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Perceptions of Primary School Teachers on Interdisciplinary Computational Thinking Skills Training*

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Abstract. This study aims to examine the impact of interdisciplinary computational thinking (CT) skills training on primary school teachers' perceptions of CT skills. The sample of the study consisted of 30 primary school teachers in Istanbul. In this study, where quantitative and qualitative methods were used together, qualitative data were obtained from the teacher identification form. Quantitative data were obtained from the scale for CT skills. After the pre-test was applied to the study group, "CT Skills Training" was applied. During the training, the basic concepts of CT skills and the subskills were covered theoretically and practically. From the quantitative data, the education applied was determined to have had a positive effect on the primary school teachers' perceptions of CT skills. From the qualitative data, it was determined that the participants had a positive opinion about the applied training and thought that they gained skills related to CT.

Keywords: primary school teachers, computational thinking, teacher training, thinking skills.

1. Introduction

The significance of technology, information, and thinking skills is gradually increasing in education. Providing enriched educational practices based not only on knowledge but also on skills is important to boost students' interest in lessons and education. Various methods and techniques have been used throughout history to obtain academic success.

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Innovative practices are vital toward satisfying the needs of the developing society and ensuring that students acquire age-appropriate skills.

The European Union has identified communication and cooperation, security, digital content creation, problem-solving, information, and data literacy as digital competencies (Carretero *et al.*, 2017, p. 11). It is unlikely to acquire these skills through traditional teaching methods. It seems impossible to acquire these competencies with the traditional teaching process, in which classical methods, such as narration, question–answer, and classical course materials, such as blackboards and textbooks, are used (Akdağ and Tok, 2008, p. 29). To gain the competencies needed today, innovative educational practices that allow the active participation of the student rather than traditional methods are required. With the use of innovative educational applications in teaching, new competencies and skills required by the digital age can be gained. Among these skills is computational thinking (CT).

1.1. *Conceptual Framework*

According to Wing (2006, p. 33), who made the topic a current issue, "CT involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science." CT is a skill that all individuals can attain starting from the preschool period through an interdisciplinary approach. Students of the digital age are expected to develop 21st-century skills, go beyond what is taught in schools; adapt and use their knowledge in other fields; and be productive, lifelong learners, problem-solvers, and competent exponents of accessing the correct information. CT skills are also among the 21st-century skills (Gülbahar *et al.*, 2019, p. 2). One set of skills that students should develop when they learn how to obtain current information is CT skills (Gülbahar *et al.*, 2020, p. 12). According to Wing (2006, p. 34), CT:

- requires multidimensional thinking at multiple levels of abstraction, beyond mere programming;
- is a fundamental skill every individual must have at the current age;
- is a way that humans think, not computers;
- is not how individuals think computationally but the method they follow while solving problems;
- complements and combines mathematical and engineering in terms of thinking;
- is used to solve problems, manage our daily lives and interact with others; and
- is for everyone, everywhere.

It is possible to infer from these statements that practices related to CT skills can be included in basic education. Moreover, acquiring these skills at an early age is important, and the practical use of these skills will enable the acquisition of various competencies. These statements further support the contention that the study results will contribute to the dissemination of CT skills in basic education.

CT uses similar methods to mathematical thinking in problem-solving, engineering in designing and evaluating a complex system, and scientific thinking in understanding concepts, such as computability, intelligence, and human behavior (Korkmaz *et al.*, 2016). CT is a thought process that involves logical reasoning whereby problems are solved and procedures and systems are better understood. These skills are used throughout life simultaneously with thinking and problem-solving skills. CT includes the concepts of algorithmic thinking, logical reasoning, generalization, decomposition, abstraction, and evaluation (Csizmadia *et al.*, 2015, p. 6). Accordingly, CT skills can be considered basic skills that should be possessed by everyone to successfully cope with problems; more easily adapt to innovations; and develop reasoning, generalization, and evaluation skills.

While teaching students CT skills, it is important to make use of collaborative exploration-based practices that will enable them to make logical inquiries. During this process, while students are expected to gain concepts, skills, and perspectives in different disciplines, their CT skills are expected to develop simultaneously (Gülbahar *et al.*, 2020). Ensuring the application of CT skills to education will support students in learning basic sciences, such as mathematics and logic, and will improve their problem-solving abilities, thereby assisting them in eliminating problems encountered in daily life. Therefore, it is concluded that using CT skills, which play a critical role in learning, is a practice that befits the innovative educational approach of the 21st century. Concordantly, educational practices aimed at developing students' digital competencies and CT skills are thought to be favorable for realizing educational goals at present.

