# Factors That Hinder in-Service Teachers from Incorporating Educational Robotics into Their Daily or Future Teaching Practice

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Abstract: As educational technology continually improves, there is an ongoing interest in using educational robotics (ER) in preschool classrooms. The acquisition of STEM experience in young children's education has found that it helps children get the appropriate tools crucial to any successful study. As the research recognizes that children must participate in STEM education from an early age, ER provides a tangible interface that could enhance the learning process by creating an enjoyable and engaging context. There is also a close relationship between educators' knowledge, views, and attitudes towards technology and how to adopt technology in early childhood classrooms. Teachers' perceptions, attitudes, and technological competencies are considered the primary determinants of technology adoption in curriculum and pedagogy. It is necessary to understand their views, problems of ER's utility, and acceptance in preschool education. This study aimed to examine preschool educators' views regarding the factors that hinder them from incorporating the ER into their daily teaching practice.



## 1 INTRODUCTION

Supporters of introducing creative thinking and problem-solving in education argue for systematic reform to primary and secondary schools that encompass modern technology educational tools demanded of students in the twenty-first century (Karakoyun and Lindberg, 2020). In this context, the scientific community regards technology in early childhood education settings as a tool to prepare students and future citizens for their role in society (Kalogiannakis and Papadakis, 2017; Mertala, 2019). Additionally, research supports that the preschool classroom environment is rich in preschoolers' connections and opportunities to engage actively in Science, Technology, Engineering, and Mathematics (STEM) activities (MacDonald, Huser, Sikder, and Danaia, 2020). Nowadays, there are numerous educational tools available for preschool-age children to engage them in STEM activities such as visual block-based environments (e.g., ScratchJr), online environments (e.g., Code.org), robotic devices (e.g., Bee-bot), and unplugged activities (Dorouka, Papadakis and Kalogiannakis, 2020; Rose, 2019).

Educational robotics (ER) kits or robots in Preschool Education offer a playful and enjoyable experience to young children to engage in STEM activities by constructing robots with or without software applications using motors, sensors, and various everyday materials. They can also acquire

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Computational Thinking (CT) skills by exploring algorithms, modularity, sequences, loops, and variables (Sullivan, Bers, and Mihm, 2017). As preschoolers are already familiar with digital devices before entry into preschool (Kalogiannakis and Papadakis, 2017), educators can easily engage children in creative activities and physical play with robotic kits. Thus, they can easily take advantage of the latest technology based on children's prior experiences, logical arguments, or other empirical evidence (MacDonald et al., 2020).

It is now widely recognized that a strong relationship exists between early childhood educators' attitudes towards technology and their actions in early childhood settings (Kalogiannakis, Ampartzaki, Papadakis, and Skaraki, 2018; Vidal-Hall, Flewitt, and Wyse, 2020). Educators' self-efficacy beliefs and knowledge in digital technologies, and lately, in STEM activities and CT concepts, can significantly impact their digital education experiences. Many educators experience uncertainty or even fear concerning digital and STEM content, which affects their confidence in STEM and CT education practices (MacDonald et al., 2020). On the other hand, Bers notes that robotics can help teachers expand interest in STEM concepts and make CT and STEM activities more appealing for students and teachers. Teachers' earlier experience in robotics education can help educators revisit their instructional designs and integrate interactive teaching approaches, such as student-centered teaching (Bers, 2008).

This paper's research study is focused on in-service teachers' perceptions regarding the factors that inhibit them from incorporating ER in their daily teaching practice (Hamed, Ezquerra, Porlán, and Rivero, 2020).

## 2 LITERATURE REVIEW

The rise of digital technologies brings new opportunities, demands, and challenges for students and teachers in the 21st-century (European Commission, 2020). Research supports the beginning of STEM experiences since preschool education as these experiences function as a critical component of their cognitive development and predictive of later reading achievement (Heikkilä, 2020). Children's developmentally appropriate STEM education approaches in early years education contribute to a positive STEM field attitude. Besides, they make students believe that they can succeed in future engagement in STEM (Çiftçi, Topçu, and Foulk, 2020). Furthermore, the research has proven that early exposure to STEM experiences reduces gender-based stereotypes of females' STEM career roles. This assumption leads to an increased interest in engineering and relative disciplines later in their academic and professional life (Bers and Sullivan, 2019).

