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Educating preservice teachers to introduce educational robotics into their future preschool classroom.

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Abstract

Many countries are developing or reviewing national policies to support children developing as computational creators and thinkers. Preschool teachers do not view coding literacy similarly to universal reading and writing literacy. However, in the light of recent evidence, they will likely change their current view as a new curriculum around the globe fosters the purposeful integration of coding and data literacy. When education systems worldwide identify Computational Thinking and coding as a prerequisite for young age children, preschool age educators will become responsible for introducing these concepts in early childhood education, even when they may have had little or no training in the specific domain. The present study presents a teaching intervention implemented to introduce CT and coding skills to university students. This paper describes the design, implementation, and evaluation of a semester-scale teaching intervention that involved 21 preservice teachers provided with 39 hours of learning activities using Scratch 3.0 and MaKey MaKey. The research question this study sought to answer is: "Can Scratch and Makey-Makey be considered as effective tools for introducing preservice teachers to concepts related to both CT and coding during their training in institutions of higher education?"

Keywords: *Preservice teachers, Makey Makey, Computational Thinking, coding skills, STEM*

1. Introduction

In recent years, concepts such as creativity, CT, and coding skills have become a focus of research and teaching interest, recognizing a priority worldwide by public and educational authorities [1]. These concepts have focused on research and teaching interest from the early years [2]. Many countries are developing or reviewing national policies to support children developing as computational creators and computational thinkers [3]. Since early, children have used Logo programming language to guide a "turtle" around the classroom; the scientific community has not ignored the challenges [4]. There are ongoing attempts to make the coding world more accessible to novices by connecting it to the real world [5]. This linkage may be a great advantage when these processes are embedded into cognitive activity to introduce young learners to computational thinking, algorithmic thinking, problem-solving and critical thinking [6].

Preschool teachers do not view coding literacy similarly to universal reading and writing [7]. When education systems worldwide identify CT and coding as a prerequisite for young age children, preschool age educators will become responsible for introducing these in early childhood education, even when they may have had little or no training in the specific domain. In any case, this will result in a change in practice, demanding from teachers to rapidly develop a series of skills to introduce CT concepts and coding skills in the classroom [8].

At a low or moderate cost, several educational resources introduce coding activities at very young ages in programmable toys [9]. Nevertheless, the preservice teachers need to be equipped with digital and pedagogical competencies to include CT in schools actively [10-11]. For this purpose, a teaching intervention has been implemented to place students at the centre of the CT discovery to leverage their inherent curiosity to engage with content through coding experiences. The research question this study sought to answer is: "Can Scratch and Makey-Makey be considered as effective tools for introducing preservice teachers to concepts related to both CT and programming during their training in institutions of higher education?".

2. Based block programming and educational robotics

The expectation of introducing CT and coding skills at an earlier age triggers a shift in preschool teachers' professional identity representing a substantial change. Teachers must undertake new responsibilities and develop different forms of interactions with children to connect their activities to

technology through fun and engaging activities [9]. This approach is considered critical to accomplishing the goals of "low-floors, high ceilings, and wide walls" [2], which describes something comfortable to get started on, yet has considerable growth potential. Furthermore, digital activities in preschool education, based on CT and coding activities and focusing on elements such as fantasy, curiosity, and challenge, raise the interest and motivation of children. This type of learning is based on curiosity to stimulate children to find new ways to solve problems and increase children's satisfaction.
The need to introduce CT concepts and necessary algorithmic and coding skills in preschool education has driven numerous commercial and research-based toys and kits. These products derive from the necessity to make technology and relative concepts more accessible to children via tangible things -touchscreen devices and infrared sensors.

2.1 The Scratch 3 visual programming environment

Scratch is maybe the most popular programming environment for novice programmers (https://scratch.mit.edu/). Scratch users can create projects by dragging and dropping visual blocks of commands on the screen. This coding method reduces the cognitive load to recall commands and strict syntax requirements [4]. Due to its popularity, people of all ages use it as it is easy for anyone to start developing their programming and problem-solving skills by creating their projects.