CT supports learning by developing thinking skills (Csizmadia *et al.*, 2015, p. 11). Therefore, to keep pace with global developments, it is important that teachers and students gain digital competencies, as well as include CT skills in their curricula and ensure the dissemination of these skills. Presently, due to the developing technology and digitalization, CT skills are becoming ever more significant. Basic education is the most important level of education for students to acquire knowledge and skills.

It is anticipated that by addressing CT skills that are not very common in basic education in this study, an innovative approach may become widespread in the arena of basic education. Therefore, it is a fact that a society aiming for sustainable development requires teachers capable of cultivating individuals who possess the capabilities needed to succeed in the 21st century. Presently, the responsibility for cultivating individuals who have acquired the necessary competencies and skills and can function in a society that aims to achieve sustainable development lies with education and therefore teachers, who are the planners and executors of curricula. Primary school teachers are the most important persons that impact the area educational and developmental achievements of individuals and society. Primary school teachers are responsible for teaching all courses from the 1st to the 4th grade, except for courses such as English and Religious Culture and Moral Knowledge. They spend a considerable amount of time teaching all core courses using the methods and techniques of their choice. Furthermore, primary school teachers can allocate more time to interdisciplinary practices in their lessons than teachers at the secondary and high school levels. Studies show that the attitudes of primary school teachers and their teaching with various methods and techniques contribute to the acquisition of knowledge and skills by their students (Baysal, 2003; Çimşir, 2019). Therefore, the reason for this study is that primary school teachers receive training on CT, an important skill today, and ensure that they transfer the outputs of this training to students. Regarding CT skills in the literature, Atiker (2019) on programming skills and academic success with secondary school students; Kalelioğlu and Gülbahar (2014) on Scratch and problem-solving skills; and Arslanhan and Artun's (2001) research on CT, algorithmic-thinking, decision-making, and problem-solving skills in science teaching. The positive results of Ertuğrul Akyol's (2020) studies on secondary school teachers' CT and problem-solving skills are remarkable. This and similar researches are the answer to the question, "Why isn't computational thinking skills training given in primary schools, which form the basis of education?" However, as there is no information technology course among the courses taught in the current primary school program, no study on information technologies or CT skills has been encountered at the basic education level. To provide CT skills training to primary school students, primary school teachers receive training first and then transfer the training they have received to their students. This study was designed based on the need for a comprehensive study on the effects of interdisciplinary CT skills training in basic education and the views of teachers. With the support of experts and trainers from different universities in Turkey, a comprehensive project study was planned in the form of teacher training and then the implementation of activities by the teachers participating in the training for their students. The study prepared was supported within the scope of the call of TUBITAK (The Scientific and Technological Research Council of Turkey) Science and Society Programs Directorate in Turkey for the TUBITAK 4005 Innovative Educational Practices 2020/1 Term. This comprehensive study is thought to potentially guide the education planners in formally adding the content of CT skills to the primary school curriculum and the education programs of teacher training universities. In addition, the primary school teachers' inclusion of interdisciplinary CT skills activities while teaching their lessons is thought to potentially support the students in acquiring this skill. Therefore, the results of this study are thought to potentially make an important contribution to the literature and guide those who prepare the training programs and practitioner teachers. Accordingly, the study sought answers to this research question: "Does interdisciplinary CT skills training affect primary school teachers' perceptions of these skills?"

1.2. *Purpose of the Study*

The overall purpose of this study is to reveal the impact of interdisciplinary CT skills training on primary school teachers' perceptions of CT skills.

Accordingly, the study aims to answer the following subquestions:

(1) Does interdisciplinary CT skills training have a significant impact on primary school teachers' perceptions of these skills?
(2) What are primary school teachers' opinions on interdisciplinary CT skills training?

2. Method

2.1. *Research Model*

In this research, enriched designs from mixed designs consisting of quantitative and qualitative research methods were used. Mixed designs involve combining and integrating qualitative and quantitative data in research (Creswell, 2009). In this design, quantitative and qualitative data are collected simultaneously, and it is checked as to whether the data collected at the end of the research support each other. During this research, quantitative and qualitative data were collected simultaneously and the data were analyzed.

