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Computational Thinking in Preschool Age: A Case Study in Greece

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Abstract: This study aims to investigate Computational Thinking (CT) in preschool age children. We tried to assess the ability of developing CT skills in kindergarten, as well as to illustrate parents' and preschool teachers' directly involved aspects on CT. More specifically, we investigated the readiness of preschool children to engage in activities that develop CT by using Scratch Jr. Moreover, via individual interviews, the research sheds some light on preschool children's parents' perceptions on personal computers use, digital media, CT and programming. Finally, we investigated the views and perceptions of preschool teachers through an electronic questionnaire about CT and its entry in kindergarten. The kindergarteners' interactive stories were evaluated with the use of a rubric which indicates the extremely high percentage of readiness to deal with CT and programming activities in kindergarten. The analysis of the parents' interviews shows their distrust on readiness regarding children's engagement in CT. Finally, the majority of preschool teachers uses personal computers in kindergarten to a different degree depending on their age, experience and training to develop a variety of learning areas. Regarding CT, kindergarten teachers' aspects appear to be swayed from positive to neutral considering its introduction in the kindergarten classroom.

Keywords: computational thinking; preschool education; Scratch Jr.; rubric evaluation; kindergarten; information and communications technology

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1. Introduction

Computational Thinking (CT) has been defined as the mental skill necessary in order to apply concepts, methods, problem solving techniques, and logic reasoning, derived from computing and computer science, with the aim of solving problems in all areas of life [1]. After the statement of Wing, according to which along with reading, writing and arithmetic, CT is a basic skill that all children should have [2], many countries already include CT in their formal curricula from preschool age. In this work we try to give an assessment of the position of CT in preschool education in Greece [3].

In Greece, according to kindergarten's curriculum [4], the development of various concepts of CT is proposed, although CT is not referred into it as a term. Specifically, it is proposed as the content of the ICT (Information and Communications Technology) section. For example, CT concepts are included in the introduction to programming games, where the children attempt to "program" a classmate or a robot (e.g., BeeBot), to create patterns, to visualize, to simulate, to model, to develop ability to judge, to make decisions and solve problems. Additional efforts for the promotion of CT in the preschool classroom are made with developmentally appropriate tools such as programming environments based on the use of graphical interface and visual programming through the use of command tiles, which do not necessarily require the ability of reading by the child [5].

The objectives of the present research are (1) to investigate the readiness of preschool children in Greece to develop their CT, (2) to investigate views and perceptions of preschool children's parents regarding CT and (3) to investigate the views and perceptions of preschool teachers about CT in the preschool class.

1.1. Computational Thinking Definition

The continuous technological progress brings people to a constant effort to acquire new skills and abilities, in accordance with the experiences gained through the Information Society [6]. Reasonably, it can be assumed that over time, the necessary skills that children must acquire as pupils/students are constantly changing—or their context is being changed—so that they can (themselves) adapt to the developing environment [7,8].

Wing argued that in the 21st century, computational thinking will be a fundamental skill used around the world and along with reading, writing and arithmetic, we must add computational thinking to every child's analytical ability [2,9]. CT is a term suggested by Wing, based on the work of Papert who defined CT as the process of problem solving, systems design and understanding of human behavior, based on the fundamental concepts of computer science [10]. Since then, many more definitions have been formulated, in order to clarify the term, to describe its properties and concepts, and to incorporate its elements in the curricula for all levels of education [11,12]. Bers' definition is also interesting, where CT is defined as a type of analytical thinking that shares many similarities with mathematical thinking (e.g., problem solving), mechanical thinking (process design and evaluation), and scientific thinking (systematic analysis) [13]. Similarly, Barr and Stephenson define CT as a problem-solving methodology that can be automated and applied to all subjects and is not limited to the field of knowledge and computer science teachers [14].

