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Development of computational thinking skills and collaborative learning in initial education students through educational activities supported by ICT resources and programmable educational robots

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ABSTRACT

The purpose of this paper is to present the PhD thesis research plan, which aims to design, integrate and evaluate educational activities mediated by ICT resources and programmable educational robots, in initial education students, obtaining collaborative learning and Training of computational thinking skills. The research will be developed through a mixed methodology, with the intention of being able to carry out a more complete analysis and evaluation of the subject, obtaining data from different sources (teachers, students and coordinators of educational level). Various instruments such as interviews, questionnaires and participant type observation will be used, focusing on teachers and students. In addition, a rubric will be used to evaluate students' performance in the development of learning activities, through the sequential programming of educational robots. The results that will be obtained with this research will allow to carry out a proposal of technological educational action of great quality, based on the benefits and limitations of the integration of ICT resources and programmable Robots, contributing in a significant way to the implementation of new approaches for the Teaching-learning curriculum content from an early age and empowering participants in the development of computational thinking skills and collaborative learning.

CCS CONCEPTS

• Applied computing → Education • Computer systems organization → Robotics • Social and professional topics → Computational thinking; Information technology education

KEYWORDS

Computational thinking, programming, robotics, collaborative learning, students, teaching.

1 INTRODUCTION

The current society experiences a series of changes motivated by the incorporation of the so-called Information and Communication Technologies (ICT) as the main support in economic, industrial, social and educational activities. In the educational field the formation of a technological educational ecosystem is proposed, in which the teaching-learning processes are becoming more ubiquitous, flexible, collaborative and innovative. ICT have become the backbone for the development of meaningful learning in a learning community marked by globalization, digitalization and the strengthening of critical thinking [1].

In this technological educational context that emerges [2], we find an initiative that is increasingly taking force and

consists of the strengthening of digital skills and skills related to the programming and development of computational thinking from an early age [3]. All this with the intention of providing society with individuals with the necessary capacities to perform effectively and efficiently in an increasingly digital and technological environment [4[4].

Therefore, it is of great relevance to carry out a study to design, develop and integrate educational activities mediated by ICT resources and programmable educational robots in the teaching-learning process, contributing to the formation of computational thinking skills and collaborative learning. The research will be based on the initial levels of education, evaluating the effectiveness in achieving curricular objectives and the acceptance of students and teachers. The proposed research will be developed within the framework of the doctoral program on Education in the Knowledge Society of the University of Salamanca [5].

2 STATE OF THE ART

Nowadays the different productive sectors that compose the society demand of the educational institutions, the training of digital skills and competences in the participants [1]. What is sought is to train individuals with the digital skills necessary to achieve quality performance within changing and highly demanding environments.

For this reason, strategies have been developed to modernize teaching learning processes [7], including initiatives with a strong component oriented towards the formation of a true digital culture, consolidating programming skills, computational thinking and learning in a collaborative way, all of this from an early age [9].

One of the main focuses of action of the transformation that occurs in educational environments is the development of computer programming and thinking skills [10], [11], in this sense, it is important to consider the definition given by Jeanette Wing in 2006 [12], which states that this way of thinking "involves solving problems, designing systems and understanding human behavior, based on the fundamental concepts of computing". Wing also considered that computational thinking should be a fundamental skill for all people, not exclusively for computer professionals [12].

Subsequently, for 2008 [13], Wing complemented his arguments by saying that this thought should be a basic competence that every citizen would have to know to develop in the digital society; computational thinking is neither routine nor mechanical, it is a way of solving problems intelligently and imaginatively.

On the other hand, internationally have been formulated projects oriented to the incorporation of computational technology, access to the internet network and development of programming skills and computational thinking. A clear example is the initiative code.org, a non-governmental organization based in the United States, formed by companies with a high technological profile such as Amazon, Apple, Dropbox, Academia Khan, Facebook, Google and Microsoft, among others. Great reference in matter of insertion to the world of the programming [14].

