Computational thinking competences training for primary education teachers

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ABSTRACT

This article provides a summary of a research plan as part of the "educational robotics" line of research of the doctoral plan for training in the Knowledge Society. The main objective of the research plan is to propose a curricular approach of Computational Thinking (CT) competences through active methodologies in Primary Education classrooms. It is a study with a mixed methodology to obtain more detailed results; the quantitative phase consists of the development of a MOOC for teacher training in CT, evaluated through questionnaires, and the qualitative phase, a didactic proposal in which these competencies are developed, evaluated through interviews, or focus groups. Thus, we start from a state of the art where it is reflected, on the one hand, that teacher training in CT competences causes positive feedback in Primary Education classrooms and, on the other hand, the need to carry out this training and include CT, programming, and robotics in educational curricula.

CCS CONCEPTS

• **Social and professional topics** → Professional topics; Computing education; Computational thinking.

KEYWORDS

Computational thinking, primary education, robotics, programming, teachers, teacher training

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1 CONTEXT AND MOTIVATION THAT DRIVES THE DISSERTATION RESEARCH

Computational Thinking is a term that is being integrated at great speed in many educational contexts, where true innovation is being sought. Its main promoter is Jeannette Wing, who in 2006 published the article entitled *Computational Thinking* [44], from which have emerged new programming languages and robotic devices accessible and adapted to children and youth, causing the trend and inclusion of programming and robotics in the educational world around the world [27].

In recent years, this interest in introducing programming and robotics in educational contexts has been observed [33], which highlights the importance of implementing this subject for the development of the so-called "Computational Thinking" [36]. The main reason for this integration is that these skills based on computation or programming are considered essential skills in daily life, so it is intended that all students are equipped with them and, thus, provide them with strategies for problem solving.

Similarly, Digital Competence is also considered an important and essential life skill in the 21st century [30]. The Joint Research Centre (JRC) of the European Commission has promoted such skills and has developed The European Digital Competence Framework for Citizens (DigComp 2.0) [39], a document that offers a tool to improve European citizens' digital competence and that serves as a reference and inspiration for many educational digital initiatives at the European level [32].

DigComp identifies five main competence areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving, which are composed of different competences. According to Demartini et al. [10], Computational Thinking can be included in four of these major areas, underlining competencies such as programming, data and digital content management, communication and interaction through digital technologies, collaboration and teamwork, problem solving, creativity, etc.

There are many advantages that Computational Thinking brings to education. First, it promotes a very attractive and effective learning through video games and educational robots, so that students feel motivated, and their curiosity is aroused during the teaching-learning process [13]. In addition, it is a competence that combines with any area of the curriculum, so it is not limited to a single subject, being able to be included in each of the curricular areas, both scientific-technological, visual, or linguistic [34].

Despite all this, several studies show that this concept is only integrated at the curricular level at the Compulsory Secondary Education stage, which causes a lack of consensus in previous stages, such as Early Childhood Education and Primary Education, on how to implement it and how to work with it [42], resulting in

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multiple forms of intervention that have a direct impact on student learning.

Teacher training in Computational Thinking is one of the main ways to reduce these controversies or difficulties [10]; therefore, as Esteve-Mon, Llopis & Adell-Segura [12] argue, teachers and future teachers should be trained in skills to formulate problems, logically analyze information, abstract, and automate solutions, etc., so that they acquire skills to develop activities and resources that are able to transmit and stimulate scientific-technological vocations among children. Similarly, there is a range of active and innovative methodologies that also help the acquisition of skills and increase student motivation and engagement to learn, which can be related to the development of computational thinking and robotics in primary education classrooms. This is the case of Challenge Based Learning (CBL), which involves the analysis, design, and development of a challenge to which students have to find a real solution so that they and other people can see and measure it [43]. Students use different resources and tools to obtain new knowledge to provide a solution to the challenge presented.