The quantitative part of the study was based on a single group pre-test–post-test experimental design. In this model, an independent variable was applied to a randomly selected group, and measurements were made before and after the experimental procedure (Karasar, 2003, p. 96). Following the pre-test, as a part of the experiment, a one-week interdisciplinary CT skills training was provided to the participating primary school teachers. The same measurement tool used in the pre-test was applied during the post-test.

In the qualitative part of the study, the basic interpretive qualitative research design was used, in which, researchers are concerned about how individuals interpret their lives, how they construct their world, and what meaning they attribute to their experiences (Merriam, 2013). Following the training, participants' opinions about the training were asked, and the answers written on the form were examined.

2.2. *Study Group*

This research was produced from a national project supported by TUBITAK. Within the scope of the project, a team of eight people consisting of executives, experts, and trainers from different universities and different institutions prepared teacher training on CT skills. The training program prepared was announced to the primary school teachers through official announcements and social media. A total of 30 primary school teachers participated in the training voluntarily. The study group research comprised 30 primary school teachers randomly selected among the volunteers from a population of primary school teachers working in public schools in Istanbul during the fall semester of the academic year 2021–2022.

Participants were selected using the disproportionate sampling method. In this type of sampling, all elements in the population have an equal chance of being selected. This sampling is also termed simple random sampling, unbiased sampling, or simple sampling (Karasar, 2003, p. 113). Findings on the descriptive characteristics of participant teachers are listed below.

Table 1 shows that of all the participants, the majority of whom were female (86.7%), aged between 41 and 45 years (33.3%), had a tenure of more than 20 years (43.3%), had a bachelor's degree (63.3%), and had not received training on this subject earlier (60.0%).

Table 1
Distribution of Teachers in the Experimental Group by Descriptive Characteristics

Groups	Frequency (n)	Percentage (%)
Gender		
Female	26	86.7
Male	4	13.3
Age		
22–30	1	3.3
31–35	5	16.7
36–40	6	20.0
41–45	10	33.3
Older than 45	8	26.7
Tenure		
0–5	1	3.3
6–10	4	13.3
11–15	3	10.0
16–20	9	30.0
More than 20	13	43.3
Education Status		
Bachelor	19	63.3
Master's Degree	9	30.0
PhD	2	6.7
Having Received the Training		
Yes	12	40.0
No	18	60.0

2.3. *Data Collection Tools*

2.3.1. *Semi-structured Interview Form*

The teacher identification form developed by the researchers was used to determine the demographic characteristics of the participating primary school teachers and their views on the training. The literature was reviewed while formulating the questions for the form. To ensure content validity, the form was checked by two separate faculty members. The form was finalized after corrections were made following their recommendations. The open-ended questions in the form were as follows:

- Were you satisfied with the training? Did the training meet your expectations? What part of the training content did you like the most?
- What skill(s) do you think the training helped you gain?

2.3.1. *Self-Efficacy Perception Scale for CT Skill (SEPSCTS)*

"Self-efficacy perception scale for CT skill developed" by Gülbahar *et al.* (2019) comprises 36 items and five factors. The factors in the scale below:

- Algorithm Design Competency.
- Problem-Solving Competency.

- Data Processing Competency.
- Basic Programming Competency.
- Self-Confidence Competency.

2.4. *Data Collection*

For the national project work, a professional team of eight people, including executives, researchers, and educators, came together. This team prepared a training program to enable primary school teachers to acquire basic knowledge and skills on CT and to consider applying the contents of this skill to their classrooms. The preparation of this training program took about three months, and the program was presented to an official institution as a project and received support. An online form was created to determine the participants. This form was announced to the teachers through the social media accounts of the project, the website, and an official letter. After the participants were determined, the content details were shared. A one-week training program was conducted with the participating primary school teachers in the first week of September 2021. Following the pre-test, an interdisciplinary CT skills training program was conducted with the participant teachers. During the training, subjects, such as drama, steam, scratch, 3D design, digital game design/story, algorithm, problem-solving, coding, and interdisciplinary course design were addressed. In the training program, academic researchers in the computer and instructional technologies department from three different universities and trainers with doctoral studies in this field took part, and studies on theory and practice were included. The training program applied to the participants is shown in Table 2.

Pedagogical approaches to CT skills, unplugged CT activities, and the subject of evaluation were addressed in detail. Following the training, the post-test was conducted.