In the European region is the Erasmus + KA2 project "TACCLE3" [9] [14] as well as other efforts by countries such as Estonia, which was one of the first to bring programming to elementary school classrooms. In the United Kingdom, the Computing subject was incorporated into the educational curriculum, in Finland they have integrated training in programming and computational and logical thinking in a transversal way, without creating new subjects to the academic load. Another of the projects that have been carried out is the so-called School 2.0 [15], which among other features has allowed the provision of equipment such as digital whiteboards, projectors and computers in school classrooms [16].

The implementation of collaborative learning methodologies in the classroom through ICT support is also part of the new digital scenario that is transforming the education sector. In this sense, "collaborative learning methodologies involve teamwork of students" and "various strategies can be used for students to work together to achieve certain common goals" In addition, "collaborative learning is cemented in the constructivist theory from which a fundamental role is given to the students, as main actors of their learning process" [17], [18].

Also, it has been mentioned that collaborative learning is a social construct, achieved through peer interaction, cooperation and evaluation between the learners and the teacher, accentuating group efforts. Currently, activities are linked to develop programming skills and collaborative learning through robotic technology tools with an educational orientation and is that "collaborative work is fundamental in robotics, where the learners work in teams, developing roles that relate and complement to achieve a common goal" [17], [18] .

3 HYPOTHESIS OF THE THESIS

For this research was initially raised a question that will be answered with the development of the study, this consists of

determining: What impact does the integration of ICT mediated educational activities and programmable educational robots have on collaborative learning and the formation of computational thinking skills in elementary school students?

Through this question, it is possible to formulate a working hypothesis for this research: With the integration of ICT mediated educational activities and programmable educational robots in primary and secondary school students, collaborative learning and the training of computational thinking skills will be achieved.

4 RESEARCH OBJECTIVES

The research has the following objectives:

- Design and integrate in educational practice activities mediated by ICT resources and programmable educational robots for the development of computational thinking skills and collaborative learning in elementary school students.
- Analyze the impact of the integration of ICT resources and programmable educational robots in the development of computational thinking skills and collaborative learning in an initial education context.

4.1 Specific Research Objectives

This research also has specific objectives:

- Describe what ICTs have the initial education students to establish if they have any influence on the development of computational thinking skills.
- Design educational activities mediated by ICTs and programmable educational robots for elementary school students.
- Integrate into the educational practice of elementary school student's activities designed with ICT resources and programmable educational robots.
- To determine the influence of the integration of ICT resources and programmable educational robots in the achievement of curricular objectives and collaborative learning in initial education students.
- To establish that characteristics or domains of Computational Thinking are strengthened with the incorporation of educational activities average by TIC's and programmable educational robots.

- Elaborate a proposal for action for the integration of educational activities mediated by ICTs and programmable educational robots in elementary school students.

5.1 Population

5 RESEARCH APPROACH AND METHODS

In this study, the mixed methods approach will be used as research methodology, with the intention of being able to carry out a more complete or more holistic analysis and evaluation of the subject under investigation. In addition, the mixed method approach allows for a more open and deep perspective of the phenomenon to be studied, taking full advantage of the complementary nature of quantitative and qualitative orientations [19][22].

In the methodological context of an investigation, the research design is of great significance; In this sense, we clarify that the design of an investigation refers to the plan or strategy that has been formulated to obtain the information that is required [19]. In this research will be used a design of sequential type (QUANTITATIVE → qualitative) This design will allow, from quantitative data, qualitative techniques can be carried out and with this, reduce or eliminate as far as possible the biases that occur in a research process when the study is carried out through a single method.

The quantitative orientation of the research will be developed in two phases, the first of a non-experimental type being "its purpose to describe the variable and to analyze its incidence and interrelation at a given moment", additionally it will be of the transversal type since the data will be collected in a Moment or single time. "The purpose will be to describe variables and analyze their incidence and interrelation at any given time" [19].

The second phase of the quantitative orientation will be through a quasi-experimental design with non-equivalent control group including pretest and posttest. Quasi-experimental designs "deliberately manipulate at least one independent variable to observe its effect and relationship to one or more dependent variables".

The qualitative approach of the mixed methodology will allow to explore the formation of algorithmic, computational thinking skills and the development of collaborative learning in an open and participatory way, involving students, teachers and parents in the process. In addition, the triangulation of methods for data collection will be used, contributing to the study a greater variety, richness and depth in the data analysis that will be carried out.

