamental parts of a narrative text, the text “Thomas’ father’s profession”, built by the trainee teachers was distributed, to fill the gaps in the text and also identify the text: the introduction, the development, and the conclusion.

Formative evaluation of learning

Evaluation, from a pedagogical perspective, is fundamental in the teaching and learning process since it is essential in regulating student learning, as well as the professional practice of teachers. In this sense, moments of formative assessment were promoted, with the objective of students and teacher trainees reflecting on the tasks developed and the difficulties experienced, thus regulating their learning and the dynamics of the teaching and learning process. (Fernandes, 2019).

Therefore, students were assessed through direct observation, based on the descriptors provided in the official curriculum documents, namely the Profile of Students Leaving Compulsory School and the Essential Learning. In addition, the students completed an exploration sheet, in which they had the opportunity to identify and reflect on their difficulties in solving the proposed tasks.

Conclusion

After this pedagogical experience, we can consider that the use of robotics in the classroom is a potential tool in terms of awareness and operationalization strategies aimed at the acquisition of new knowledge and skills. In other words, children have contact with technology from an early age, and teachers should see this as an opportunity to innovate their practices.

In the context in which it was applied, Educational Robotics and ICT, as an innovative pedagogical practice, undoubtedly triggered greater interest and motivation in performing the proposed activities and in their dissemination to the class, having enabled the significant, integrated, and socializing learning expected.

Given this reality, it is essential to diversify teaching strategies and methodologies, promoting articulated, interdisciplinary, and innovative practices that enable experimentation and active and autonomous participation of students in the discovery of new knowledge. In this way, students remain truly involved in the tasks, acquiring meaningful, integrated, and socialising learning.

In short, programming and robotics can be fruitful tools, streamlined in an interdisciplinary, meaningful, and socializing, and presented in a gradual and challenging way. Consequently, it develops various skills in students, namely organisation and discipline, the spirit of cooperation, motivation for learning, the spirit of initiative and responsibility, and self-assessment of their performance.

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