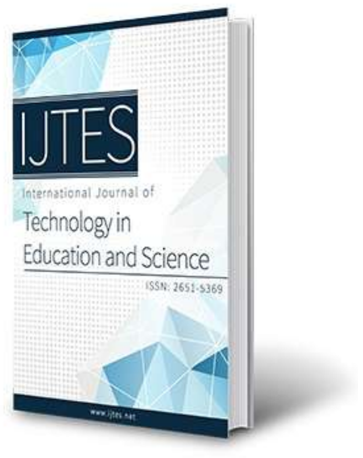

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Kindergarten Teachers' Acceptance of Educational Robotics Online Tools for Computational Thinking

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Abstract

Worldwide, the importance of computational thinking (CT) and its integration into the educational process at all levels of education has been highlighted as a fundamental skill for all. Nowadays, there is strong research interest in the integration of CT into curricula as early as kindergarten. As kindergarten teachers play a key role in this effective integration, the paper discusses the acceptance and intention to use of three online tools for educational robotics (ScratchJr, ELPeIDA and Beebot simulation with Genial.ly) by kindergarten teachers. For the purposes of this research the teachers participated in distance learning sessions to be introduced to computational thinking in kindergarten and to become familiar with the three tools. The research tool was a Technology Acceptance Model (TAM) based questionnaire including factors such as perceived ease of use, perceived usefulness and intention to use and the external factors of self-efficacy, facilitating conditions and perceived enjoyment. One hundred and twenty-seven (127) kindergarten teachers participated in an online workshop and answered the questionnaire. The findings indicated that all the factors under study were highly rated by the kindergarten teachers, except for facilitating conditions. All factors showed positive intercorrelations among them. No statistically significant differences were found for the factors in relation to age, work relationship, educational experience and level of training in ICT of the kindergarten teachers. Kindergarten teachers who make extensive use of ICT and programming tools/environments in their teaching showed higher scores for all factors including the intention to use.

Introduction

In recent years, computational thinking (CT) has been the focus of the educational and research community as it is considered a primary skill for thriving in academia and the workplace (Bers et al., 2022) and an asset for citizens as 21st century literacy (Wing, 2011). Globally, the importance of cultivating CT from the critical age of kindergarten has been highlighted (Bati, 2021). However, a necessary condition for the effective integration of computational thinking in the kindergarten curriculum is the acceptance and utilization of tools that promote CT by kindergarten teachers. During the last years a new generation of coding related games and a plethora of online tools aiming at fostering CT in kindergarten has been developed promoting coding through creative collaborative activities (Sullivan & Bers, 2019).

The purpose of this study was to investigate kindergarten teachers' acceptance and intention to use online tools to foster students' computational thinking in a distance education context, based on the Technology Acceptance Model (TAM) theoretical framework as well as factors that are related to kindergarten teachers' intention to use specific online CT tools.

School Distance Education in Kindergarten

Distance education comprises three main forms: (a) fully distance education; (b) complementary distance education, that works in addition to in person education; and (c) blended education, which aims to combine the best features of both. For distance education in kindergarten to be effective, it is necessary to adapt it to the needs of early childhood. Young learners need interactive and hands-on activities, such as art, music, and movement, to develop social and emotional skills that screen-based teaching cannot fully provide (Hao, 2020). The role of teachers in e-learning is differentiated and focuses more on counseling, carefully planning activities and supporting students (Anastasiades, 2022) while teachers need to have the ability and competence to create appropriate educational resources and tools for teaching (Tafazoli, 2021). Teachers are encouraged to maintain flexibility and switch between synchronous and asynchronous teaching methods, while enhancing family involvement and children's smooth adaptation to the new educational environment by acting as a bridge of communication (Anastasiades, 2022). Teacher-parent collaboration is also crucial, as parents are called to support children in online learning, often playing an active role (Plotka & Guirguis, 2022). During the Covid-19 pandemic, the sudden shift to emergency remote teaching created significant challenges (Ford et al., 2021). Most kindergarten teachers were forced to create their own materials, rely on or adapt existing online resources (Μπρατίτσης & Μουζακιώτη, 2022). Many teachers used asynchronous tools and digital platforms to communicate with students and send materials (Atiles et al., 2021).