For these reasons, in recent years, concepts such as STEM, robotics, CT, and coding, have been promoted by educational institutions and other organizations as skills that are as fundamental for all 21st students with equal importance as numeracy and literacy (Papadakis, Zaranis and Kalogiannakis, 2019). In preschool classrooms, the educational goal is not to introduce coding literacy in separate subject classes. Indeed, the aim is to teach students how to use digital technologies as tools to produce well-educated people. At the preschool education, the aim is to ensure a broader focus so that students use the digital technologies and the CT and coding activities as learning opportunities for cognitive growth, creative problem solving, and entrepreneurship (Heikkilä and Mannila, 2018).

Especially, ER technologies offer hands-on methods to young students about everything they encounter on a typical day, such as sensors, batteries, detectors, and lights. The term Educational Robotics (ER) is used to define a broad area of knowledge-based approaches requiring students to utilize their reasoning skills either to program a robot or design and create its part(s) and program it (Di Lieto et al., 2017). For these reasons, ER is considered an appropriate tool for early childhood development because it helps children develop fine motor skills and coordination, aids in cognitive development and social and communication skills (Sullivan et al., 2017). It also helps children understand cause and effect and take their early imagination to a new level while developing problem-solving, logical thinking, and cognitive skills to acquire programming skills (Toh, Causo, Tzuo, and Chen, 2016).

This shift has profound implications for teachers' skills and practices as teachers are expected to find creative approaches to teach children to read, write, and develop mathematical skills and code and programming (Atmatzidou and Demetriadis, 2016; Barianos et al., 2019). Thus, we need to understand the beliefs and reasoning that guide teachers' ER introduction and classroom practices. In this aspect, before designing and introducing an ER, STEM, CT integrated curriculum that effectively accommodates preschoolers' needs is imperative to understand the complex challenges teachers face in their daily teaching practice. These challenges include inadequate training, strict curricula, flawed methodologies, limited educational content, and lack of infrastructure (Reinoso, Delgado-Iglesias, and Fernández, 2019).

For many teachers, this is a considerable challenge, and several studies highlight the gap between teachers' ability in technology use and the actual technology use. Each tool requires an understanding of its pedagogical potential and classroom deployment options, as well as the necessary facilities (Levy and Kucirkova, 2017).

Earlier research has revealed several obstacles that could hinder a teacher from integrating educational technology in the classroom (Kalogiannakis and Papadakis, 2017). The importance of teachers' beliefs and attitudes for the everyday use of educational technology in teaching practice has been broadly addressed in the literature (Vlasopoulou, Kalogiannakis, and Sifaki, 2021). For instance, Vidal-Hall et al. (2020) highlight that integrating digital technologies forms a challenge for early childhood educators. In conjunction with teachers' beliefs, these limitations can explain how in-service teachers introduce ER in their classrooms and how in-service teachers instruct students in CT and ER activities (Cormas, 2020). Vidal-Hall et al. (2020) comment on a British study result showing that 25 percent of the United Kingdom practitioners feel that new forms of technology do not belong in the preschool classroom.

A teacher's positive or negative attitude towards introducing educational technologies in the classroom can either ease or hinder digital media use in the daily teaching practice (Papadakis and Orfanakis, 2016). Many educators experience uncertainty or even fear concerning STEM content, which affects their confidence in STEM education. Besides, meaningful STEM professional development contributes to positive effects on teacher attitudes, increasing their confidence and enrollment in relative fields (MacDonald et al., 2020). Tang, Tung, and Cheng (2020) state that teachers outside of technology-oriented fields may not have the technical competencies to use ER. Furthermore, a lack of technological infrastructure and training support could prevent teachers from using new technology, and teachers' biased attitudes towards new technology, namely their perceived utility and ease of use, could be another hurdle.

For a shift in teachers' beliefs toward STEM, innovative approaches for effective training should be applied to guarantee the practical implementation of STEM concepts and educational technologies into the classroom (Çiftçi et al., 2020). For this purpose, the present study investigated the beliefs, skills, and attitudes of a group of participants consisting of in-service early childhood teachers' before attending a seminar relative to STEM integrated practices.

The research question guiding the study was:

(1) What are the educator's beliefs on the factors that inhibit ER use in early childhood education?

# 3 MATERIALS & METHODS

## 3.1 Methodology

In this study, the quantitative approach to data collection and analysis was followed utilizing a survey instrument designed for the present inquiry, which had an exploratory character (Petousi and Sifaki, 2021). The main aim was to gain insights about in-service preschool teachers' beliefs on the use of Educational Robotics in preschool education and specify which factors hinder their incorporation into the formal curriculum.

