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COEDU-IN Project: an inclusive co-educational project for teaching computational thinking and digital skills at early ages

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***Abstract*— Learning to program is the new literacy of the 21st century. Computational thinking, closely related to programming, requires thinking and solving problems with different levels of abstraction and is independent of hardware devices. The early childhood education stage provides teachers with the opportunity to lay the foundations for a comprehensive quality education using innovative tools and technologies. Educational robotics in early childhood education becomes a tool that facilitates the acquisition of knowledge to children, playfully, based on the principles of interactivity, social interrelationships, collaborative work, creativity, constructivist and constructionist learning, and a student-centered didactic approach, allowing in turn that student can acquire digital competencies and develop logical and computational thinking in an underlying way. This project explores the current state of teaching and learning computational thinking and programming in early childhood education in an inclusive manner. Moreover, the lack of diversity and inequality is particularly latent in science, Technology, Engineering, and Mathematics (STEM) fields. Therefore, this work considers this problem and presents an inclusive coeducation approach to this new literacy, eliminating gender stereotypes and extending them to people with Down syndrome and hospitalized minors.**

Keywords—Computational thinking, programming, inclusion, digital literacy, STEM, childhood education

I. INTRODUCTION

Today, there is a growing need for a future workforce that understands technology. Given this new reality, national educational programs and private initiatives are focusing on STEM (Science, Technology, Engineering, and Mathematics) / STEAM (Science, Technology, Engineering, Arts and Mathematics) literacy and making programming and computational thinking a priority for education [1, 2].

The initial education stage provides teachers with the opportunity to lay the foundations for quality comprehensive training through innovative tools and technologies [3, 4]. In this sense, educational robotics in early childhood education becomes a tool that facilitates the acquisition of knowledge to children in a playful way, based on the principles of interactivity, social interrelationships, collaborative work, creativity, constructivist and constructivist learning, and student-centered learning [5, 6, 7], which in turn allows them to acquire digital skills and the development of logical and computational thinking [8, 9, 10, 11] in an underlying manner.

The theoretical basis of this work is based on two main theories: the constructivism of J. Piaget (1971) [12] and the constructionism of S. Papert (1980) [13]. Papert's educational philosophy starts with Piaget's constructivism but adds that new learning is more efficient when the learner elaborates it using tangible objects with some meaningful representation for them: this is the origin of the "learning by doing" method [13, 14, 15]. Consequently, robots are an excellent tool to explore the constructionist philosophy because it allows learning by building, through experience [7, 16].

Another core area of this work is to bring STEM/STEAM education into the classroom, particularly at the early childhood education level and in inclusive settings [14, 15].

This work follows an educational approach for equality or coeducation, inclusively, following some studies highlighting the importance of revealing this type of knowledge to children at early ages, avoiding the formation of stereotypes [17, 18].

A 2003-2009 literature review called for more innovative ways to link literacy, technology, and learning as digital texts and technology intertwine with early literacy skills [19]. Therefore, there is a need to look at teaching technology and programming in an early and innovative way. Moreover, research on teaching computational thinking to people with cognitive disabilities or specific learning needs is still scarce [18].

Consequently, this research aims to contribute to the study of how this new literacy is being introduced in schools (pedagogical foundations, strategies, tools, regulations), in particular using tangible technologies in early childhood education [19], in order to propose then an educational method that allows incorporating computational thinking in an inclusive co-educational way. Therefore, this project addresses the analysis of the main initiatives related to computational thinking in early childhood schools, using specific tools, such as robotics kits or educational programming environments, and the main teaching-learning strategies used in early childhood education (3-6 years) [20]. Likewise, an educational method for teaching and learning computational thinking is proposed, adapted to local (Canary Islands, Spain) and particular special learning needs (Down syndrome) [21] and particular contexts (Hospital Classrooms) [22] as well as for specific and. This method will follow the principles of active constructivist learning and maker culture [23].

Therefore, the present proposal will analyze current initiatives and propose an inclusive co-educational method for teaching programming and computational thinking at early ages [24]. Next, the objectives, method, instruments, expected results, and the offer for carrying out the necessary tasks will be described.

II. METHOD

The main research objectives of this project aim to answer the following research questions:

- How are computational thinking and educational robotics in the educational system addressed at the regional, national and international level?. Moreover, specifically, to know the current literacy situation in early childhood education and the different existing tools and methodologies for its teaching.
- How do children interact with technologies at an early age?
- What computational thinking and engineering concepts and skills do children learn through robotics? What positive behaviors do early childhood children develop in learning environments with educational robotics? Are roles and stereotypes reproduced in their behaviors?
- How do teachers integrate the teaching of programming and computational thinking into curricular activities? What training needs do they have on this topic? Are roles and stereotypes reproduced in STEM/STEAM teaching?
- How to develop a proposal for inclusive co-educational teaching of computational thinking for people with specific and special educational needs, specifically for people with Down syndrome and hospitalized children?

