Integration of educational robotics with active didactic methodologies in primary school

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ABSTRACT

Primary schools are increasingly considering educational robotics as well as active didactic methodologies such as cooperative learning, project-based learning or gamification. However, it is key to implement an appropriate roadmap in order to align these aspects with the educational curriculum, contemplating teachers' motivation and training. In this sense, the objective is to make the most of didactic methodologies and information and communication technologies as robotics to consolidate emerging pedagogies in schools as a commitment to the future. In this paper, the strategy followed by Claret Las Palmas School to combine the usage of educational robotics together with active methodologies in primary schools is presented. This approach is beginning in the first two years of primary school in this 2019-2020 course. As a first step, the involved teachers have completed an initial survey in order to check their expectations in this initiative and how they see the integration of active didactic methodologies and the usage of educational robotics. The results of this survey show that teachers are concerned by lack of time or not knowing about robotics, but are motivated to include it in the curriculum aligned with methodologies and transversal competences.

Keywords: educational robotics, active methodologies, didactics, integration, teaching

1. INTRODUCTION

The use of robotic systems is becoming a key aspect, applied since the earlier stage of education. In primary schools, robot programming is attractive and therefore represents an excellent tool for both introducing Information and Communication Technologies (ICT) and helping the development of children's logical and linguistic abilities [1].

A relevant aspect to take into account in order to successfully implement robotics in primary schools is teacher's knowledge and motivation to integrate robotics in the educational curriculum. Primary schools can play a decisive role in preparing children for their future, yet science and technology do not have a strong focus in primary education. Examination of learning and teaching robotics illuminates the problems encountered in improving technological literacy through primary education [2]

Educational robotics in primary school is not a standalone discipline, but a field which requires integration with active didactic methodologies. According to Demo et al [3] Inquiry Based Learning and Problem Based Learning paths are valid approaches to manage learning through robotics. In this paper, these approaches together with other active methodologies such as Project Based Learning and Cooperative Learning are assessed in order to determine how primary school teachers foresee and appropriate integration.

The rest of the paper is organised as follows: section 2 presents the combination of robotics and didactic active methodologies in primary school following the strategy of the Claret Las Palmas School; section 3 introduces the survey design in order to get teachers opinion and the associated results. Finally, in section 4, the most significant conclusions are outlined.

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2. THE COMBINATION OF ROBOTICS AND DIDACTIC ACTIVE METHODOLOGIES IN PRIMARY SCHOOL

2.1 Global framework

In the first years of primary school, educational robotics should be introduced not to directly learn robotics, but to learn with robotics [4]. In this sense, the related objectives of a robotics project at this stage could be the following:

- To access to curricular contents from a different perspective.
- To overcome programming challenges, implementing concepts and cognitive abilities aligned to several curricular areas.
- To acquire basic concepts of the programming language.
- To initiate students in computational thinking (a problem solving method through an ordered sequence step by step).
- To introduce students in a graphic programming language in a natural and ludic way.
- To develop discovery learning and trial-and-error learning.
- To teach teamwork, organization and to make agreements respecting colleagues contributions.
- To value educational robotics as an additional resource to learn.
- To arise the curiosity with respect to the world of science and robotics.

Moreover, educational robotics may especially help in subjects where abstraction is highly required, such as Mathematics, from primary school to university courses [5]. In this field, for instance geometry studies could be supported with robotics in order to enhance the experiences required in the first Van Hiele levels of geometry understanding [6]. In this scope, educational robotics make possible to settle physical platforms, useful to learn concepts by discovery learning. Figure 1 shows an example of a mat created for a Next 2.0 robot, the selected option by the authors [4] in which primary students learn how to measure sides in a rectangle triangle prior to learn the Pythagoras theorem. The robot can go through and measure the triangle hypotenuse without using the referred theorem (each robot step covers a unit, being the defined unit the 15 cm. side of a square in the mat).