## 3.2 Sampling

The sample consisted of in-service preschool teachers (N=102) who attended a seminar on educational technology, which complete the survey questionnaire before the beginning of the session. The in-service teachers were females with 10 to 25 years of teaching experience in kindergartens in the region of Crete. It is worth emphasizing that the in-service teachers had not received a systematic education and training in ER, CT, and STEM concepts and activities previously, and for the majority, that seminar was their first experience in ER, CT, and STEM.

## 3.3 Instrument

The survey questionnaire used for data collection included, besides demographic items, questions sought to determine the teachers' thoughts on various aspects hindering ER's implementation in daily teaching practice and items measuring their readiness to conduct ER. The latter were eleven closed-ended items on a five-point Likert scale of Strongly Agree (5), Agree (4), Undecided (3), Disagree (2), and Strongly disagree (1).

## 3.4 Validity and Reliability Issues

To reserve validity and reliability issues, special attention was paid to stating the appropriate and straightforward questions. The items were developed and checked by experienced educational technology lecturers and scientists, who avoided any complicated language unfamiliar to participants. Moreover, the instrument's factorial validity was verified by

Principal Components Analysis, and the Cronbach's alpha for internal consistency was measured. However, in this report, we present only the dimension of the negative (hindering) factor, and we treat each item as a separate variable.

### 3.5 Limitations of the Research

A limitation of this study is the generalizability of the findings to other contexts, given the opportunity sampling and the relatively small sample size. Besides, the participants were from the same geographical area. Thus, the sample was not representative of the in-service population. However, given the exploratory characters, the finding is considered indicative and informative on the primary research questions.

### 3.6 Ethical Considerations

In this research context, national and international research ethics guidelines were followed (Petousi and Sifaki, 2021), such as the guidelines suggested by the University of Crete code of Ethics & Research Ethics Committee. We obtained informed and voluntary consent from the teachers who participated in this study. We also informed potential participants of the importance of their participation and what would happen to the information provided by them.

## 4 RESULTS

This article focuses on our analysis of in-service teachers' responses to the factors that hinder them from incorporating ER into their daily or future teaching practice. The Statistical Package for Social Sciences (SPSS™ Version 23.0; Chicago, III, USA) software was used for data analysis. Next, we present the results of specific analyses regarding the selected research question.

Teachers were asked to rank order the reasons that may hinder the use of educational Robotic. Figure 1 shows the frequencies of various choices taken from a cross-tabulation. Among the five choices, the 'lack of infrastructure' and the 'lack of knowledge' were the first two most significant factors.

Teachers were asked to express their worries, negative feelings, or positions towards educational Robotics. Illustrations in Figure 2 depict the frequency distribution of teacher responses to four items of those positions. The histograms show a relatively adequate variance in all cases, which permits further inductive testing.

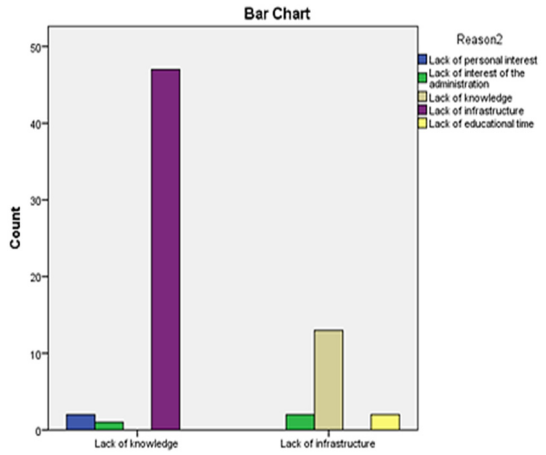



Figure 1: Frequencies of five choices are taken from a cross-tabulation. Lack of infrastructure and lack of knowledge were the first two most significant factors.