Table 2
Training program applied to participants

	1. day	2. day	3. day	4. day	5. day
1.session	Pretests, acquaintance meeting	Unplugged CT activities 2	Coding toys (Field trip)	Generalization and algorithm/ Bilge Kunduz Questions	Interdisciplinary course design
2. session	Why and how is CT?	Steam training	3D modeling / Autodesk (Field trip)	Scratch 1	Interdisciplinary course design
3. session	Unplugged CT activities 1	Steam activities 1	CT through game development	Scratch 2	Evaluation and presentation of prepared course designs
4. session	Pedagogical approaches in CT teaching	Steam activities 2	CT through game development	Evaluating CT skills	Posttests Closing of the program

2.5. *Data Analysis*

The findings obtained using the measurement tools were considered to determine whether the study objectives were met. In the analysis of quantitative data, the paired sample t-test was performed to determine whether there was a significant difference between the pre-test and post-test scores of the participating teachers. The t-test is used to determine whether the mean difference between two sets of observations is 0. When measurements regarding the dependent variable are performed with the same sample before and after an experiment, the results of the said repeated measurements are related to one another (Büyüköztürk, 2017, pp. 367–368). In the study, Kurtosis (Kurtosis) and Skewness (Skewness) values were examined to determine whether the variables showed a normal distribution. In the relevant literature, if the results regarding the kurtosis skewness values of the variables are between +1.5 and −1.5 (Tabachnick and Fidell, 2013), +2.0 and −2.0 (George and Mallery, 2010), the distribution is accepted as normal. In this study, it was determined that the variables showed normal distribution, and parametric methods were used in the analysis of the data. This t-test is conducted to determine whether there is a significant difference between the means of two measurements taken from the same sample. An evaluation was made on the basis of whether there was a significant difference between the pre-test and post-test scores of the experimental group.

Content analysis and descriptive analysis were performed while examining the qualitative data. Relations and concepts were investigated with the help of content analysis. Alternatively, descriptive analysis, an approach that enables the interpretation and explanation of the collected data under the established themes, examined the cause–effect relationships and arrived at the result. In the descriptive analysis method, direct quotations are used to best reflect participants' opinions. First, the obtained data are systematically and clearly described. Subsequently, they are explained and interpreted, the cause–effect relationships are examined, and conclusions are drawn (Yıldırım and Şimşek, 2013, pp. 239–240). The forms completed by the participating teachers were coded as T1 (Teacher 1), T2, etc., and the responses given to each question were read by the researchers. The statements in the forms were coded and categories were identified.

Written documents were coded separately by the researchers to ensure the reliability of the study. The rank correlation coefficient was calculated using the formula [Consensus/(Agreement + Disagreement) × 100] and was found to be 90% (Miles and Huberman, 1994). Subsequently, they addressed the disagreements regarding the names of the categories and arrived at a common decision. Later, tables were created with the determined categories, subcategories, frequencies, and percentages, and the descriptions were included.

3. Findings

3.1. *Findings Regarding the Quantitative Data Obtained from the SEPSCTS*

The data obtained from the SEPSCTS were analyzed using the statistical package for the social sciences (SPSS) program. The changes from the pre-test to the post-test in the perception of self-efficacy for CT skills were analyzed using the dependent groups' t-test.

According to Table 3, the difference between the SEPSCTS pre-test ($\bar{x}$ = 83.20) and the SEPSCTS post-test score ($\bar{x}$ = 104.13) was found to be statistically significant ($t = -11.64$; $p = .00 < 0.05$). It was determined that the increase in the post-test values was significant when compared with the pre-test values of Algorithm Design, Problem-Solving, Data Processing, Basic Programming, and Self-Confidence. According to the amount of increase in favor of the post-test between the pre-test–post-test mean scores in the subdimensions of the scale, it was determined that the training applied had a positive effect on the perceptions of the participant teachers' CT skills in the algorithm-designing, problem-solving, data-processing, basic programming, and self-confidence subdimensions.

3.2. *Findings Regarding the Qualitative Data Obtained from the Interview Form*

The findings regarding participants' perspectives on the interdisciplinary CT skills training are presented in this section. Participants' answers in the teacher identification form were analyzed by researchers and grouped under themes and categories.

Table 4 depicts participants' responses to the following questions: Were you satisfied with the training? What part of the training content did you like the most? Did the training meet your expectations? Participants' opinions regarding the training were grouped under the following categories: liked the training and can be improved. These categories were divided into subcategories. It can be observed that the subcategories related to the category of liking the training were more emphasized by the participants.