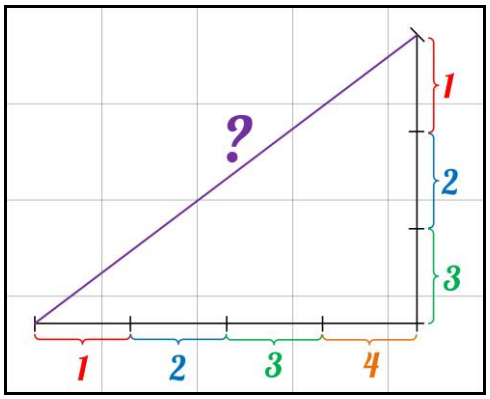

Figure 1. A mat designed to learn how to measure the hypotenuse of a rectangle triangle without using the Pythagoras theorem

These and other reasons are remarkable for our context to assess the integration of educational robotics with active didactic methodologies in Primary School, at the very beginning of the implementation in our school: Claret School, located in Gran Canaria (Canary Islands, Spain). In fact, the use of Information and Communication Technologies (ICT) in our society has made our educative community conscious of the importance of educating digital competences of students and teachers. Consequently, the ICT Plan of Claret school aims to integrate information and communication technologies in the teaching and learning processes. Promoted experiences in the school are carefully studied and aligned one to another, for instance the usage of tablets from primary to secondary school [7] supports the implementation of robotics as a way to manage robots.

ISBN 978-84-09-14325-2

2.2 Active learning and technological choices in Claret School

The teaching and learning process has suffered an extraordinary change in last years [8]. Competences such as cooperation, creativity, problem solving or communication are key in terms of new laws in education and its applications in the curriculum core. Indeed, digital competence, as already commented, has become a compulsory aspect to be included in the class [9] [10]. For these reasons, Claret School seeks the implementation of the following methodologies as a way to relate technology and teaching, respond to society demands, educational research and curriculum orientation:

- *Cooperative Learning*: Collaboration in the class involves the use of small teams in which members support each other in order to maximize their learning abilities. Many researchers studied the influences of working in teams in the school and the results show that cooperative learning improves the learning process in the students, instead of individualism or competition interactions in classes [11] [12]. ICT and robotics, specifically, is a good scenario to boost cooperative learning in the class, due to many of the challenges that are presented to pupils are established to reach them in teams.
- *Project-Based Learning (PBL)*: Investigation is promoted in schools by Project-Based Learning. It consists in practising scientific processes in order to let students learn by themselves. The phases are: set a problem, hypothesize explanations or responses, experiment, observation and conclusions [13]. Teachers' role is similar to a guide who structure learning, questions and resources but encourage their students to be protagonist in the investigation. PBL suits perfectly with ICT and Robotics integration because students can search their information and create together every research they must complete.
- *Gamification:* A tool based on game rules and dynamics applied to learning. It is a methodology that, not only in schools but other areas, is spreading in last years and it can offer interesting outcomes if teachers use it [14].
- *Problem-solving and creativity:* Competences that are transversal in S. XXI schools. Besides, in the Digital School Framework [10] these areas are included with digital competences to be developed by ICT's. Robotics can be related with these transversal elements such as affectivity, communication or creativity [15]
- *Technological choice:* INTEF (Instituto Nacional de Tecnologías Educativas y Formación del Profesorado) proposes some methodological changes in classrooms: promotion of school collaboration, the improvement of learning spaces, the development of skills for the s. XXI and digital educational competence [10]. ICT and Pedagogical change based on active learning demands to get deeper into comprehension of the teachers' digital competence structure in order to reorient the sense of their training in the same direction of their professional development and pupil's needs [16], [17].

In this sense, Claret school started an ICT plan in 2017, with actions every school year. In this term, 2019-2020, robotics is the main objective in the ICT agenda in the school. This plan will be carried out in progress, starting in primary school first years (1st and 2nd grade) with the idea of continuing the project in higher years.

The selected option to implement robotics in our school (Next 2.0) is ideal for helping young learners to begin exploring programming and technology. It can be programmed using the buttons situated on the top of his head (in previous courses students have already programmed similar robots using this option) or through a specific app, as shown in Fig. 2, which connects with the robot via bluetooth.