Seeking to define CT and its importance, many scientists, as mentioned above, have tried to identify CT and 'fundamental parts' comprising the term. The most popular among these '*fundamental parts*' are:

- Subtraction: it is the process of focusing on the important parts of a problem, hiding irrelevant information, so that its key features emerge [2,15,16]. Example in the preschool class: plastic animals such as a gazelle, a lion, a snake, an elephant and a giraffe are placed in front of the children and they are asked what they have in common. The removal process leads to the answer 'they are jungle animals'.
- Generalization: it is the recognition of common elements that allows the creation of one solution that applies to many similar problems [14]. Example in the preschool class: while playing, children discover that if they put cylindrical bricks in the base of their construction of a car and in the base of a robot, they roll, so they are able to generalize that any construction equipped with a circular base will roll.
- Algorithm: it is a set of steps performed sequentially in order to solve a problem or fulfill a goal [17]. Example in the preschool classroom: children ponder and answer the question 'what are the steps we follow to create a fruit salad in the classroom?' Step one: wash the fruit, step two: peel the fruit, step three: cut the fruit, step four: place and mix in a large fruit bowl, step five: serve in individual bowls for everyone.
- Problem Deconstruction: the process of segmenting the problem so that one can process it into smaller, more manageable components [2,18,19]. Example in the preschool classroom: in the classroom there is a board with the children's names and the names of the pedagogical corners they play at daily. The problem 'where do I play today?' decomposes into smaller ones, as to (a) find the card with the name, (b) notice the name of the corner in which the child plays, (c) search between the corners to find the card that writes it, so that they reach the solution of the problem.
- Data collection: the ability to collect data related to the problem to be solved is considered essential [14,19]. Example in the preschool class: children worry about 'what are the right conditions for a plant to grow?' They plant seeds in pots, take care of them, take photos of their growth every day.
- Data analysis: through data analysis, we reach their interpretation, drawing conclusions and identifying patterns [14,19]. Example in the preschool class: children serialize photos taken during the growth of the plants, compare them, find similarities and differences, and draw conclusions about the appropriate conditions for growing a plant in the immediate environment.

- Data presentation: rendering data in a suitable for computer processing format, e.g., with graphs, sentences or pictures [14,19]. Example in the preschool class: children, after three weeks of plant growth, draw a bar chart with their growth path.
- Parallelism: the arrangement of resources for conducting parallel experiments aimed at problem solving [19]. Example in the preschool class: children conduct parallel experiments with plants that are in different conditions (no soil, no water, no sun, and no air) in order to confirm the most suitable environment for their growth.
- Automation: working through machines or computers in order to make it easier to achieve a goal [19]. Example in the preschool class: the bar chart with children's 'towers' is transferred to the Microsoft Excel spreadsheet program with the help of the preschool teacher so that children process it, print it, etc.
- Modeling: the representation of a concept or object based on important data. Example in the preschool classroom: children creating a model of lungs of the human body using simple materials such as balloons, straw, plastic bottle.
- Simulation: the process of performing experiments through a constructed model. Example in the preschool classroom: children experiment with the lung model and understand the respiration-exhalation process and the respiratory system's function.
- Debugging: trying to find possible errors in the construction of a job that needs correction [2]. Example in the preschool classroom: a child draws in the computer drawing program of the personal computer (PC). S/he draws clouds and tries to fill them with color, but instead the whole page is colored, because the cloud-shape was not closed. S/he presses the undo button and tries to make a new plan. After several attempts and experiments s/he concludes that a shape will be filled with color only if it is perfectly closed around the perimeter.

1.2. Computational Thinking in Preschool Education

Programming skills play a leading role in children's digital eloquence [20]. Through engaging in programming, children benefit significantly as they become not only users but also creators of technology. Furthermore, programming allows an in-depth look at the functional world of digital media, making their use more successful. The effect of programming in the development of mathematical skills is also important [9], since this way children come in contact with concepts such as 'feedback', when, e.g., the program they create does not correspond to the desired result or 'variable', or when, e.g., the course of the hero they plan is changed by the obstacles they encounter [21].

Undoubtedly, programming skills help in the development of CT, since planning creates problem-solving opportunities. At the same time, through programming, children are involved in the construction efforts of models and systems; computer science itself one could say that it derives from thoughts of engineers [22]. Finally, programming can, by modeling the problem and its solution process, reflect and bring us into contact with our way of thinking [23]. A glance at recent studies has demonstrated that programming environments can be used in early childhood education and positively promote CT [24]. Programming helps develop cognitive abilities including executive functions that help children formulate, solve and analyze problems [25], algorithmic abilities to present solution logically [26], working memory and inhibition skills [27]. Scratch Jr., which is the chosen programming tool used in the current study to examine the readiness of preschool children to engage in CT activities, could develop students' independent thinking, problem solving, and CT abilities [28] and familiarize preschoolers with basic programming concepts in a playful way [29]. Lastly, Scratch Jr., could foster young children's CT concepts (e.g., sequence, event) and practice (e.g., testing and debugging, remixing and reusing), and enhance their enjoyment to decorate their programming projects [30].