The category liked training was divided into seven subcategories, namely, "awareness-raising," "teaching tools," "introducing methods," "expert guidance," "pedagogical

Table 3

Findings Regarding Pre-test and Post-test Difference

Measurements	Pre-test		Post-test		N	T	p
	Mean	Sd	Mean	Sd			
SEPSCTS Total	83.200	12.246	104.133	5.316	30	−11.640	0.000
Algorithm design competency	17.367	4.902	26.167	1.289	30	−10.468	0.000
Problem-solving competency	26.700	5.325	29.467	1.717	30	−3.154	0.004
Data processing competency	18.367	3.399	20.733	0.828	30	−4.165	0.000
Basic programming competency	9.000	2.319	13.167	2.086	30	−7.265	0.000
Self-confidence competency	11.767	2.596	14.600	0.724	30	−6.226	0.000

Table 4
Views of the Participants Regarding the Training

Categories	Subcategories	F	%
Liked the training	Awareness-raising	19	21.84
	Teaching tools	16	18.39
	Introducing methods	11	12.64
	Expert guidance	8	9.19
	Pedagogical attainment	8	9.19
	Lifelong learning	5	5.75
	Production	5	5.75
Can be improved	Duration	10	1.15
	Practical activities	5	5.75
Total		**87**	**100**

attainment," "lifelong learning," and "production." Among these, the "awareness-raising" subcategory was emphasized by most participants. Statements of the participants regarding each subcategory are given below for clarity.

The participant teachers' views that can be grouped under the "awareness-raising" subcategory included the following: "All activities were functional and beneficial." (T3, T4, T14, T15, T23, T25, T30); "I think now I can teach algorithmic thinking; I realized that it is necessary to arrive at the correct solutions for real-life problems in stages, to see and fix the mistakes we make." (T1); "This training showed that we can utilize unplugged CT skills in all courses. For example, I learned how to pose a problem and create a solution algorithm using these skills in math class." (T20); "I had heard of the concept of CTS, but I did not know about it in detail. I gained a great deal of knowledge and insight about these skills." (T13); "I liked all sessions of the training. I learned what CTS implies and how to use it in an interdisciplinary manner." (T14); "I really liked the Kodugame, Beaver, Scratch, and Autodesk Fusion 360 sessions." (T15, T16, T19, T20); "I understood Steam better and my awareness regarding CTS increased. I will develop an eTwinning project on this subject." (T21); "I really liked the activities related to the stages of CTS: Steam, Scratch, and Beaver." (T16); "I did not guess that the CT skills training would be structured so effectively." (T5); and "I liked the Scratch session; I learned insights that I can teach my students. The project overall increased my awareness of CT. I would like to thank everyone who contributed to it." (T29).

The participant teachers' views that can be grouped under the "teaching tools" subcategory included the following: "I really liked the coding activities with Scratch, game development with CoduGame, and 3D modeling with Autodesk Fusion." (T1, T4, T8, T10, T11, T12, T13, T15, T16, T18, T19, T20, T22, T29); "I liked all the practice-oriented activities. I also loved the sessions on coding and creating 3D animations. I think it was more effective, efficient, and permanent because it was a practical activity." (T13); and "I really liked the Scratch session." (T12).

The participant teachers' views that can be grouped under the "introducing methods" subcategory included the following: "The adaptation of drama activities to the topic of the algorithm was great." (T2); "Unplugged CT activities were great."(T4); "All practical activities were enjoyable and good." (T3, T9, T12, T13, T18, T19, T20); "The training was great. We learned new insights like our students, and it was very important that the new interdisciplinary CTS methods were blended with evaluation and drama and that they were interactive." (T24); and "It was good that the concepts in the guidelines for the 5E, 5T, Cynetur model, and Beaver activities were clear." (T27).

The participant teachers' views that can be grouped under the "expert guidance" subcategory included the following: "All sessions on Scratch, drama, and CTS were great, the Steam tutorial was great as well." (T11); "I really liked that all aspects of CTS skills were taught by academics." (T12); "All activities were planned following the subject content." (T17); "I liked the drama activities, the elaborated topics, and the Scratch training." (T18); "All of the subjects were explained very well, but I especially liked the activities on Beaver, CodeGame, and strategy, which can be utilized in the classroom environment. I hope more teachers will discover this project." (T20); "I liked the project specialist's first lesson, algorithmic toys lesson, and "Bilge Kunduz Activity." All of them explained everything properly and provided us with useful information." (T21); "The sessions on academic pedagogy and assessment in the context of CT were delightful. I enjoyed learning the basics of the topic from expert academicians." (T26); and "It was an intense program, I understood the cognitive dimension of the subject along with its philosophical background." (T28).