This paper stresses the importance of teacher training in Computational Thinking skills, such as sequences, loops, functions, and conditionals. It presents the design of the research that is going to be carried out, including its objectives, hypotheses, and research methodology. In addition, it makes reference to different studies whose research objectives are similar to the one to be achieved, helping to establish a more detailed hypothesis.

2 STATE-OF-THE-ART

In the last 5 years have been carried out some international studies similar to the one proposed in this doctoral thesis. In Spain, a study has been found, concretely in Catalonia [29], which seeks to elaborate a teacher training to carry out a curriculum in which Computational Thinking and robotics form its methodological basis. For this purpose, a small sample was taken, formed by four teachers of 3rd grade of Primary. It was used a questionnaire as an instrument of evaluation for teachers and students, whose conclusion is that this methodology of teacher training in robotics, CT and STEAM learning is sufficiently solid to be reproduced in other schools.

Several EU countries, including Spain, represented by University of Salamanca, have developed the Project TACCLE-3 [18, 22]. It consists of teaching computing to children between 4 and 14 years old in which is used mainly the Arduino LilyPad smart textile object through learning activities. These activities include a teacher training and a tutorial for beginners in programming and in this technology that. Finally, teachers' opinions have been of great help in achieving the main objective.

Within the European Union, there are more studies on the importance of training Primary Education teachers in Computational Thinking. At the University of Coimbra (Portugal), Marcelino et al. [35] have developed a study in which a training course based on Computational Thinking is carried out through Scratch. It is evaluated through satisfaction questionnaires, which reflect that the content provided by the course contributes to the consolidation of learning and it could be beneficial to implement this learning in the classroom with their students.

In Switzerland, El-Hamamsy et al. [11], have recently developed a research, which consists of a training course for primary school teachers through resources and materials needed to implement robotics and programming activities in their classrooms. The evaluation has been carried out by means of 4-point Likert scale questionnaires and the results have had positive feedback towards classroom experiences.

The "Riconnessioni" project has been carried out in Italy [10], which consists of different phases. Phases 3 and 4 consists of "training of trainers", with the aim of promoting innovative and practical ideas through a training course in digital technology for teachers, offering five training programs. Among these programs, training is offered in digital content creation and computational thinking, highlighting logical reasoning, problem solving and introduction to programming and robotics. Teachers should be able to design projects and educational plans for their schools by working with Scratch. This research concludes with the importance of teacher training and "cascade training", in which specialist teachers show the rest of the group so that they can use Computational Thinking in their classrooms.

Outside Europe, a study has been conducted in the USA with control and experimental groups for the integration of CT in K-12 classrooms. The experimental group, which has received training in CT skills, was better able to integrate robotics and programming in their classrooms, highlighting the importance of integrating CT as training within existing teacher education [45].

In Argentina, it is also carried out a study whose main objective is to train teachers in CT and programming, in order to teach their competencies that allow them to work with an innovative educational practice through new technologies [6]. The training is divided into CT, robotics, and mobile applications, which, according to the sample of teachers, is necessary for any didactic proposal at any educational level, providing them new alternatives more appropriated and motivational by introducing CT in their classes.

There are other researches [4, 5, 7, 37] that they are not part of this state of the art because the training was not aimed at primary school teachers, but at other educational levels or students. However, all of them conclude that it is important to have previous teacher training to include CT and programming in the classroom, as these concepts are considered as skills that promote students' own personal development.

3 HYPOTHESIS/THESIS AND/OR PROBLEM STATEMENT

Thanks to the studies and research works found in the previous state of the art, it is considered that the main hypothesis of this research is the following:

The training course that is going to be provided to the sample of primary education teachers is going to offer them different competences of Computational Thinking. These competences will help them to carry out the educational proposal offered in their classrooms with the least possible difficulties.

4 RESEARCH OBJECTIVES AND GOALS

The objectives sought to be achieved in the research are these:

General objective:

- To propose a curricular approach to Computational Thinking competencies through active methodologies in Primary Education classrooms.