Computational Thinking

The concept of CT is attracting the interest of researchers and practitioners worldwide to empower children in the digital age (Zeng et al., 2023). Although the importance of CT is widely recognized, there is still no single definition, providing that CT is still in a developmental stage (Relkin et al., 2021). Papert's (1991) work many years ago had already mentioned the importance of programming in education, and then Wing (2006) argued that CT should be integrated into the educational process along with reading, writing and arithmetic, as it fosters children's analytical thinking, and it concerns everyone not only computer scientists.

CT includes key dimensions such as *decomposition*, *subtraction*, *algorithms*, *debugging*, *repetition* and *generalization* (Shute et al., 2017). *Decomposition* refers to the breaking down of a complex problem or system into smaller individual pieces. *Abstraction* refers to the process of simplifying complex ideas or phenomena and the ability to extract general principles that can be applied in corresponding contexts. *Algorithms* are a sequence of rational and well-organized steps to solve a problem. *Debugging* refers to identifying errors and correcting them when a solution does not work as it should. *Iteration* through successive/repeated attempts contributes to optimizing solutions and finding the ideal one while *generalization* allows for the application of computational thinking skills to a multitude of contexts (Shute et al., 2017; Yadav et al., 2016).

CT is closely related to programming, as it can be seen as a means to transmit the principles of computational science (Bers et al., 2019). Although these two concepts have slight yet important differences (Yang et al., 2022) they are often confused and used as identical. Programming is considered a form of writing (code) directly related to technology and expressed symbolically through a computational language (Bers et al., 2019), involving the creation and interpretation of instructions read by the computer (Yang et al., 2022). However, the perspective of a computer scientist goes beyond programming ability (Wing, 2006), as computational thinking constitutes a broader concept that involves not only problem solving but also personality expression, creativity through design, and social interaction (Kafai & Burke, 2014).

Computational Thinking in Kindergarten

At a global level, increasing emphasis is being placed on the cultivation of computational thinking skills and the integration of programming concepts starting in kindergarten (Bers et al., 2022) as CT is an integrated framework through which students are exposed to the principles of computational science through the subjects they are already being taught (Yadav et al., 2016). Computer science education during preschool years is particularly important as it engages children with its fundamental concepts, promotes personal expression, debugging and problem solving within an environment suitable for all ability levels (Sullivan & Bers, 2019). Furthermore, integrating CT into education promotes not only the use, but also the creation of tools, providing students with invaluable tools for their future lives. At the same time, it makes them competitive by integrating theoretical knowledge with real life (Sykora, 2021). CT allows both boys and girls to participate before stereotypes about their coding abilities become established (Manches & Plowman, 2017), while it also serves as a means to promote social equality by reducing stereotypes and ensuring equal accessibility to digital literacy for all young children (Bers et al., 2022).

In Greece, CT has been integrated in the new curriculum for kindergarten, in the category of technology and science competences (Πεντέρη κ.ά., 2022a) and in particular in the subsection called "Discovery, programming and digital play" (Πεντέρη κ.ά., 2022b) which focuses on supporting students for exploration, experimentation, problem solving through software and open source software, visual and tactile programming, design and construction of robots (Πεντέρη κ.ά., 2022b). For the development of CT in kindergarten, programming is mainly used, allowing students through direct observation to make cause and effect connections.

Teachers' Training in Computational Thinking

The cultivation of computational thinking skills in preschool children is directly related to the teachers' ability to introduce them to this world (Kalogiannakis & Papadakis, 2017). However, the successful integration of CT into the educational process requires teacher training (Φεσάκης & Πραντσούδη, 2021). There is therefore a need for large-scale in-service professional development programs, with the selection of appropriate assessment strategies, development of support materials and learning activities. Teachers face challenges such as limited classroom time (Kourti et al., 2023; Rich et al., 2019), inadequate subject knowledge, frustration with lack of support and difficulties in problem-solving skills, and lack of student understanding of CT concepts (Kourti et al, 2023). Important factors in this direction include linking CT to the teaching practices already in place (Yadav et al., 2016), exploring the most challenging concepts (Rich et al., 2019), connecting CT to children's real life and collaboration between teachers (Angeli et al, 2016), and feedback on successful or unsuccessful practices (Pollock et al., 2017), elements that could enhance teachers' confidence (Kourti et al., 2023). Various training programs for current and future teachers have been documented in the literature, with variations in duration, from short workshops to annual programs but few trainings exclusively aimed at kindergarten teachers were identified.