The participant teachers' views that can be grouped under the "pedagogical attainment" subcategory included the following: "I thoroughly enjoyed all the activities. I think we can use them in the classroom." (T6); "I liked the Beaver activity; it helps students gain CT and algorithmic-thinking skills." (T7); "All activities were planned following the subject content. I liked the activities on CT through drama, Steam, and game design, and I will use the information I learned during these activities in my classroom." (T17); "I liked the drama activities, the elaborated topics, and the Scratch training. I liked it because these activities can be utilized in the classroom environment." (T18, T19, T29); "I believe that this training will improve my teaching skills." (T13); and "This training showed that we can use CT skills in all courses. For example, we learned how to pose a problem and create a solution algorithm using these skills in math class." (T20).

The participant teachers' views that can be grouped under the "lifelong learning" subcategory included the following: "The training was great. We learned new insights like our students, and it was very important that the new interdisciplinary CT methods were blended with evaluation and drama and were interactive." (T24); "All the subjects and activities were good, the only downside was the duration. I wish it was longer training in the form of a camp. Thank you for everything." (T25); "The sessions on academic pedagogy for CT and assessment were enjoyable."(T26); "It was an intense program. I understood the cognitive dimension of the subject along with the philosophical background. A significant accomplishment for me was finding the drive to create an interdisciplinary lesson plan as it gave me confidence that I could do it." (T28); and "All the activities in the program were great, I greatly benefited from them." (T30).

The participant teachers' views that can be grouped under the "production" subcategory included the following: "I liked the coding games, the material development tasks, and the simple coding instruction." (T22); "I liked the product development activities." (T1, T4, T9); and "The important gain for me was the emotional motivation to make an interdisciplinary lesson plan; it gave me confidence that I can do it." (T28).

The category that can be improved was divided into two subcategories, namely, "duration" and "practical activities."

The participant teachers' views that can be grouped under the "duration" subcategory included the following: "The project would have been more successful if each subject had been addressed a bit longer." (T2, T5, T25); "I would have liked to spend more time on creating the lesson plan because it was extremely enjoyable." (T9); "Had the training been longer, we would have had a better understanding of the topics." (T10); "All the training sessions on Scratch, drama, and CTS were great; the STEM session was great. I wish it was a longer training; other than that I cannot say anything negative." (T11, T23); "All the sessions and activities were good; the only downside was the duration. I wish it was a longer training session in the form of a camp. Thank you for everything." (T25); "I wish there were more time for hands-on Scratch activities." (T12); and "All the practical activities were fun and good. However, it is important to use time efficiently. Some of our guides could not complete the sessions on time." (T3).

The participant teachers' views that can be grouped under the "practical activities" subcategory included the following: "A few practice games could be played using coding toys to conduct a practical activity." (T17); "The number of practical activities could be more." (T5, T12, T26); and "The project could have focused on practice and in-depth learning by addressing several dimensions of the subject." (T28).

The participants' answers to the question "Which skill(s) do you think the training helped you gain?" were examined, and two categories in Table 5 were determined: related to CT skills and others.

Table 5
Skills that teachers say they learned from training

Category	Subcategory	F	%
Related to CT skills	Algorithm	15	21.43
	Pattern recognition	12	17.14
	Scratch	9	12.86
	Coding	9	12.86
	Problem-solving	3	4.29
	Steam	3	4.29
	Digital game development	2	2.86
	Debugging	2	2.86
Other skills	Interdisciplinary course design	11	15.71
	Differentiated teaching skills	2	2.86
	Critical thinking	1	1.43
	Decision-making	1	1.43
Total		**70**	**100**

Participants stated that they acquired eight skills that fall under the category related to CT skills, with the most prominent being "algorithm skills." Participants T1, T2, T4, T5, T7, T8, T11, T15, T17, T18, T19, T20, T22, T24, and T30 stated that they gained "algorithm skills" owing to the training program. The following are the views of some participants: "I learned how to use the word algorithm in lessons and daily life. I have learned extremely useful information." (T24); "I learned what to pay attention to when creating an algorithm." (T17); "I learned about the interdisciplinary approach of algorithmic thinking, and I will try to utilize it in my classroom." (T18); "I gained in-depth knowledge about utilizing algorithmic-thinking and interdisciplinary approaches, as well as the ability to easily use them while teaching." (T19); and "I was given the chance to make up for my shortcomings in algorithmic-thinking abilities, and as a result, I now have a clearer understanding of what it is." (T20).