Moreover, programming skills help in the development of CT, since it affects their mathematical skills [31] and planning creates problem-solving opportunities. At the same time, through programming, children are involved in the construction efforts of models and systems; computer science itself one could say that it derives from thoughts of engineers [22].

The research on parents' perspectives and their roles in children's engagement in CT is very limited [32,33]. Studies considering childrens' usage of mobile devices show that parents want to support their children's learning and seek to provide a stimulating home learning environment for them [34]. Another study considering parents perspectives on CT lays their concerns such as their limited programming knowledge to help their children engage on CT competencies.

What is clear through recent studies is that parents' role in promoting their childrens' engagement on CT is integral [32,35], therefore this study seeks to shed light into parents' perspectives and beliefs of CT's entrance into kindergarten.

Teachers attempts to bring CT in the classroom meet a variety of challenges, such as subject knowledge, lack of time and support, suitable approaches to teaching topics, students' understanding, and ability to problem solving [36].

Teachers are also concerned about bringing CT into teaching due to limited class time and the difficulties of addressing high level CT thinking in developmentally appropriate ways [37].

Even after receiving professional development and support to integrate CT and computer science into their classroom lessons some teachers find themselves insufficiently prepared and sometimes do not feel confident enough teaching a new activity connected to CT skills [38].

What some teachers believe is that CT could enhance student engagement, literacy skills, and mathematics skills [39]. Though, according to other studies, it is believed that CT is a difficult topic to understand which often cannot feasibly be integrated into K-12 education due to curriculum and instruction constraints [40].

Recent data suggest that CT can be promoted through a variety of software tools in the context of preschool education. The categories are as follows [41]: The logo family programming environments (e.g., Bee-Bot, Code-a-pillar), the software roamers (e.g., Ladybug leaf), the visual programming environments (e.g., Scratch Jr.), the commercial programming learning environments for entertainment purposes (e.g., Kodable), physical computing environments (e.g., Kibo, Arduino robot car) and lastly miscellaneous unplugged applications and environments that promote CT without the use of a computer [42].

Indicative Presentation of Programming Toys for Children

Bee-bot from GRobotronics is the most popular robot found in preschool classes and is suitable for children aged 3 and over. Blue-bot is its transparent version. The robot-bee is programmed with on-board keys to move in space and helps the child to approach spatio-temporal concepts and create a script by programming it. The advantage of the bee-bot is that it can move on a variety of surfaces such as paper, tarpaulin, wood, carpet and does not necessarily require a special surface, a fact which allows preschoolers to imagine and create their own boards [43–45].

The rugged robot of GRobotronics is a robot designed for outdoor use so it can be used on sand, soil, gravel and grass. There is a possibility to integrate a camera, so that children can see where the robot is going to as well as storage space to use it to collect objects. The rugged robot can be connected to a tablet and is suitable for 3 years old and up [46].

The Fisher-Price Code-a-pillar Twist game is a caterpillar robot, suitable for children aged 3–6 years, which can be programmed with many different program combinations by pressing or turning the caterpillar paddles, so that it moves left, right and/or emits light and sounds. It promotes the development of the concepts of CT such as problem solving, sequencing, and critical thinking [47].

The Fisher-Price Code 'n' Learn Kinderbot is a robot game, suitable for children aged 3–6, which helps them become familiar with mathematical concepts, colors, shapes and letters through programming opportunities. Children interact with the problem-solving process trying to create a path for the robot and practice engineering activities through its components [48].

The activity set for the Code & Go® Robot Mouse class of learning resources is a game suitable for children aged 4–8 and includes four robot mice, a math pack and a board game that are interactive learning sets and teach coding concepts such as sequencing, through touch play without the need for an additional screen or application [49].

The Learning Resources Coding Critters Rumble & Bumble are animals that are programmed according to an instruction book to move around the space and complete missions while there is the possibility for each child to create her/his own program for her/his pet. Designed for children aged 4–10 years old [50].