Tools for the Cultivation of Computational Thinking in Kindergarten

A new generation of programming games is an advantageous option for cultivating computational thinking in preschoolers (Sullivan & Bers, 2019). For example:

Kibo, a creation of the DevTech research team, helps children aged 4 to 7 engage with programming through wooden coding blocks. KIBO has a built-in scanner, allowing barcodes on the wooden blocks to be read. As a result, children engage in programming while avoiding screens or adult guidance (https://kinderlabrobotics.com/kibo/). The programming language used includes 21 different blocks that if connected in a suitable way can form complex sequences. All these features can be used to teach children the basics of computational thinking (Bers et al., 2019).

The board game Robot Turtles (http://www.robotturtles.com/) promotes the development of computational thinking skills in children aged three years and older by encouraging them to create sequences and engage in problem-solving activities (Sullivan & Bers, 2019).

The popular beebot allows up to 40 motion commands to be entered, to move forward or backward, and to turn left or right at an angle of 90, using directional buttons located on the top (Sullivan & Bers, 2019). There is also the ability to delete and pause commands and it moves accurately in 15 cm steps and uses audio and visual cues to communicate the execution of commands (Angeli & Valanides, 2020). Blue-Bot, a more recent version of beebot, with a characteristic transparent design, has bluetooth and connects to tablets and laptops, allowing the creation of on-screen algorithms (https://www.digitalfutureaotearoa.nz/digital-pikau/bots).

Colby, the mouse robot, a floor robot, shows common functions with other programmable robots such as beebot. (Colby). Ozobot's Evo and Bit educational robots for children aged 5 years and older offer two modes of coding, screenless using color codes and ozobot blockly using a screen (https://ozobot.com/).

Research interest in preschool studies has focused on beebot (Misirli & Komis, 2014) which was effective in developing computational thinking through two scaffolding techniques, offering benefits to both genders, with different effects depending on the technique (Angeli & Valanides, 2020). Bers et al. (2019) used a different robot

Kibo combining computational thinking and programming with the teaching of numbers, shapes, colors and letters. The pivotal role of teacher guidance (scaffolding) was highlighted in recent research (Berson et al., 2023) with the Sphero robot (https://sphero.com/)

Online Tools for Computational Thinking in kindergarten

There is a plethora of online tools aimed at fostering CT in kindergarten. An important initiative is the EU Code Week (https://codeweek.eu/) which attracts millions of participants and promotes programming through creative collaborative activities. Participants are encouraged to organize or participate in an activity by choosing a theme and a target audience for their event. Then they add the activity to an aggregated map of all events. The CoSpaces Edu platform (https://www.cospaces.io/) allows students through construction and programming to explore their own creations in virtual or augmented reality. Another platform "Hello Ruby" offers resources for children, parents and teachers, focusing on fun and imaginative exploration of programming for children aged 4-10 years (https://www.helloruby.com/). Kodable, on the other hand, is a programming game that uses drag-and-drop mode and helps children understand basic programming principles through an interactive and enjoyable environment and has 45 levels of difficulty (Pila et al., 2019). However, it is important to note that programming games provide a limited range of experiences in contrast to block-based programming languages and provide a flexible open-ended environment for creating different projects and engaging with fundamental concepts of computer science (Sullivan & Bers, 2019). In this context, it is important to mention the three CT online tools chosen for the needs of the present study: the Visual Programming Language ScratchJr, the Simulation of the Beebot on Genial.ly, the The ELPeIDA Software.

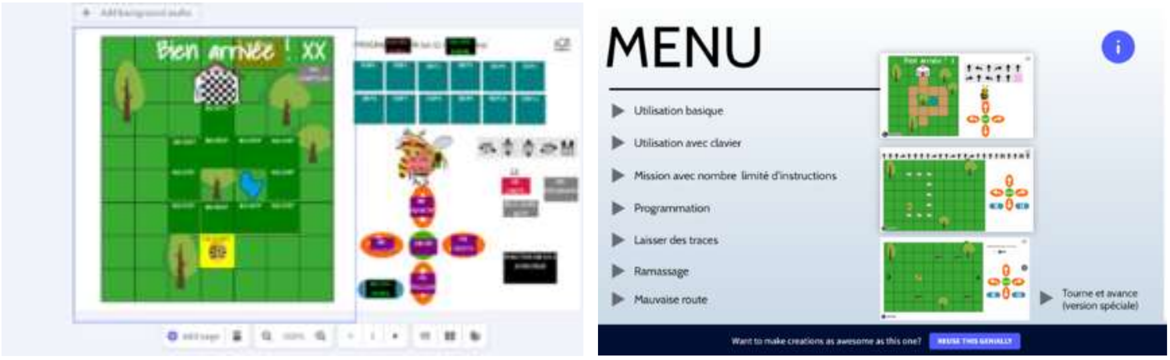
The Visual Programming Language ScratchJr