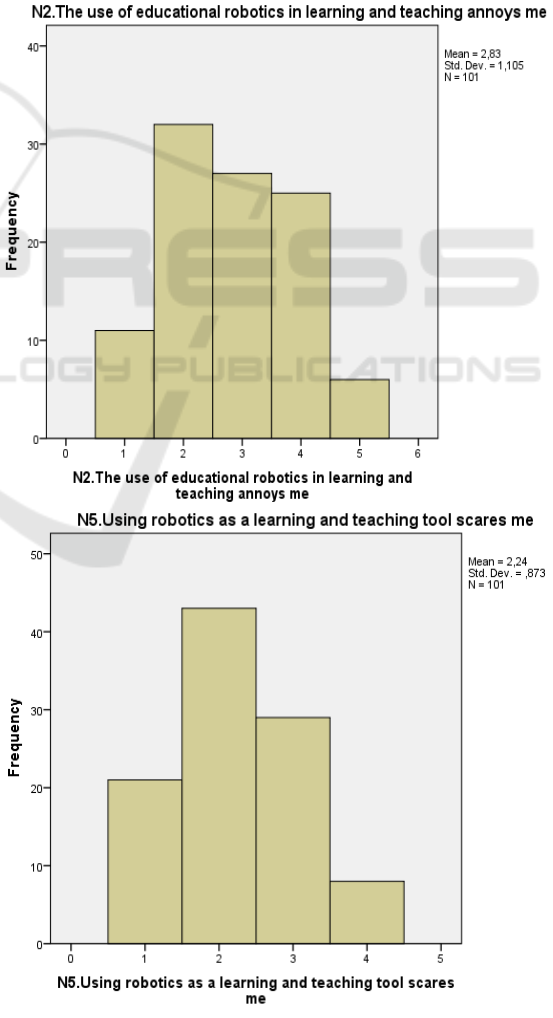



Figure 2: Frequency distribution of teacher responses to four items regarding feeling and positions about the use of educational Robotics.

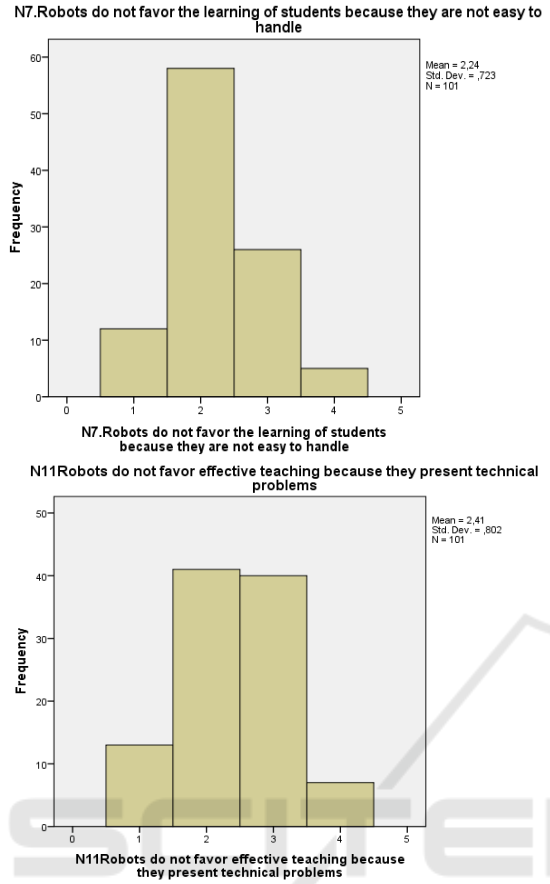



Figure 2: Frequency distribution of teacher responses to four items regarding feeling and positions about the use of educational Robotics (cont.).

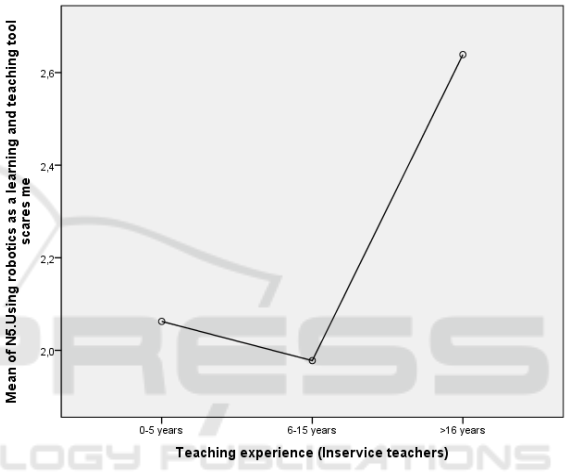
Table 1: Correlations between teachers' worries, negative feelings, or positions with their level of robotics knowledge and their knowledge of educational robotics.

| | Level of robotics knowledge | Knowledge of educational robotics |
|---|---|---|
| Level of robotics knowledge | 1 | 0,494** |
| Knowledge of educational robotics | 0,494** | 1 |
| N2. The use of educational robotics in daily teaching practice annoys me. | -0,027 | -0,124 |
| N5. Using robotics in my daily teaching practice scares me | -0,049 | -0,265** |
| N7. Robots do not favor the learning of students because they are not easy to handle | -0,105 | -0,325** |
| N11. Robots do not seem useful tools because they present technical problems | 0,022 | -0,272** |