The KIBO is a robot designed for children aged 4–7 years old, after decades of research by the scientific team of Marina Umaschi Bers of Tufts University, creator of the programming application Scratch Jr.—which we used in our research—is aimed at both children who are interested in ICT as well as to children who have an appeal in the arts and physical activities. Children plan a sequence with the wooden cubes (blocks), the robot scans the program and executes it [51].

Scratch Jr. was inspired by the popular Scratch programming language (scratch.mit.edu) and has been redesigned to be developmentally appropriate and compatible with the cognitive, personal, social and emotional development of young children. It is an introductory programming language that allows young children (5–7 years old) to create their own interactive stories and games. Children 'button' the graphic programming blocks, as they would do with real Lego tiles, to make the characters move, dance and sing. Preschool children can modify the characters in the color editor, add their own voices and sounds, and then use the programming blocks to bring their characters to life [52].

2. Materials and Methods

2.1. Design

There are two main research methods, quantitative and qualitative. Assuming that each of the two methods has significant advantages and limitations, the operation of combining the two methods into a mixed one, can contribute to an in-depth understanding of research problems but also help the researcher access the limitations of each method separately [53]. In fact, a study that collects qualitative and quantitative data provides a greater degree of reliability in the analysis and results [54]. Moreover, the mixed research method can highlight different aspects of the same phenomenon [55].

Essentially, the present study was designed considering the elements of the triangulation technique. According to Robson, there are four types of triangulation: data triangulation, observer triangulation, methodological triangulation and theoretical triangulation [56]. In this research we used data triangulation, utilizing more than one methodological tool and resources for data collection. Specifically, observation, Scratch Jr. educational software, interview and questionnaire were used as methodological tools and data were collected from different sample groups, such as preschool children, parents of preschool children and preschool teachers. Following the method of triangulation, we tried to highlight the CT of preschool children through different sources in order to ensure greater reliability in our research data.

2.2. Sample

The sample of the study is 24 preschool children (12 preschool boys and 12 preschool girls), 10 parents (2 male and 8 female) and 100 female preschool teachers. All individuals were from the area of Lamia, Fthiotida, Greece. In all cases informed consent was given.

2.3. Tools

In this particular research we used data triangulation, leveraging more than one methodological tool as well as sources for data collection. To collect information about CT of preschool children, we used the application Scratch Jr., which is a programming environment suitable for preschool children. All children participating in the study were introduced to a Scratch Jr. software tutorial based on the suggested through the official page by Scratch Jr. which was created by its technology development research group in Tufts University. Considering the parents' perception and beliefs on CT, semi-structure interviews were conducted. Finally, the preschool teachers' perception and opinions on CT were gathered through an on-line questionnaire, uploaded on various kindergarten teachers' groups on social media. The questionnaire consisted of multiple-choice questions and open-ended questions, designed accordingly to collect descriptive and explanatory data on kindergarten teachers' opinions, behaviors, characteristics, and attitudes regarding the use of a PC or tablets in the classroom and on CT. The reason that the study combines quantitative and qualitative data is because *a mixed methods study, ensures a better understanding of its research problem than each species by itself* [57]. The evaluation of children's CT after completing the activities of the Scratch Jr. tutorial was conducted using a rubric. It is believed that rubrics have become the most consistent and popular technique for assessing learners' performance, as they are used for a wide range of knowledge, skills, competencies in a variety of learning objects and activities [58]. The detailed evaluation rubric created consists of four separate performance criteria which are analyzed and evaluated separately from each other [59]. In the specific rubric, children were evaluated on the following criteria: comprehension of commands (e.g., move right), comprehension of concept (e.g., pattern recognition), use of the tablet and original project creation, where childrens' projects are evaluated on their level of creativity and variety of Scratch Jr. blocks used in their creation. All of these were evaluated by the researcher in the duration of the activity the children were engaged with (e.g., the children were given an activity to understand pattern recognition, the researcher takes notes on the rubric of the child's level of understanding). The rubric provides scores on each performance criterion and by adding them up (the scores), a final score can be produced [60]. Completing the evaluation rubric was as follows: during the production of projects completed in pairs with the Scratch Jr. software, the researcher, who supervises children, completes an assessment rubric for each child. After the evaluation on each project, the children's overall performance is evaluated through the results of all four rubrics completed for each child.