ScratchJr is a visual programming language for children aged 5 to 7 years, which enables them to engage with basic programming concepts and allows them to create their own interactive stories and games (https://www.scratchjr.org/) in a developmentally appropriate way through play (Papadakis et al, 2016). ScratchJr is available via mobile devices, iPads, Android devices, Chromebooks and iPhones (Blake-West & Bers, 2023). It is offered to cultivate skills such as reading, writing and mathematics (Papadakis et al., 2016), within an inclusive learning environment. The ScratchJr environment includes 28 distinct instruction tiles, grouped into six categories based on their color combination. These blocks allow children to create simple but logical sequences of actions, in a manner like putting together pieces of a puzzle, reducing the chances of syntactic errors.

Simulation of the Beebot on Genial.ly

Genial.ly is a platform for creating interactive content, enabling teachers to create engaging educational material and students to create digital projects through pre-designed templates (https://genial.ly/). A group of educators from France developed tools based on the JavaScript programming language offering additional options for creating educational activities and escape rooms. The S'cape tools work as discrete pieces of code and work by linking the text/word corresponding to the code to the desired image or text and grouping them together (Allirot

& Morris, 2020). In this paper, the Genial.ly extension was used to simulate the programming of the beebot.



(a) (b)

Figure 1. Presentation Slide with Programming Buttons (a) - BB Simulation of Beebot in Genial.ly (b)

The ELPeIDA Software

The educational software ELPeIDA (https://elpeida.github.io/#portfolio) *(Early Childhood Education Software for Creative Skills and Cognitive, Emotional and Social Development*) is specifically designed to enhance creativity, cognitive, emotional and social development skills for children aged 4 to 6 years. The software has been developed to meet the needs of the new curriculum for pre-school education in Greece and offers playful activities without predetermined answers. During the teachers' training in the frame of the present study, four learning objects for the development of CT were presented: " *Ink in the Ocean 1 and 2*" and "*Programming 3 and 4*". Their interface includes three distinct fields: *the blue field containing the manipulation commands*, *the green field where the user compiles the program*, and *the yellow field containing icons for control commands such as run, pause, stop and clear memory* (see Figure 2).

Figure 2. Floor Recycling from the Learning Object Programming 4

Aim of the Study and Research Questions

The aim of the study was to investigate the acceptance and intention to use online tools for the cultivation of computational thinking in a distance education context by kindergarten teachers.

The research questions were formulated as follows:

RQ1. To what extent do the kindergarten teachers who participated in the training accept the use of online tools for the cultivation of CT in their teaching in terms of perceived ease of use, perceived usefulness, perceived enjoyment, self-efficacy, facilitating conditions and intention to use?

RQ2: How do TAM factors and external factors relate to kindergarten teachers' intention to use specific online CT tools?

RQ3: How do participants' demographics and degree of use of ICT and programming tools/environments in their teaching relate to the factors being studied?

Method

A correlational quantitative methodological approach was followed. An anonymous questionnaire was used as the research tool and distributed to the teachers who participated in the training. For the data analysis needs, descriptive and inferential statistics exploited. Kolmogorov-Smirnov criterion used that showed non-normal data distributions. Therefore, non-parametric tests were used to detect statistically significant differences in the values of the factors between groups and subgroups of the sample and correlations between the factors. The χ^2 - goodness of fit tests, Mann-Whitney's U test for two independent samples, Kruskal-Wallis for more than two independent samples and Spearman's correlation coefficient ($_{rs}$) were used. Data was processed using the SPSS 27 package.

The Research Tool

The tool was an anonymous questionnaire, created through Google Forms and completed by the kindergarten teachers who participated in the training. The questionnaire was based on the Technology Acceptance Model (TAM) and research tools from previous studies (Panetas et al., 2024; Teo et al., 2019). The first part of the questionnaire included 10 questions about the demographic characteristics of the participants, such as *gender, age, work relationship, studies, previous work experience, training in ICT and the use of programming environments/tools in their lessons*.

