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Research Paper

Developing Computational Thinking Scale for Primary School Students and Examining Students' Thinking Levels According to Different Variables

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ABSTRACT

In recent years, computational thinking has been considered as one of the 21st century skills that all students should have. Researchers emphasize the importance of determining and developing students' computational thinking levels from the earliest possible age. However, no measurement tool has been found in the literature that aims to reveal the computational thinking levels of primary school students. In this study, it was aimed to develop the computational thinking scale for primary school students and to examine the computational thinking levels of primary school students according to different variables (grade level, daily computer use time). In the first stage of the study, a scale with appropriate psychometric properties was developed to measure computational thinking. In the scale development phase of the research, exploratory sequential mixed methods research design was used. In the other phase of the study, it was investigated whether the computational thinking levels of primary school students differed according to the grade level and daily computer usage time without any intervention. For this reason, the research was carried out in accordance with the general survey model, which is one of the descriptive research types. For the first stage, the study group of the research consisted of 287 students studying in the 1st, 2nd, 3rd and 4th grades of primary schools in Ankara Golbasi district in the second term of the 2021-2022 academic year. In the process of examining the students' computational. thinking levels according to the variables of grade level and daily computer usage time, the study group consisted of a total of 96 students attending the primary education classes of a private school in Ankara in the second term of the 2021-2022 academic year. In this context, the one-dimensional computational thinking scale consisting of 17 items was applied to 287 primary school students and the obtained data were subjected to validity and reliability analysis. According to the explanatory factor analysis, the scale explains 46% of the total variance. When the results of the explanatory factor analysis are examined, it is seen that the factor loads of 17 items in the scale vary between 56 and .86. The internal consistency coefficient of the scale was found to be Cronbach Alpha .92. The developed scale was applied to primary school students in the next stage. As a result of the study, it was found that the generally computational thinking levels of primary school students differed significantly according to the grade level. On the other hand, it was observed that the students' computational thinking levels differed significantly according to the time spent in front of the computer daily, and the mean of the students' computational thinking scale increased as the daily computer use time increased.

INTRODUCTION

Today, the needs of societies, science and technology are changing rapidly. This situation undoubtedly changes the characteristics expected from individuals. Learning and teaching approaches, theories and strategies also differ in order to raise individuals with desired and needed characteristics (MEB, 2018). Individuals need new skills different from traditional methods at the point of accessing and using information, revealing new information and sharing the information produced (Polat, 2006). For this purpose, the "21st Century Learning Framework" has been determined by the "21st Century Skills" joint working group, which includes high-level companies and associations such as Microsoft, Lego, American Association of School Librarians, Pearson, National Education Association, Intel, Dell, Apple (DODEA, 2014). In line with this determined framework, the 21st century skills that individuals are expected to have been put forward in detail (P21, 2009). These skills are defined as three main themes: learning and innovation skills, life and career skills, knowledge, media and technology skills, and different skill groups under each theme (Kalemkus & Bulut Ozek, 2021). At this point, computational thinking emerges as one of the 21st century skills that every student should have (Grover & Pea, 2013; Gulbahar, Kert, & Kalelioglu, 2019).

Computational thinking is defined as mental processes used in areas such as understanding human behavior, designing systems, solving problems efficiently and effectively, being aware of information processing capacity, and designing autonomous processes (Wing, 2006). According to Barr and Stephenson (2011) computational thinking is explained as the reconstruction of data through abstractions such as models and simulations, use of the data and producing appropriate solutions to existing problems by considering the limits of computing. Computational thinking is also expressed as skills such as processing, building and transforming information, technology literacy and creating creative and innovative products as a result of all these processes (Sendurur, 2018; Yolcu, 2018). Computational thinking is seen as a prerequisite for future professions and when evaluated in terms of 21st century competencies, it is considered as one of the basic skills such as reading, writing and calculation (Ambrosio, Almeida, Macedo, & Franco, 2014). Computational thinking develops skills such as problem solving, critical and logical thinking and creativity in individuals. It also prepares them for the global race and blends success in school life with success in real life (ISTE, 2011; Korkmaz, Ozden, Oluk, & Sarioglu, 2015). For this reason, in today's information and technology age, computational thinking is considered as attitudes and skills that can benefit not only computer engineers, but also all individuals from every profession, and it is emphasized that these skills should be gained to every student as early as possible (Wing, 2006). As a result, computational thinking defines skills such as processing, constructing and transforming information, technology literacy and creating creative and innovative products as a result of all these processes (Sendurur, 2018; Yolcu, 2018). Computational thinking is seen as a prerequisite for future professions and when evaluated in terms of 21st century competencies, it is considered as one of the basic skills such as reading, writing and calculation (Ambrosio, Almeida, Macedo, & Franco, 2014). For this reason, developed countries carry out studies to include more computational thinking in their K12 curricula and develop programs in which computational thinking takes a large place.