2.4. Procedure

Four sessions were performed in the whole preschool class and four tasks per pair, which means that 48 tasks were completed in pairs with the method of guided collaborative learning [61]. Sessions took place as a daily preschool activity within the program schedule. Working in pairs was applied during free play, which allowed the researcher to focus on the pairs during the creation of the projects in Scratch Jr. as all other children were engaged in the classroom's pedagogical corners.

Session 1. In the first session with Scratch Jr., all preschool children take an introductory course on the application. The concepts of programming, command and sequence are discussed and defined.

Session 2. In the second session children encounter the game character selection area and learn how to change their color or size. They also learn about the background selection process through examples.

Session 3. The third session is about speed, repeat, and the ability to adjust the frequency of a command by selecting numbers on the tiles.

Session 4. Preschool children under the researcher's guidance learn how to record and add sounds to their characters. They are also introduced into alternative ways to start and stop a program, such as by contributing another program to the script.

3. Results

3.1. Computational Thinking Level of Preschool Children through the Rubric

The analysis showed that preschool children performed well to excellent in all four dimensions of assessment (Table 1). More specifically, they had an almost excellent performance in creating an original project (M = 1.30, SD = 0.37) and in understanding commands (M = 1.48, SD = 0.56). Similarly, they had almost excellent performance in understanding concepts (M = 1.51, SD = 0.61). Moderate performance was obtained when using the tablet (M = 1.97, SD = 0.96).

Table 1. Rubric evaluation results regarding the computational thinking level of preschool children.

Rubric Dimension	M	SD
Tablet use	1.97	0.96
Understanding concepts	1.51	0.61
Understanding commands	1.48	0.56
Creating an original project	1.30	0.37

Table 1 reveals the results of preschool children's performance in tablet use. The analysis showed that 15 of the 24 preschool children had a good to excellent performance (values between 1 and 2), four of the 24 preschool children had a moderate to good performance (values between 2 and 3) and five of the 24 preschool children performed between moderate and poor (values between 3 and 4). Moreover, the analysis showed that 20 of the 24 students had good to excellent performance (values between 1 and 2) and four of the 24 students had moderate to good performance (values between 2 and 3). None of the students had an average performance between moderate and poor (values between 3 and 4). In addition, analysis showed that 22 of the 24 students had good to excellent performance (values between 1 and 2) and two of the 24 students had moderate to good performance (values between 2 and 3). None of the students had an average performance between moderate and poor (values between 3 and 4). Finally, analysis showed that 23 of the 24 students had good to excellent performance (values between 1 and 2) and one of the 24 students had moderate to good performance (values between 2 and 3). None of the students had an average performance between moderate and poor (values between 3 and 4).

As expected, the four dimensions of the assessment are also correlated as seen in Table 2. As we can see, all pairwise correlations are statistically significant with an r (Pearson's correlation coefficient) greater than 0.5. Only the pair "understanding concepts" and "understanding commands" seems to lack a significant correlation.

Table 2. The correlation of the four dimensions of assessment. We used the Pearson correlation coefficients. In parenthesis the *p*-value is given.

	Table Use	Understanding Concepts	Understanding Commands	Creating an Original Project
Table use	1.0000	-	-	-
Understanding concepts	0.535 (0.0070)	1.0000	-	-
Understanding commands	0.723 (0.0001)	0.322 (0.1244)	1.0000	-
Creating an original project	0.619 (0.0012)	0.784 (<0.0001)	0.517 (0.0097)	1.0000

3.2. Parents Attitude toward Computational Thinking

The results from parents' (Table 3) interviews showed that their relationship with digital media is very strong, with the data indicating daily long-term use of either a PC, or a mobile phone with Android or iOS software, or a tablet.

P6 quoted: "*Work time is half of entertainment time*"

Most of the parents answered that they deal with the computer, the tablet and the mobile phone more for entertainment reasons than for projects execution. Most of the parents consider digital media to be a positively accepted human skill, a function they can perform with their children. Fewer parents believe that long hours of digital media should be avoided when their children are present, as there is a risk of addiction.

P1 quoted: "*I let my child us the tablet on its own, but I have already checked and approved of the applications used each time...*"

Assessing the level of parental mediation, it was found that many parents choose to be actively involved (active mediation).