The second part included 34 questions (see Table 1), related to *TAM factors and external factors*. Specifically, the TAM model factors of *perceived usefulness, perceived ease of use and intention to use*, as well as the external factors of *perceived enjoyment, self-efficacy, and facilitating conditions* were assessed. Responses were mainly given either on a five-point Likert scale or in a multiple-choice format, while some additional questions asked participants to choose between the three tools presented during the training (*ELPeIDA, Genial.ly, ScratchJr*) regarding ease of use, usefulness and pleasure (Fessakis & Prantsoudi, 2019).

During the online training the teachers participated in two synchronous online meetings and an asynchronous part through the eclass platform. Participants had the opportunity to interact with online CT tools such as the ELPeIDA software, the beebot simulation on Genial.ly and ScratchJr.

Table 1. Part B of the Questionnaire

Question number	Description	
1-5	Perceived ease of use (PEU)	TAM*
6	The most ease-of-use tool	
7-9	Perceived usefulness (PU)	TAM
10	The most useful tool	
11-15	Perceived enjoyment (PE)	EF**
16	The most pleasant/entertaining tool	
17-20	Self-efficacy (SE)	EF
21-28	Facilitating conditions (FC)	EF
29-32	Intention to use (IU)	TAM
33	Level of intention to use the tools	
34	Role of CT in education	

* TAM: Technology Acceptance Model, * *EF: External Factors

(a) ELPeIDA Software

(b) Simulation of Beebot in Genial.ly

(c) ScratchJr

Figure 3. Screenshots from the Workshop

At the end, they were asked to complete an anonymous questionnaire and post their work on a Padlet.

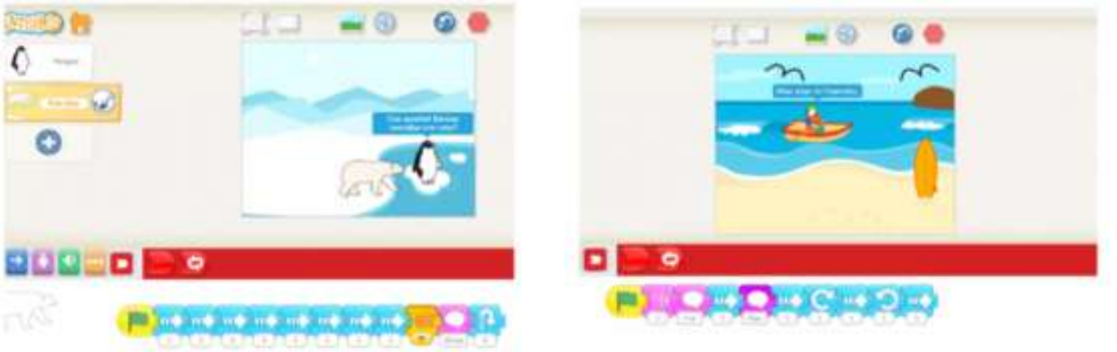


Figure 4. Screenshots of Participants' Sample Work on Padlet Featuring ScratchJr

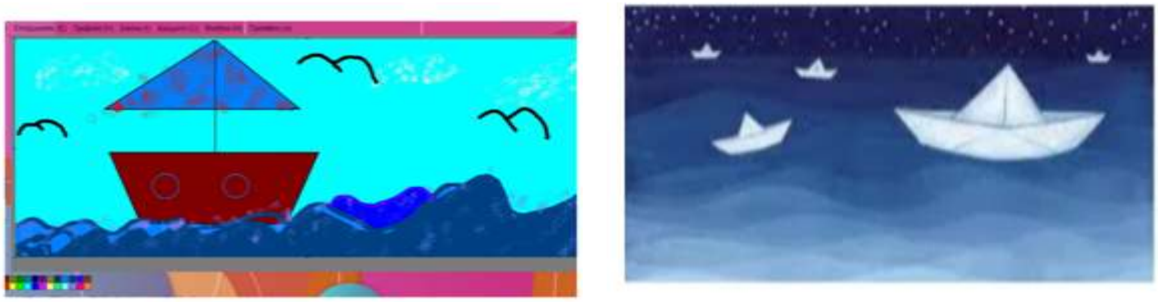


Figure 5. Screenshots of Participants' Sample Work on Padlet Featuring ElPeIDA

Validity and Reliability

To ensure the validity of the research, emphasis was given to the formulation of the questionnaire questions to be clear, understandable, short, non-directive with a focus on the research questions (Creswell, 2011). To ensure the content validity of the questionnaire, it was thoroughly checked by an expert in new technologies in education and distance education. To test face validity the questionnaire was piloted with five teachers. Cronbach's α internal consistency reliability coefficient was used to test the reliability of the overall questionnaire as well as for the subscales of the tool, which showed high reliability with a total value of 0.92.