As for other participants who acquired skills related to CT, the prominent skills gained owing to the training were "game development with digital tools" for T9 and T17; "problem-solving" for T1 and T17; "debugging" for T1 and T11; "pattern recognition" for T11; "Scratch" for T15 and T23; "coding" for T15, T23, and T30; and "Steam" for T21, T25, and T21. Some of the participants mentioned their eagerness to develop the skills they gained during the training. They stated that "I better understood what Steam is, my awareness of CTS has increased, and I will develop an eTwinning project on this subject." (T21); "I think now I can teach algorithmic thinking. I realized that it is necessary to arrive at the correct solutions for real-life problems in stages, to see and fix the mistakes we make." (T1); and "I understood the importance of thinking skills thanks to Beaver, which offered skills such as designing process steps in problem-solving and developing games." (T17).

In the other subcategory, the participants stated that they acquired four different skills, the most prominent being "differentiated teaching skills." As for other participants who acquired other skills during the training, T9 and T10 gained "differentiated teaching skills"; T5, T6, T7, T13, T14, T16, T18, T19, T24, T26, and T28 gained "the ability to design interdisciplinary courses"; T10 gained the "critical-thinking skill"; and T13 and T25 gained the "cooperation skill."

4. Conclusion, Discussion, and Recommendations

The findings of this study show that interdisciplinary CT skills training had a significant impact on primary school teachers' perceptions of CT skills. Participants expressed their positive opinions about this training, and they acquired various skills related to CT. As a result of the research, the qualitative and quantitative findings were seen as supporting each other. From the analysis of the quantitative data, it was concluded that the training applied had a significant effect on the participant teachers' CT skills self-efficacy perceptions, algorithm-designing, problem-solving, data-processing, basic programming, and self-confidence subdimensions and that the applied training positively affected the participant teachers' perceptions of CT skills. From the analysis of the qualitative data, it was concluded that the participating teachers had the most positive opinions in the categories of awareness, tool, method, and expert effect and that they met the wishes and needs of the teachers for lifelong learning and production with this training. In addition, with this training, the participating teachers gained algorithm, pattern recognition, Scratch, coding, problem-solving, Steam, digital game development, debugging; interdisciplinary course design, critical-thinking, and decision-making skills are among the important results of the research.

The quantitative data measurement tool identified the competencies of the algorithm, problem-solving, data processing, basic programming, and self-confidence. Subcategories of the skills participants acquired during the training, such as algorithm, problem-solving, lifelong learning, and production, were subsequently identified after the analysis of the qualitative data. This study determined that the qualitative findings suggested that teachers' training is beneficial for themselves and their professional development, they have the opportunity to produce, and even the duration of education should be longer in the context of "improving" education. It can be stated that such training/experimental studies, which provide opportunities for the development of teachers, will positively affect the cognitive development of students and therefore the quality of education.

Arslanhan and Artun (2001) deduced that the use of CT skills in science teaching improves students' algorithmic-thinking, decision-making, and problem-solving abilities; enhances students' readiness, motivation, teamwork, peer communication, and knowledge retention; helps gain high-level skills; and improves learning. Atiker (2019) determined that CT activities have a positive impact on the programming skills and academic achievement of secondary school students. Ertuğrul Akyol (2020) suggested that STEM activities have a positive impact on computational, critical, creative-thinking, and problem-solving skills. These findings are consistent with the findings of this study, wherein participants stated that they acquired CT skills, as well as other skills related to CTS aspects, such as algorithms, debugging, problem-solving, and collaboration.

Kalelioğlu and Gülbahar (2014) conducted a sequential mixed-method study, wherein they investigated the effect of Scratch programming on the problem-solving skills of 5th-grade students. The findings obtained from the quantitative part of the study demonstrate that programming on the Scratch platform did not lead to a significant improvement in the problem-solving skills of primary school students; there was a non-significant increase in the average of only the factor of "confidence in problem-solving abilities." The data obtained from the qualitative part of the study reveal that all students liked programming and wanted to improve their programming skills and that most students found the Scratch platform easy to use. These findings are similar to the positive opinions of the participants of this study regarding Scratch and game development. In the qualitative findings of this study, the participating teachers stated that they enjoyed using the Scratch program as a "tool effect" and that they were willing to teach it to their students. This situation brings to mind the question of why there is no course content for Scratch education in primary school programs. It can be said that primary school curricula and course contents should be improved in terms of teacher competencies, skills that students need, and content they are interested in.