P3 quoted: "*...I see that he is able to grow into skills that I couldn't when I was his age...the more he engages with the device, the more he is able to familiarize with new apps...*"

According to most parents, children have acquired several skills in handling digital media, so children's digital literacy can be achieved outside the classroom. Regarding the positive changes, parents observe an increase in concentration and observation, acquaintance with ICT, acquisition of knowledge and also utilization of ICT as a means of gaining new knowledge.

P2 quoted: "*...even when we have agreed beforehand about the time given to use the device, she still pushes for more, when time ends*."

In the negative consequences, parents classify the addiction and the appearance of problematic behavior, such as unwarranted irritability. Regarding the connection of applications and activities with cognitive object, parents replied that their children are engaged in educational activities related to language, mathematics and the environment. Furthermore, parents recognize that their children's computer thinking is actually enhanced through engaging with digital media.

Lastly, it is important to report some of parents' beliefs on their children's abilities as noted through interviews.

P4 quoted: "*He is rather young to be able to solve problems by using the computer.*"

They seem to underestimate their children's digital abilities although their children have respectable skills as shown through their work with Scratch Jr.

P9 quoted: "*No, I don't think it is necessary to engage in programming activities at this age*."

Moreover, parents do not consider that preschool children are mature or capable enough to solve problems or produce work through digital media. Plus, they do not feel that preschool children should or can engage in programming activities.

Finally, none of the parents interviewed knew what CT is before given all related information by the researcher or the existence of a possible connection between programming and computational thinking.

Table 3. Parents sample.

Code Name	Age	Sex	Education	Number of Children
P1	25–29	Female	High School Graduate	1
P2	35–39	Male	University Degree	1
P3	30–34	Female	High School Graduate	3
P4	30–34	Female	University Degree	1
P5	35–39	Female	University Degree	1
P6	35–39	Female	University Degree	2
P7	40–44	Male	MSc Degree	1
P8	35–39	Female	High School Graduate	3
P9	40–44	Female	High School Graduate	2
P10	35–39	Female	University Degree	1

3.3. Teachers Attitudes toward Computational Thinking

The demographics of the preschool teachers that responded to the questionnaire are given in Table 4. Results showed that only 8% (n = 8) of school units have no computers while in 92% (n = 92) of the cases preschool teachers confirmed the existence of a computer in their school units. In addition, it turned out that 75% (n = 75) of preschool teachers allow the use of computers from children. Findings showed that a significant percentage of preschool teachers use computers in the classroom for activities that are part of the learning area of arts (n = 71, 71%), mathematics (n = 63, 63%), language (ν = 61, 61%) and ICT (v = 50, 50%). Moreover, 71% (n = 71) of preschool teachers recognize that the cultivation of CT of preschool children is the goal of the program in the preschool classroom, though only 65% (n = 65) of preschool teachers recognize that the kindergarten curriculum should include more than learning technological skills, as programming activities. Moreover, 53% (n = 53) of preschool teachers agree or strongly agree with the fact that CT is a basic skill that all children should have along with reading, writing and arithmetic, though 33% (n = 33) of preschool teachers appear neutral towards this fact.

Open-ended questions showed that the majority of preschool teachers recognize the usefulness of the computer as a tool for creative thinking and solving complex problems. Finally, the majority of preschool teachers recognize that teaching basic programming concepts develops digital eloquence, that is, the ability to design, create and link digital content.

Table 4. Kindergarten teachers' demographic data.

		n	%
Sex	Male	0	0.0%
	Female	100	100%
Age	20–30	14	14.0%
	31–40	34	34.0%
	41–50	37	37.0%
	51 and over	15	15.0%
Education	Kindergarten Teacher (4 year degree)	60	60.0%
	Kindergarten Teacher (2 year degree)	7	7.0%
	MSc.	32	32.0%
	PhD.	1	1.0%
Teaching experience	0–5 years	18	18.0%
	6–10 years	21	21.0%
	11–15 years	16	16.0%
	16–20 years	22	22.0%
	21–25 years	12	12.0%
	26–30 years	7	7.0%
	31 and over	4	4.0%