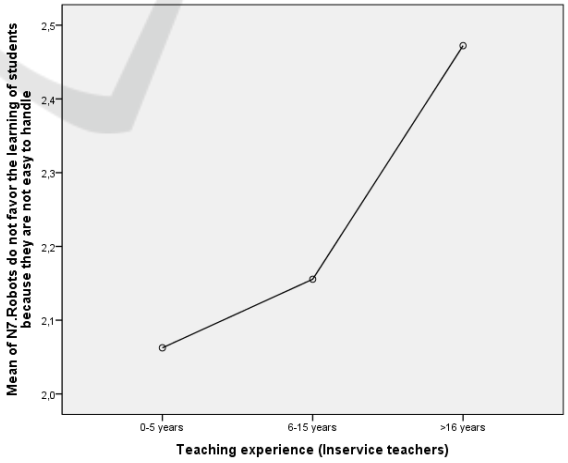
**p<0.01

These items expressing worries, negative feelings, or positions were correlated with several independent variables such as the level of robotics knowledge and the knowledge of educational robotics. Table 1 shows the corresponding Pearson correlations. It is observed that the knowledge of educational robotics is negatively correlated with those items representing worries and negative feelings.

Besides, in-service teachers' responses to their feelings were associated with age and their teaching experience. The illustrations in Figures 3 show that the elder and more experienced teachers express more intense worries and have rather negative feelings about educational robotic use in the formal curriculum.

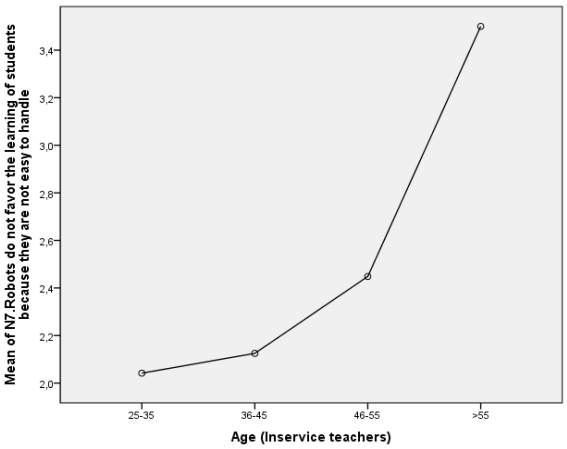



(a)

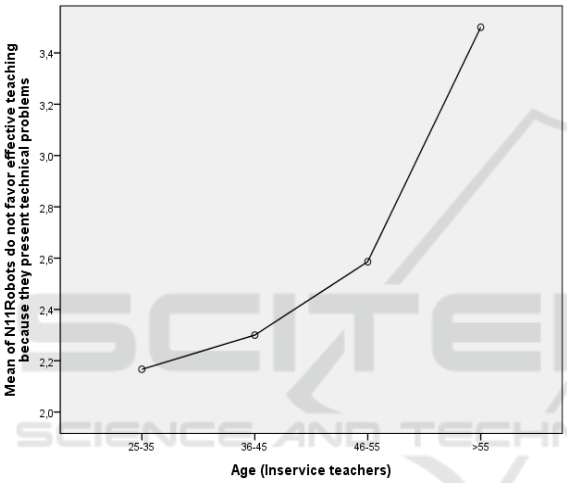



(b)

Figure 3: (a, b, c, d, e). Differences in the in-service teachers' responses (worries, feelings, and positions) across age and years of teaching experience.




(c)




(d)

Figure 3: (a, b, c, d, e). Differences in the in-service teachers' responses (worries, feelings, and positions) across age and years of teaching experience (cont.).

From Figure 3 (a, b, c, d, e), we can see that the elder and more experienced teacher express more intense worries and have a rather negative feeling and positions about the use of educational robotic in the formal curriculum.

## 5 DISCUSSION

Research demonstrates that early exposure in STEM and CT fields contributes to developing significant cognitive outcomes and critical skills, such as executive functioning and fluid reasoning, leading to later school success (Bustamante et al., 2020). Robots, robotics kits are recognized as an effective means of introducing CT, STEM, and 21st-century skills to preschoolers. These tools are often combined with mobile applications (apps) that utilize a smart mobile device (Kalogiannakis, Nirgianaki, and Papadakis, 2019). Since the combination of robotic kits and related apps can make the instruction more exciting, teachers must be trained and supported to use these digital media effectively (Chan, 2019).