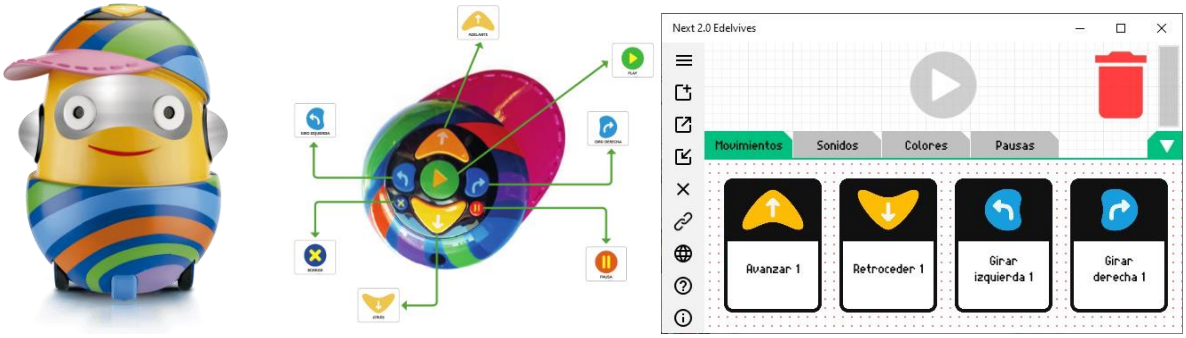

Figure 2. From left to right: Next 2.0 robot, buttons programming and app programming

ISBN 978-84-09-14325-2

3. SURVEY DESIGN AND RESULTS

3.1 Survey design and results summary

Once presented the considered didactic active methodologies together with the robotics choice, the survey design and the associated results of this implementation are presented in this section. This approach conforms an initial step for the proposed research.

The survey is mainly focused on getting information from tutors of the first two primary school years who will work this course 2019-2020 with educational robotics. The objective is to highlight methodologies in which the integration may be more useful. Besides, the main issues to accomplish the methodologies applicability, together with an analysis of the advantages and disadvantages of the proposed integration are also analysed.

As a result, a survey of 15 questions was proposed to 10 tutors. Considering their ages a subdivision in two groups (first group of 6 teachers from 36 to 45 years and second group of 4 teachers from 46 to 55 years) was made. The survey was divided into three sections:

- The first section, shown in Table 1, is composed by 11 questions assessed considering scores from 1 (totally disagree) to 5 (totally agree). Questions are related to how educational robotics can aid to implement didactic methodologies in the classroom and to check teachers' motivation to implement robotics in the classroom. According to the answers the use of educational robotics will mainly help to develop cooperative learning and gamification methodologies in the classroom. It is remarkable that the average score of all the questions exceeds 3 over 5 excepting on knowledge about robotics (question 6, average: 1.4) and forecast of integration of robotics with curricular elements (question 8, average: 2.8). It is also relevant that when age groups are considered, the results vary a lot in some questions, especially in questions designed to check teachers' motivation with the subject (average difference of 0.98 in questions 8, 10 and 11).

Table 1. First section of the survey (5 questions assessed from 1 to 5)

Question	Age 36-45	Age 46-55	Average Score
1.- Do you think that the integration of robotics will aid you in developing cooperative learning?	4.5	3.5	4.1
2.- Do you think that the integration of robotics will aid you in developing project-based learning?	3.75	3.33	3.5
3.- Do you think that the integration of robotics will develop gamification strategies in your classroom?	4.33	3.75	4.1
4.- Do you think that the integration of robotics will aid students to solve problems?	3.83	3.75	3.8
5.- Do you think that the integration of robotics will favour students creativity?	4.17	3.5	3.9
6.- Generally speaking, what do you think is your knowledge about robotics?	1.5	1.25	1.4
7.- Integration level of robotics with the curricular elements	3	2.5	2.8
8.- Would you like to receive specific training on robotics?	3.83	2.75	3.4
9.- Considering a functional robot with instructions, I prefer using a teacher guide than preparing the didactic proposal by myself	4	3.25	3.7
10.- I think that robotics should be gradually integrated in the educational curriculum of primary school	4.16	3.25	3.8
11.- Robotics should promoted in the school even more, with additional actions such as competitions, forums, etc.	3.67	2.75	3.3