Table 2. Cronbach's Alpha for the Overall Scale of TAM Questions for Online CT Tools and the Subscales

Scale and subscales	Number of questions	Cronbach's Alpha
Perceived ease of use	5	0.92
Perceived usefulness	3	0.94
Perceived enjoyment	2	0.896
Self-efficacy	4	0.95
Facilitating conditions	7	0.71
Intention to use	4	0.91
Whole part b of questionnaire	25	**0.92**

The Sample

The sample of the study is a non-probability convenience sample. The participants were 127 active kindergarten teachers working in kindergartens in all regions of the country. The sample was exclusively female (100%) and the majority of the participants (56.7%) were over 46 years of age. Most of the participants (56.7%) were aged 46 years and above. A percentage of 52.8% use ICT in teaching to a moderate degree, while a percentage of 37% utilize programming tools or environments in their teaching.

Results and Discussion

Please use 10-point font size. Please margin the text to the justified. Manuscripts should be 1.5 times spaced. A paragraph should have at least 3 sentences. Footnotes and endnotes are not accepted. All relevant information should be included in main text. Do not indent paragraphs; leave a space of one line between consecutive paragraphs. Do not underline words for emphasis. Use italics instead. Both numbered lists and bulleted lists can be used if necessary. Before submitting your manuscript, please ensure that every in-text citation has a corresponding reference in the reference list. Conversely, ensure that every entry in the reference list has a corresponding in-text citation.

The majority of the teachers (90.6%) stated that CT enhances students' ability to solve problems and a percentage of 81.1% of teachers stated that CT is a basic skill that all students should acquire. Central tendency measures (mean and median values) and measures of dispersion (standard deviation, range of values) were utilized to describe trends in the data regarding the factors in the questionnaire (see Table 3 and Table 4).

Table 3: Mean, Median and Standard Deviation of Factor Values

	Mean	Median	St. Dev.	
Perceived ease of use	3.68	3.80	0.69	high
Perceived usefulness	4.04	4.00	0.72	high
Perceived enjoyment	4.12	4.00	0.75	high
Self-efficacy	3.45	3.50	0.84	medium
Facilitating conditions	3.23	3.14	0.5	medium
Intention to use	4.02	4.00	0.60	high

The kindergarten teachers who participated in the study showed high *perceived ease of use* and *perceived usefulness* for the specific online CT tools. They believe that the use of the specific online tools will be without difficulties. These findings are consistent with the research of Kalogiannakis and Papadakis (2018) in which perceived ease of use and perceived usefulness have high values for the acceptance of ScratchJr by pre-service kindergarten teachers. The kindergarten teachers in the study express high *perceived enjoyment* of these tools for cultivating CT. They believe that using these CT tools in their teaching will be, in addition to being easy and useful, also enjoyable for them and their students.

The teachers consider that the *facilitating conditions* for online CT tools are moderate. This result reveals that they are concerned about having the required support on multiple levels (*pedagogical, technical, infrastructure, workload, training, curriculum, etc.*). Consequently, for the successful integration of these online CT tools into teaching, support from the relevant institutions is a prerequisite. Kindergarten teachers consider their *self-efficacy* for online CT tools to be also moderate. They consider that they have a moderate degree of the skills required to integrate online CT tools into their teaching. This finding is particularly important as for young children, skilled "scaffolding" by the teacher is crucial to engage with CT (Angeli & Valanides, 2020). Conversely, if the teacher feels that he/she cannot cope with teaching CT, this may have negative implications for students' learning of the relevant concepts (Israel et al., 2015).

The kindergarten teachers in the study expressed high *intention to use* the specific online CT tools. This finding suggests that the teachers finding the specific online CT tools easy to use, useful and enjoyable, show a clear intention to integrate them into their teaching.

Kindergarten teachers ranked first in terms of *perceived ease of use*, ELPeIDA software followed by ScratchJr and beebot simulation for Genial.ly. Similarly for *perceived enjoyment* the highest rating is given to ScratchJr, followed by the beebot simulation on Genial.ly and then the learning objects of ELPeIDA about programming. No statistically significant differences were found in the ratings of the three software in terms of perceived usefulness.