Nevertheless, the effective integration and use of educational technologies into preschool education remain a significant issue (Vidal-Hall et al., 2020). As preschool teachers play a critical role in digital technology integration in early childhood education (Papadakis, Kalogiannakis, and Zaranis, 2018), teachers need to acknowledge digital media necessity (Vidal-Hall et al., 2020). In the published literature, it has been found that teachers' attitudes to digital technologies affect the use of technology in educational practices. Thus, to effectively change their teaching behavior, teachers must realize that there is a clear benefit of using educational technology to promote STEM learning. Teachers need to understand emerging technology to incorporate these modalities into their classrooms (Chan, 2019). This follows Vidal-Hall et al.'s (2020) findings, which showed that any attempt to integrate digital technologies effectively is needed to consider the teacher's pedagogical beliefs and practice.

In this study, similar to other studies, teachers were open-minded towards integrating ER into the curriculum (Çiftçi et al., 2020). Nevertheless, it was also found that they must receive appropriate and adequate pedagogical and technical support to build confidence and self-esteem to integrate these technologies into their daily practice (European Commission/EACEA/Eurydice, 2019). Providing teachers with knowledge and experience in using innovative technology will help them develop a positive attitude towards the new technology and become more self-confident. A professional training experience may affect their attitudes towards technology use (Chan, 2019). Teachers must acquire skills and practice to intentionally and systematically use this digital pedagogy (Papadakis, Vaiopoulou, Kalogiannakis, and Stamovlasis, 2020). Their efforts should be focused on children's engagement in rich, playful, and challenging activities, emphasizing the critical ideas of early childhood development (Dunphy, 2020). This study found that young teachers are considered digital natives who can easily support the effective integration of innovative technologies into the preschool environment. On the contrary, older teachers can be characterized as anxious about technology use. This study's findings highlight this generational dichotomy: it seems, therefore, that the

opinions of the younger teachers differ from those of, the older teachers; Similar to other studies, the present study revealed that younger teachers believe that the integration of technologies such as robots into the early childhood classroom improves student learning outcomes (Chan, 2019).

Reflecting on our findings allows us to point to some implications for teacher education. Firstly, we suggest that teacher education programs should create learning opportunities adapted to the teachers' learning needs to understand and support educational technologies in their daily teaching practice. Moreover, we suggest that teacher training should be a continuous process that commences at the initial teacher education stage and continues with teaching practice and ongoing learning (Hamed et al., 2020). Thus, we suggest that teacher education programs should create learning opportunities adapted to the new learning environments that the teachers experienced to understand and support teachers' knowledge progression undergoing initial training. Moreover, we suggest that teacher training should be a continuous process that begins at the initial teacher education stage and continues with teaching practice and ongoing learning (Hamed et al., 2020). As Tang et al. (2020) advise, the university administrators' strategic visions of teaching and learning enhancement would incentivize teachers to adopt ER in curriculum and pedagogy. Thus, ER's holistic integration may need to be considered at the university-level rather than at the subject-level, as expediting its use in one subject could hamper students' learning in another subject.

# 6 CONCLUSIONS

Digital technology has revolutionized the world of education, and children today grow up and live in a world where technologies are ubiquitous. Innovative digital technologies affect how education is delivered and perceived, and they play their role in preparing students for a high tech-enabled world (European Commission, 2020).

Based on the present study results and our educational experience, several recommendations can be made to improve preschool classrooms' ER integration further. Teachers must receive timely and proper education from universities and educational organizations to acquire CT and STEM literacy (Reinoso et al., 2019). This can be done by using problem-solving and constructivism across the curriculum and creating stronger links between theory and practice (Levy and Kucirkova, 2017). Concerning the lack of experience and knowledge among teachers, educational institutions must organize conferences, seminars, and workshops to familiarize themselves with CT, ER, and STEM concepts. These actions can help teachers look beyond the 'traditional' classroom and realize the potential learning opportunities provided by educational technology (Seow et al., 2017). Teacher training must ensure that teachers understand the objectives, goals, and outcomes of using educational technology. These include the introduction of various technologies into the preschool classroom to fit with the curriculum properly. Teachers must realize how all these components can be woven into high-quality early learnings (McManis and Parks, 2011).

Given the limitations of research conducted in one geographical area, the findings' generalizability to other settings is uncertain. Thus, further research in more geographical areas is needed to help the researchers understand whether similar trends are evident elsewhere. Such research would aim to develop a professional learning model for integrating digital technology in the preschool classroom.

# DISCLOSURE STATEMENT

The authors reported no potential conflict of interest.

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