The population on which this research will be carried out will be constituted by students of initial educational levels

(infantile education) of centers located in urban zones. In this regard, considering the support and disposal received from the Maestro Ávila school, located in Salamanca, community of Castilla y León, presenting the research project.

It will be possible to have direct access to the student and teacher resources of the level, using in this way the total of the existing population in the center, corresponding to about 131 students and about 8 teachers who work within this educational context.

5.2 Study variables

For this research, the variables to be used are classified as independent, dependent and control. About the independent variables these will be: educational activities designed using ICT resources and programmable educational robots oriented to the population under study. However, as dependent variables for the development of this research we have the skills of computational thinking and the development of collaborative learning through the achievement of curricular objectives established in the content plan for elementary school students.

5.3 Instruments and techniques

For the collection of the data will be used various instruments such as questionnaires, interviews and observations, obtaining in this way a greater understanding of the phenomenon under study. To guarantee a similarity in the groups that will be used for the development of the experiment in the quantitative approach, some control variables will be used, linked to the students and teachers who will participate in the experiment.

On the one hand, we have the previous knowledge in ICT resources and programming of robots that present the students and on the side of the teachers the equalization of knowledge that they possess in the field of ICT and programmable educational robots.

6 RESULTS TO DATE

To achieve favorable acceptance from the first interventions, in the insertion of educational activities mediated by ICT resources and programmable educational robots, a combination of didactic resources using traditional techniques and others with technological support was used. These include: robotic corner preparation in the classroom, projection of videos, electronic presentations, storytelling, coloring pages, poster and graphics (Fig. 1).

Figure 1: Educational intervention using ICT resources in the initial education classroom

About the first educational interventions, which are part of the pilot tests, we can establish that the attitude expressed by teachers regarding the use of ICT resources and programmable robots in the classroom to achieve curricular objectives was positive. After applying a questionnaire, with an attitude scale, the mean value of the answers was 4.6, which is very close to 5, which corresponds to the very agreed option, on the scale used.

Figure 2: Percentage representation of responses obtained by questioning students about whether they want robotic kit to continue in their class.

In the case of the students, since they correspond to the initial educational levels, the attitude scale used to evaluate the perception about the robotic resource was an adapted Likert scale; for which images or icons were used, facilitating their understanding. Three possible values were established (disagreement-1, neutral-2 and agreement-3). The students expressed a positive initial acceptance of the question: Do you want Bee-Bot to continue in your class? In this sense, we obtained a total of 125 responses to the agreement option, six

to neutral and zero responses to the disagreement option; the percentage values of the responses obtained are shown in Fig. 2.

7 DISSERTATION STATUS

At the moment of presenting this work the study shows an advance in the activities planned for the period 2016-2017, including: literature review, initial contact with the educational center, design of activities for educational robotics at the initial level, initial training of teachers, preparation of instruments for data collection, development of the pilot phase of interventions and dissemination of the research project through congresses and scientific forums.

8 CURRENT AND EXPECTED CONTRIBUTIONS

During the present research, we hope to evaluate the impact that will have on collaborative learning and the development of programming skills and computational thinking, the incorporation of activities mediated by ICT resources and programmable educational robots.

The impact will be measured in the level of achievement of curricular objectives and the acceptance of the participants, students and teachers, when developing content using the technologies mentioned above.

In addition, we hope to design a proposal for educational action that serves as a model for developing an educational innovation strategy that involves the use of ICT resources and programmable educational robots at initial educational levels.

9 CONCLUSIONS

As we have specified during this communication, the development of programming skills, computational thinking and collaborative learning from an early age are essential requirements in the formation of individuals that will constitute the so-called information and knowledge society.

The first results obtained through the interventions that form the pilot tests have yielded favorable results which will allow us to strengthen the design of proposed activities as well as the instruments of data collection that will be used.

Our study will also delve into the characteristics necessary to achieve an effective use of ICT resources and programmable robots through the preparation of a proposal of educational action in robotics for initial educational levels which could be useful for both teachers and students in improvement and strengthening of the teaching-learning process.

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