Table 4. Mean and Standard Deviation in Intention to use Values for Each CT Online Tool

	Mean	Standard Deviation	
Intention to use Genial.ly	3.62	1.076	high
Intention to use ELPeIDA	3.94	0.824	high
Intention to use ScratchJr	3.78	0.942	high

Participants were asked to choose which one of the three tools to be the *easiest to use*, the *most useful* and the *most pleasant/entertaining* one. The answers highlighted ELPeIDA as the easiest to use (55.9%) and the most useful tool (40.2%) and ScratchJr as the most pleasant/entertaining tool (56.7%) (see Figure 6).

(a) (b) (c)

Figure 6. a) Ease of use tool b) Usefulness c) Pleasant/entertaining tool

Positive and statistically significant correlations were found between the factors (see Table 5).

Table 5. Correlations between the Factors of the Research

r_s \ Factor	Factor	PEU	PU	PE	SE	IU
r_s	PU	.523				
r_s	PE	.502	.653			
r_s	SE	.763	.394	.486		
r_s	IU	.556	.690	.577	.501	
r_s	FC	.431	.270	.296	.410	.388

* All the correlations are statistically significant at 0.001 level (2-tailed)

A statistically significant moderate positive interaction between *perceived ease of use* and *perceived usefulness* was found. The same conclusion is also reported in Al-Abdullatif's (2022) research on the acceptance of three digital applications by pre-service early childhood teachers. *Perceived ease of use* is often a predictor of *perceived usefulness*, this means that when the score on perceived ease of use increases, the score on perceived usefulness also increases (Al-Abdullatif, 2022).

Consequently, the easier it is for teachers to use the tools in their teaching, the more useful they perceive the tools to be. *Perceived ease of use* is positively and moderately statistically significantly correlated with *perceived enjoyment*. This finding is consistent with previous research (Abdullah & Ward, 2016).

Perceived ease of use is positively highly statistically significantly correlated with *self-efficacy*. The strong positive correlation between these two factors is confirmed in many research studies in a meta-analysis on eLearning (Abdullah & Ward, 2016). *Perceived ease of use* is positively and moderately statistically significantly correlated with *intention to use*. This finding is confirmed in Ling et al. (2017) in Malaysia in which a strong correlation between *perceived ease of use* and *intention to use* is recorded as well as in Ogegbo's (2023) research. *Perceived ease of use* is positively statistically significantly but weakly correlated with *facilitating conditions*.

Perceived usefulness is positively strongly statistically significantly correlated with *perceived enjoyment*. *Perceived enjoyment* had a significant impact on *perceived usefulness* in previous research (Abdullah & Ward, 2016). *Perceived usefulness* is positively but weakly statistically significantly related to *self-efficacy*. *Perceived usefulness* is positively strongly statistically significantly correlated with *intention to use*, consistent with previous research (Al-Abdullatif, 2022; Ogegbo, 2023; Teo et al., 2019). *Perceived usefulness* is positively but weakly statistically significantly correlated with *facilitating conditions*.

Perceived enjoyment is positively moderately statistically significantly correlated with *self-efficacy. Perceived enjoyment* is positively moderately statistically significantly correlated with *intention to use*. According to Davis et al. (1992), who incorporated *perceived enjoyment* into the original TAM, it is concluded that *perceived enjoyment* has a significant effect on the *intention to use* technology. If participants feel pleasure when using online CT tools, they will be more positive to use them in their teaching. This finding is consistent with Teo et al.'s (2019) research on the utilization of web 2.0 technologies by pre-service teachers in China. *Perceived enjoyment* is positively but weakly statistically significantly correlated with facilitating conditions.

Self-efficacy is positively and moderately statistically significantly correlated with *teachers' intention to use* online tools to cultivate CT. *Self-efficacy* promotes goal accomplishment and well-being of individuals as it determines their emotions, thoughts, motivation and behavior, making them able to cope with difficulties as challenges rather than threats (Bandura, 1994). However, other research does not show a statistically significant correlation between teachers' *self-efficacy* and *intention to use* (Ogegbo, 2023). *Self-efficacy* is positively moderately statistically significantly correlated with *facilitating conditions*. This finding is confirmed in Teo et al. (2019) study in China in which *facilitating conditions* was found to be a predictor of Web 2.0 technologies adoption as an individual's desire to implement an activity is influenced by environmental factors such as facilitating conditions (Scherer et al., 2019). *Facilitating conditions* in the case of teachers may be related to functional infrastructures in the field of ICT, the availability of professional development opportunities, technical support and advice, and educational policies that promote the use of technologies in educational contexts (Teo, 2009).