In order to answer the above questions, the following specific objectives are defined:

- To analyze state-of-the-art art related to computational thinking and educational robotics at regional, national, and international levels in early childhood education.
- To know the different technologies and forms of interaction with technologies in early ages and the recommendations and good practices in their educational use.
- To analyze the behaviors developed by boys and girls at early ages about technologies and reproduction of roles and stereotypes.
- To analyze how teachers integrate programming and computational thinking in their curricular activities and the reproduction of roles and stereotypes.
- To design a constructive proposal for inclusive co-educational teaching of computational thinking and programming.
- Disseminate and disseminate the results obtained.

Besides, the training proposal to be developed, aimed at educators, children, and their families, will include the following areas:

- Programming and computational thinking as literacy.
- Inclusion, Equity, Diversity, and STEAM.
- Values, Critical Thinking, and STEAM
- Gender, Coeducation, and STEAM
- Bio-engineering
- Maker culture
- Digital competencies in health and safety
- Neuroscience and STEAM education

In order to achieve the objectives proposed in the project, a methodology divided into different phases is proposed. In the first phase, a literature review is carried out to analyze the state of the art in terms of the central themes of the research. In the following phases, a mixed quasi-experimental methodological approach is followed for the intervention in educational centers and with case analysis, combining qualitative and quantitative techniques in contexts of attention to diversity, such as hospital classrooms and educational care for people with Down syndrome.

Phase 1 analyzes the main initiatives related to computational thinking in schools, using specific tools such as robotics kits or educational programming environments, and the main teaching-learning strategies used in early childhood education. It also seeks to a) identify which tangible technologies have been used, b) recognize the educational

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purposes and uses of these technologies, and c) present a synthesis of the available empirical evidence on their educational effectiveness.

In Phase 2, concepts, skills, and behaviors related to computational thinking in early childhood education will be studied. In addition, different methods and strategies for integrating the teaching of programming and computational thinking into curricular activities will be analyzed.

Teachers from different centers in Tenerife will be trained in early childhood education (minimum 5) using a convenience sample of teachers in coeducation and teaching programming and computational thinking. It is a blended learning training to adapt to educational institutions' "safe presence" guidelines. The training has 20 hours, of which 12 are in online mode and 8 in face-to-face mode. The face-to-face sessions to be developed will be repeated according to the groups formed in the sample of up to a maximum of 10 professionals per session. The training will follow an approach based on active methodologies. The main learning axis will be a set of activities that will allow applying the contents mentioned above. Precisely, the training will guide participants to define their own strategy and actions to modify at least one of their subjects to incorporate principles of equality and coeducation, in addition to computational thinking and programming. Once the training is over, the online space will be maintained as a communication space between the participants and the teaching team. There will be a follow-up and support for implementing the strategies and actions proposed during the training. The objective of this action is that the knowledge and techniques worked on during the course are materialized in real subjects of the curriculum.

It should be noted that the participating teachers will develop a teaching experience in programming and computational thinking with children aged 3 to 5 years old from the participating centers within the framework of the co-educational proposal previously designed (Bers, González and Armas, 2019).

Likewise, we will work on an online training adapted for families to allow the accompaniment of the activities designed for the home using a collaborative platform of unplugged educational games of computational thinking and programming.

On the other hand, the project whose impact is to be evaluated has an estimated minimum number of teachers of 50 and 1000 students and their families.

The sample of students will be those who wish to participate in the study from participating schools and whose families authorize their participation.

In Phase 3, the previous proposal will be adapted to create an inclusive co-educational method to bring the new literacies (particularly computational thinking and coding) to students with specific or special learning needs. We applied in this study the observation method to analyze during the sessions the emotional states, engagement, and understanding of the programming sequences (Gonzalez et al., 2019). The proposal will also be adapted to the characteristics of hospital classrooms to teach cross-disciplinary computational thinking and programming without screens and robots, including working with emotions (González et al., 2020).

Participants will receive an informed consent form, will be able to leave the study at any time, and data processing will be followed according to current European regulations. The Committee will approve all instruments and procedures of Ethics of the ULL.

III. Conclusions

We are starting the project and developing the first phase of it. Currently, there is no proposal for inclusive co-educational teaching of computational thinking and programming at an early age. Therefore, we highlight the innovative nature of the project and the social impact that it can generate on both the teachers of educational centers and the students and their families.

On the other hand, the project whose impact we wish to evaluate has an estimated minimum number of teachers of 50 and 1000 students and their families who will be direct beneficiaries of the training program and activities carried out.

In addition, as direct beneficiaries, we will find the centers involved in the training and experimentation, as well as the Down Tenerife Association and the hospital classrooms in the Canary Islands where the case studies will be carried out, their teachers, students, and families.

We can also mention as beneficiaries the students and teachers of the degrees and masters of the ULL related to early childhood education, education, and technologies.

We highlight as benefits of the project the promotion of interest and commitment of schools and local entities to develop initiatives to improve the training of children in early childhood education and their digital literacy, simultaneously working digital skills in health, safety, values, critical thinking, bio-engineering, and maker culture.

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