Specific objectives:

- To carry out a systematic review of the literature on Computational Thinking and active methodologies.
- To elaborate a training course on Computational Thinking competences oriented to Primary Education teachers.
- To evaluate the level of competencies acquired in the training course in educational contexts.
- To know and evaluate the effect of the training course on the competences acquired and executed by the teachers in Computational Thinking.

5 RESEARCH APPROACH AND METHODS

The methodology to be used in the study consists of a mixed methods research. Creswell [9] defines mixed methods as a process of collecting, analyzing, and mixing both quantitative and qualitative data within a single study, with the objective of getting a better understanding of the research problem. In this way, both methods complement each other, taking advantage of the benefits of each one.

More in detail, a sequential mixed methods explanatory design is desired, which involves first collecting and analyzing data in a quantitative phase and then carrying out a qualitative phase, these phases being consecutive and forming part of the same research study [8]. The main advantage of this method is its simplicity and relevance in establishing quantitative results in more detail [28].

The proposed research consists of the following stages:

Initial stage. The Systematic Literature Review (SLR) and mapping are carried out to prepare the corresponding theoretical framework and the state of art [15, 31].

Quantitative stage. It consists of the development of a teacher training course implemented through a MOOC (Massive Open Online Course) [19], which aims to train teachers of Primary Education in Computational Thinking competencies.

The instrument used to collect data will be a questionnaire that has not determined yet. The starting point or basis for this questionnaire is the Computational Thinking Test proposed by Román [41], whose possible adaptation will be studied, which should be validated properly [46].

Qualitative stage. It consists of the elaboration of a didactic proposal in which the Computational Thinking competences learned in the training course are developed using the Scratch 3.0 programming environment. Scratch is an open-ended block-based visual programming environment created for teaching programming and CT to children and adolescents [40].

The data collection instrument to be used in this third part of the research is still to be decided, but it will be through focus groups or individual interviews.

Final stage. Contrast and triangulation of results. During the research a triangulation between quantitative and qualitative methods will be carried out. Therefore, in the same way, we will seek to obtain results through the triangulation of these and, thus, contrast the information collected [1].

This research is aimed at a population formed by teachers of Primary Education. It will probably focus on teachers of the last cycle of this educational level (5th and 6th grade of Primary Education) due to the maturity level of the students.

The population participating in the second phase of the research (quantitative stage) will be the same as that participating in the following phase (quantitative stage). In this way, it is intended that Primary Education teachers who are trained in Computational Thinking competencies subsequently carry out an educational intervention proposal in their classrooms.

The software that is going to be used to analyze quantitative data will be SPSS, while Nvivo will be used for the qualitative ones.

The code of ethics in educational research [3], as well as the Organic Law 3/2018, of December 5, on Personal Data Protection and guarantee of digital rights, will be attended throughout the development of the research.

6 DISSERTATION STATUS

Nowadays, I have finished the first year in PhD Programme on Education in the Knowledge Society and I have defined the research plan. In the following months, I am going to start the Systematic Literature Review (SLR) and mapping, as well as the design of the teacher training course.

7 CONCLUSIONS

The importance of introducing Computational Thinking in education is evident. The different analyzed research works point out the relevance of introducing it at early ages such as Early Childhood and Primary Education [25]. As reflected in the study with Lego Education WeDo carried out by Pinto-Llorente et al. [38], there positive results regarding the incorporation of CT in primary education, stating that it is a fundamental skill in today's society and should be part of core content areas.

However, as Álvarez-Herrero [2] points out, there is no consensus for using these practices in education, so it would be necessary to establish a framework and common guidelines that allow the correct implementation of programming, robotics, and CT in childhood.

In consequence, as it has been mentioned throughout the paper, there is also an urgent need for adequate teacher training in CT competencies such as critical thinking, creative thinking, problem solving, etc. Therefore, this research supports the creation of a MOOC course that offers this training to Primary Education teachers and its subsequent proposal for educational intervention, using programming and robotics environments suitable for children, such as Scratch.

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