Intention to use is positively but weakly statistically significantly correlated with *facilitating conditions*. This result is expected as when kindergarten teachers feel that they have the necessary support they will be more willing to use these tools in their teaching.

In conclusion, kindergarten teachers who express high values for *perceived ease of use*, *perceived usefulness*, *perceived enjoyment*, *self-efficacy* and *facilitating conditions* seem to express high values for *intention to use*. The correlation between *facilitating conditions* and *intention to use* appears to be weaker.

No statistically significant differences were found in terms of age, work relationship, educational work experience and level of training in ICT in relation to the TAM factors. However, statistically significant differences were found in the self-efficacy factor among graduates of higher education institutions and postgraduate degree holders, with postgraduate degree holders reporting a significantly higher level of self-efficacy. Regarding the degree of kindergarten teachers' use of ICT in their teaching, there are statistically significant differences for the factors of perceived ease of use, perceived usefulness, perceived enjoyment, intention to use, facilitating conditions and self-efficacy among the four degrees of kindergarten teachers' use of the ICT.

Kindergarten teachers who report a higher degree of ICT use in their classroom also show higher scores on all TAM factors. Regarding the degree of use of programming tools/environments by kindergarten teachers in their teaching, there are statistically significant differences between the degrees of use of programming tools/environments in all factors except the perceived enjoyment factor. Kindergarten teachers who report a higher degree of use of programming tools/environments in their teaching also show higher scores on all TAM factors. Kindergarten teachers who note that they use programming tools/environments very much in their teaching have the highest scores on all factors under study.

Conclusion

The purpose of this research was to investigate the acceptance and intention to use online tools for the cultivation of computational thinking in a distance education context, by kindergarten teachers who participated in distance training workshop concerning ScratchJr, learning objects of the ELPeIDA software related to programming and the simulation of beebot with Genial.ly software. Exploiting TAM and external factors, 107 kindergarten teachers answered a questionnaire, and the conclusions arising according per research question are as follow:

RQ1: The kindergarten teachers who participated in the study express high *perceived ease of use* and high *perceived usefulness* for the three online CT tools. The teachers also express high *perceived enjoyment* of these tools for cultivating CT. The teachers consider that the *facilitating conditions* for the tools are moderate, concerning the required support on multiple levels (pedagogical, technical, infrastructure, workload, training, curriculum, etc.). The teachers consider their *self-efficacy* to be moderate. They expressed high *intention to use* the specific CT tools. They rank first in terms of perceived ease of use the ELPeIDA software in terms of perceived enjoyment the ScratchJ. No statistically significant differences were found in the ratings of the three software in terms of perceived usefulness.

RQ2: Statistically significant correlations arose between *perceived ease of use* and *perceived usefulness* and *perceived enjoyment* and *intention to use* (moderately), *self-efficacy (strongly) and facilitating conditions*. (weakly). *Perceived usefulness* is statistically significantly correlated with *perceived enjoyment* and *intention to use* (strongly), and *self-efficacy* (weakly). *Perceived enjoyment* is moderately statistically significantly correlated with *self-efficacy,* and *intention to use*. *Self-efficacy* is positively moderately statistically significantly correlated with kindergarten *teachers' intention to use* online tools to cultivate CT and *facilitating conditions.* Additionally, *intention to use* is positively but weakly statistically significantly correlated with *facilitating conditions*. Therefore, kindergarten teachers who express high values for perceived ease of use, perceived usefulness, *perceived enjoyment*, *self-efficacy* and *facilitating conditions* seem to express high values for *intention to use*.

RQ3: Postgraduate degree holders reporting a significantly higher level of self-efficacy. Teachers who report a higher degree of ICT use in their classroom show higher scores on all TAM factors. The ones who report a higher degree of use of programming tools/environments in their teaching also show higher scores on all TAM factors. The teachers who note that they use programming tools/environments very much in their teaching have the highest scores on all factors under study. No statistically significant differences were found in terms of age, work relationship, educational work experience and level of training in ICT in relation to the TAM factors.

Recommendations

Extensive research and experimentation with various online tools required to identify the most appropriate and free tool for the training of kindergarten teachers. It is proposed to conduct similar studies with random and representative samples of kindergarten teachers to enable generalization of the results. Also, collecting qualitative data through interviews with participants could provide in-depth exploration of the topic. Finally, it would be interesting to repeat the training workshop with different online tools or with a smaller number of participants to facilitate group work.

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