Korkmaz *et al.* (2016) determined that half of the individual's perceptions of their CT skill level were high and the other half were moderate. In the study, algorithmic thinking and problem-solving were found to have the lowest average scores among participants, and cooperation was shown to have the highest average score. The finding that algorithmic-thinking and problem-solving skills, determined to be low in this study, showed a high level of improvement in the current study, shows that the applied education is functional. The findings of the study regarding the skill of cooperation are consistent with the positive statements made by the participants of this study for collaboration and group work within the context of the subcategories of "expert guidance," "lifelong learning," and "production." The fact that the teachers like to work and produce together and are satisfied with the training on innovative approaches and skills shows that teachers need and are willing to undergo such training. Therefore, the quality of education needs to support more practical and skill-based training for teachers this way.

In the present study, the findings that the algorithm adequacy subdimension develops in quantitative data and that the participants had positive opinions on algorithmic-thinking skills in qualitative data are important and support each other. Among the crucial findings of this study are the participants' positive opinions about algorithmic-thinking skills. Brown (2015) stated that daily life is full of algorithms and complex problems and that schools must help develop these skills. Yavuz-Mumcu and Yıldız (2018) examined the algorithmic-thinking skills of 5th- and 6th-grade students and determined that the students could not use these skills effectively. It was observed in the study that students were more successful in using a given algorithm and monitoring its progress rather than developing and using an algorithm suitable for the current situation or determining its effectiveness. Considering the results of the said study along with the findings of this study, it can be concluded that teachers in secondary and high schools who are confident in their ability to create content that will impart their knowledge of algorithms will help students develop these skills. Accordingly, it can be stated that the training in algorithmic thinking provided to participants will lead to positive results and that the increase in the number of such experimental studies will increase the quality of education.

Avşar (2023), found that the design-based in-service training program had a positive effect on preschool teachers' coding and computational thinking skills. In his research, Sayın (2020) determined that the design-based research method and online learning activities can be functional in the development of CT skills. He also determined that CT is not a spontaneous skill but that it should be developed with purposeful and specific activities and that it often requires a challenging and time-consuming teaching process for users. When the results of this study are evaluated together with the results of the present study, it can be said that the development of CT skills should start from the primary school level. To this end, it can be stated that the programs of teacher training schools should be reviewed and the training of on-duty teachers should be supported by universities.

It was found in this study that interdisciplinary CT skills training positively impacted primary school teachers' perceptions CT skills in terms of algorithm, problem solving, data processing, basic programming and self-confidence sub-dimensions and improved their algorithm, problem-solving, game design, collaborative work, and interdisciplinary course design skills.

It is assumed that the positive perceptions of primary school teachers – who are the executors of curricula and represent the most influential factor of the education system – toward CT skills will translate into innovative educational practices and influence the attitudes as well as the methods and techniques teachers employ. Therefore, it can be concluded that the CT training provided to primary school teachers will increase the utilization of this skill at the primary school level, consequently improving the quality of education, facilitating students' acquisition of relevant skills, and enhancing their academic achievement. In line with the results reached within the scope of this study and similar results in the literature, it can be emphasized that teachers' perceptions of the development of CT skills, their proficiency levels, and their professional needs should be considered and that teachers and therefore students should be supported in gaining new skills by giving similar training. In future studies, more personalized environment designs can be made by making a detailed analysis of personal interests, needs, and thinking processes.

The data of this study is limited to the data obtained from 30 primary school teachers participating in training in Istanbul in Turkey. The results of this research cannot be generalized to the whole country or different countries. However, the positive views of primary school teachers regarding education cannot be ignored. Because today, where information technologies are more important day by day, it is important for such trainings to become widespread and the data obtained to be disseminated. Therefore it can be suggested that In-service training activities related to CT skills can be developed. It can also be suggested that studies on CT can be conducted on the basis of different variables and with different samples.

Considering the positive opinions of primary school teachers about CT education and their opinion that the training is beneficial for themselves and their students, it may be recommended that information technologies and software courses be included in primary school programs. Moreover CT skills-related topics, such as scratch, coding, and algorithm designing, can be included in the primary school education curriculum.

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