ISBN 978-84-09-14325-2

- The second section, is composed by two lists of priorities from 1 to 5 (questions 12 and 13, presented in Table 3) in order to determine the applicability and the main associated issues, respectively. Analysing Table 2 and question 1, cooperative learning seem to be more appropriate to be considered in education robotics. Moreover, the pedagogical management of the tool and the contents preparation are the main concerns for teachers according to question 13.

Table 2. Answers to Question 12 - Priority (from 1 to 5)
of the applicability of the active methodologies using educational robotics

Active methodology	**Average Score**	**Order**
Cooperative Learning	1.67	1
Problem Solving	2.67	2
Creativity	3	3
Project Based Learning	3.25	4
Gamification	3.43	5

Table 3. Answers to Question 13 - Priority (from 1 to 5)
of the main issues of the proposed integration

Issue	**Average Score**	**Order**
Pedagogical management of the tool	1.7	1
Contents preparation	2.1	2
WiFi connection	2.75	3
Device security (thefts, vandalism...)	3.71	4
Inappropriate use by the students	4.11	5

- Finally, the third section is composed by 2 open questions in order to determine the advantages and disadvantages of the proposed integration (both questions are covered in the following subsections) and a final question to give the opportunity to include any additional comment. Answers are especially based on the necessity of training in educational robotics and the lack of time to prepare required contents. In any case, teachers express the necessity to integrate robotics in the curriculum in order to be aligned with the society needs, motivating students at the same time.

ISBN 978-84-09-14325-2

3.2 Main advantages of the technology integration in the classroom

The following sentences are extracted from the question 14 of the survey, in which teachers highlighted the main advantages of the technology integration in the classroom:

- Adaptation and response to current students necessities.
- More knowledge, computer management, creativity and problem solving techniques.
- Students motivation and interest.
- It is essential for the society needs.

3.3 Main disadvantages of the technology integration in the classroom

The following sentences are extracted from the question 15 of the survey, in which teachers listed the main disadvantages of the technology integration in the classroom:

- Lack of time.
- Coordination among teachers and robotics advisor.
- Tutors lack of knowledge.
- Students time with screens.
- It may interfere in the communication among students

4. CONCLUSIONS

In this paper, the initial steps of the integration of robotics together with didactic methodologies have been analysed through a survey to primary school teachers. For further research, there are some questions that need to be answered: do children really learn from robotics? Is it a different way to learn Maths, Language, social skills and problem solving? Are teachers ready to this?

Some remarkable conclusions that can be highlighted in this paper are:

- In relation to the methodologies and pedagogical advances that can be seen in the classroom, cooperative learning and problem solving are two of the elements that are considered as priorities when introducing robotics into the classroom.
- It is noticed that teachers' concerns are about their knowledge about robotics. Moreover, generally speaking, the younger the teacher, the higher the motivation to introduce this kind of topics in the curriculum. These facts make us think that teachers training is highly recommended in order to make robotics familiar to them.
- Another aspect to take into account is the lack of time. We can relate this with coordination with the advisor or for other contents in the class. It is important to transmit that robotics will be applied in terms of curriculum contents, helping teachers to reinforce student’s knowledge in the different areas as said before.

This is a key year to introduce and develop robotic program in the school. In this sense, future research to be conducted will explore the main benefits and disbenefits of this experience, considering not only teachers but student knowledge, through observation in class. When teachers find support in trainers, advisors and school authorities, they can introduce robotics in class daily life [18].

 ISBN 978-84-09-14325-2

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ISBN 978-84-09-14325-2