2.2 The Makey Makey educational robotic kit

Makey Makey is a robotic device used in teaching and learning. It is a low-cost electronic board that plugs into any keyboard computer. Additionally, it includes actuators and sensors for enhanced experiences with the physical world. Unlike other robotic tools, the device's potential is connecting familiar elements like bananas or aluminium foil. All this favours people's interaction with the robotic kit, endorsing positive behaviours relative to programming with little cognitive effort [10].

3. The teaching intervention

3.1 Participants

The participants were 23 greek female preservice early childhood students who took a university course in the winter semester of 2021-2022 in the Department of Preschool Education. The participants voluntarily attended the course, and national and international research ethics guidelines were followed [12].

3.2 Study design

The intervention focused on activities that strengthened CT concepts and coding connections to other concepts. They also focused on developing positive attitudes and behaviours in preservice childhood students based on educational robotics problem activities. The intervention's development was based on the Makey Makey and Scratch 3. The intervention focused on project-based and inquiry-based learning as a pedagogical strategy, solving real problems with the teacher and peers' support. The pedagogical actions carried out tried to support students by scaffolding their learning, which meant that they worked as a team. The approach assumed that learning occurs when the learner is actively involved in knowledge construction while having the freedom to decide for their projects to acquire knowledge and skills in new situations. Students' teams created their projects to promote CT and digital-making skills, social interaction, imagination, and creativity. Students were encouraged throughout this process as their projects were considered for their evaluation for this course.

3.3 Data collection

The course evaluation included both cognitive and affective factors. For this purpose, the researchers collected and analyzed quantitative and qualitative data. The study's quantitative part was conducted in a pre-test/ post-test comparison of a quasi-experimental design.

3.4 Data analysis

Project analysis: The pre-test and post-test results were analyzed to verify educational robotics activities' influence on the acquisition of computational thinking skills. The dependent variable was the students' computational thinking and programming skills, considering seven dimensions, evaluated through Dr. Scratch (http://drscratch.org/).
Students' self-efficacy analysis: The Teachers' Self-Efficacy in Computational Thinking (TSECT) questionnaire [13] was used to evaluate students' self-efficacy beliefs regarding CT concepts and coding skills in their future teaching practices.

3.6 Limitations

This study's findings investigated female students' responses at just one Greek university. Furthermore, this study was conducted with a relatively small sample and a short intervention, limiting statistical power.

4 Results

The differences between the pre-test and post-test were analysed with a paired sample test and revealed a statistically significant increase from pre-test ($M = 9.72$, $SD = 2.55$) to post-test ($M = 14.57$, $SD = 1.22$), $t(22) = 2.34$, $p < .0001$. After the teaching intervention, we can conclude that the students felt confident enough to create projects with Scratch and Makey Makey and, more importantly, use these tools as an educative tool within the preschool classroom. The two researchers also conducted the student focus group interviews using a semi-structured interview protocol. Students noted that they could handle the cognitive course effort, and they feel confident in introducing relative CT and coding activities in the preschool classroom. The students mentioned that they experienced a significant improvement in their representations towards CT or coding. Although the lack of CT and coding knowledge was a significant challenge before the teaching intervention, they mentioned that they do not consider themselves novices after the course completion. These students reflected on their intention to incorporate similar activities in their future teaching career and practice in kindergarten during their university studies in the following semesters.

5. Discussion and conclusion

Given the increasing number of young children using apps that promote CT concepts and coding skills and the abundance of robotic toys or kits available for educational activities, preschool educators are responsible for introducing these new forms of technology into the preschool learning experiences [9]. With the pace of technology change [14,15], it is paramount that preservice teachers be provided with training opportunities through their university studies that will intensely focus on CT pedagogy and coding literacy, which can be easily transferred to young students with minimal difficulty [2-13]. This study provides implications for the implementation of coding literacy in educational institutions. Given the importance of CT and coding skills, understanding how best to support preservice teachers in meaningfully and successfully implementing coding literacy is of great importance.

6. References

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