4. Discussion

The results indicated that preschool children performed well to excellent in all four dimensions of assessment (concept comprehension, command comprehension, tablet use, original project creation). More specifically, most children understood the concepts of CT represented by software, such as the concept of programming, sequence and repetition, which confirms the proposition that preschool children can understand basic programming concepts [60]. Furthermore, most of the children understand the commands represented by the blocks of the software. According to Resnick, engaging with programming environments help children develop the process of drawing conclusions which is a skill that they can use in the future school and their academic development [22]. It is important to mention that preschool children had excellent performance in creating an original project. Children in particular were asked to use their new knowledge and make something on their own without specific instructions, thus releasing their creative thinking and relying on their own decision-making mechanism [10,62]. Moreover, several research works have proved that teaching the planning and development of CT contributes to preschool children's cognitive skills [63,64].

The evaluation revealed that preschool children had a moderate performance in terms of the tablet use, i.e., they used it but often asked for help. This fact is backed up by a recent survey conducted by Konstantinopoulou, where errors in Scratch Jr. are very often tablet handling errors [65]. The particular realization does not surprise us, since visual-motor coordination in preschool is a developing skill. In fact, dealing with ICT can support the development of specific motor skills, such as practicing hand-eye coordination through playful activities for the use of mouse and keyboard in educational software.

Analyzing the data that we collected from parents' interviews, we discovered elements about their personal involvement with technological means, their involvement or not in the use of technological means by their children and the role of technological means in the development of PC and cognitive skills of preschool children. Parents who participated in the research appear to be closely connected with technology, as they use electronic digital media on a daily basis and even consider it 'socially normal' [66]. Most parents are positive about their children's involvement in technology as long as they allow or use technology with their child for recreational purposes, while the ones avoiding it argued that there are risks regarding their children such as addiction. Both groups of parents tend to use digital media with their children mainly for entertainment, ignoring other uses, such as work, education, the search for new knowledge, etc. As regards CT, preschool children's parents seem to agree that the applications that their children are involved in develop CT, as they treat "digital media as learning tools" [67]. On the contrary, they do not acknowledge any relation regarding programming and CT, nor do they know what CT exactly includes.

Having a computer in the classroom does not necessarily imply its use by preschool children, although 75% of teachers say they allow children to use it. It is worth mentioning the fact that new teachers with little teaching experience (under 5 years) do not allow the use of the computer in their classroom, a fact that could be justified by the stress of preschool teachers during their first years at work [68]. The essential reasons for using computers and ICT in the preschool classroom are transformation of educational practices and integration of all curricula subjects—even physical education. From our research we concluded that a significant percentage of preschool teachers agree that an effort has to be made so that CT in kindergarten is developed [69].

5. Conclusions

The aim of this work was to investigate preschool children's CT and answer questions about their readiness to develop and use CT in programming environments, as well as to highlight the views of parents and preschool teachers on CT. The study was conducted in a preschool classroom with Scratch Jr. 1.2.7 software. It is worth mentioning that evaluation rubrics demonstrated that the ability to use the tablet had an upward trend for each student from the first to the last project. In addition to the development of CT, dealing with the software also improved children's ability to handle the tablet. Papadakis claimed that children who participate in programming interventions in the classroom, even if they have short duration, maximize their kinesthetic experiences, and still show significant improvement in fundamental skills, such as literacy and math skills [70]. Lastly, children who learn computational skills and computer science concepts could gain problem-solving strategies that are considered to be a way of human thinking to facilitate their learning and living [71].

Rightly so, "all the advanced Western countries have integrated or intend to integrate directly into their educational systems teaching of Programming and Computer Science already at Preschool Education level" [5]. With the current development of digital technologies and the concerns about CT literacy, how teacher education should prepare teachers to teach CT is an important question to be studied [72].

There are few limitations of the present study that should be addressed. The first one is the sample size of the study. The sample size (24 preschool children, 10 parents of preschool children and 100 preschool teachers) allows us to draw some conclusions but prevents us from generalizing the results [55]. It is reasonable that future research could shed more light on the issue of CT in preschool children. Additionally, another limitation is the lack of a control group of students against which the comparison would have been performed. Alternatively, the students could have been evaluated prior to the intervention and the relative performance may have been evaluated. The CT could also be studied under considering other parameters; for example: (a) in relation to the place of residence of preschool children and (b) regarding educational software of non-programming content.

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