Research context

Education and training programs in Turkey are updated in accordance with the needs of the age. The special objectives of the Information Technologies and Software course curriculum updated in 2018 include the development of students' problem-solving and computational thinking skills (MEB, 2018). This situation clearly reveals the necessity of increasing the importance given to computational thinking, which is seen as a 21st century skill in educational environments. Because the computational thinking process includes many concepts and processes such as critical and creative thinking, abstraction, algorithm design, automation, data collection, data analysis, data presentation, parsing, pattern recognition, pattern generalization, collaboration and modeling (Gulbahar, Kert, & Kalelioglu, 2019; ISTE, 2011). In this respect, it is thought that it is important to actively integrate computational thinking into education systems. However, researchers emphasize that there are not enough resources and activities to carry computational thinking into the classroom environment (Barr & Stephenson, 2011). In addition, it is another problem that studies in the relevant literature tend to develop this skill before determining the computational thinking levels of individuals (Berikan, 2018; Gulbahar, Kert, & Kalelioglu, 2019). However, it is very important to determine the level of computational thinking that already exists in individuals, as well as to acquire computational thinking skills, or to evaluate to what extent individuals have acquired computational thinking skills as a result of the designed applications. Therefore, the process of determining the level of computational thinking in individuals, whose scope is extremely wide, should also be structured comprehensively, and computational thinking competencies should be carefully evaluated by considering knowledge, attitudes and skills (Snow, Katz, Elliott Tew, & Feldman, 2012). Student development files, multiple choice tests, computational thinking pattern graph, project and performance evaluation, computational thinking scale and rubrics can be used to evaluate computational thinking (Gouws, Bradshaw, & Wentworth, 2013; Grover, Pea, & Cooper, 2015). When the literature is examined, it is seen that there are limited studies on the measurement and evaluation of students' computational thinking level. Again, it is noteworthy that a very limited number of measurement and evaluation tools have been developed for the relevant subject in our country. When the measurement tools developed in our country are examined; there is a computational thinking skills scale for university students (Korkmaz, Cakir, & Ozden, 2017) and a computational thinking skills test for secondary school students (Ozmen, 2016). It is also seen that the computational thinking skill measurement tool (Yildiz, 2021) and the self-efficacy perception scale (Gulbahar, Kert, & Kalelioglu, 2019) for computational thinking skills have been developed for secondary schools. It is emphasized by researchers that there are not enough measurement tools to measure the level of computational thinking, especially in our country (Demir & Seferoglu, 2017). In addition, when the literature was reviewed, no measurement tool aimed at revealing the computational thinking levels of primary school students was found. Again, no other study has been found in the literature examining the computational thinking levels of primary school students according to different variables. At this point, this study aims to provide a valid and reliable computational thinking scale for primary school students to the relevant literature. Another aim of the study is to examine the computational thinking levels of primary school students, who are the sample group in which there are limited studies on computational thinking levels, according to various variables (grade level, daily computer use time) within the scope of this research.

Therefore, there are two main problem statements in this research. The first problem statement of the study was "What are the psychometric properties of the Computational Thinking Scale (CAI) that will be developed for primary school students?" has been determined.

The other problem statement of the research is "Do primary school students' computational thinking levels vary according to different variables (grade level, daily computer use time)?" is in the form.

METHOD

Research model

This study, which aimed to develop the computational thinking scale and to examine the computational thinking levels of primary school students according to different variables, was carried out in two stages. In the first stage of the study, a scale with appropriate psychometric properties was developed to measure computational thinking. In the scale development phase of the research, exploratory sequential mixed methods research design was used. In the other phase of the study, it was investigated whether the computational thinking levels of primary school students differed according to the grade level and daily computer usage time without any intervention. For this reason, the research was carried out in accordance with the general survey model, which is one of the descriptive research types. Descriptive research is defined as research in which the current situation of the subject is examined and the relationship between the variables is revealed without changing (Buyukozturk, Akgun, Karadeniz, Demirel, & Kilic, 2016; Yildirim & Simsek, 2018). Survey models are studies in which research data are collected from a sample group representing the universe, rather than the entire universe, in order to reveal the views or characteristics adopted by large populations (Fraenkel & Wallen, 2009). The general screening model is defined as a model in which the researcher has no effect on the independent variable and includes studies conducted in the entire universe or in a smaller group to be taken from the universe in order to reach a general judgment about the universe (Karasar, 2017).

Working group

The study group of this research was determined by convenient sampling (Cohen, Manion & Morrison, 2007). In convenient sampling, the researcher or researchers conducting the study select the participants who will form the study group from volunteer individuals who are suitable for the research and easy to reach (Gravetter & Forzano, 2012). During the scale development process, which is the first stage of the research, the study group of the research consisted of 287 students studying in the 1st, 2nd, 3rd and 4th grades of primary schools in Golbasi district of Ankara in the second term of the 2021-2022 academic year. It is stated by Bryman and Cramer (2001) that the sample size reached in the scale development studies should be at least five times the number of items in the scale. Since the draft scale consists of 26 items, it is thought that the sample size of 287 students is sufficient.

In the process of examining the students' computational thinking levels according to the variables of grade level and daily computer usage time, the study group consisted of a total of 96 students attending the primary education classes of a private school in Ankara in the second term of the 2021-2022 academic year. Of the 96 students in the study group, 24 are 1st grade, 24 2nd grade, 24 3rd grade and 24 4th grade. The frequency distribution of the students in the study group according to the grade level and daily computer usage time is given in the table below (Table 1).

Table 1. Frequency distribution of the study group according to the variables of grade level and daily computer usage time

Variable		f	%
Grade level	1st grade	24	25
	2nd grade	24	25
	3rd grade	24	25
	4th grade	24	25
Daily computer usage time	Less than 2 hours	22	23
	2-4 hours	34	35
	4-6 hours	21	22
	More than 6 hours	19	20

Data collection tool

The data collection tool used in the research is the Computational Thinking Scale developed by the researchers. The development process of the scale and its psychometric properties are given below in detail.

Before starting the research, it was aimed to investigate whether the computational thinking levels of primary school students change according to different variables. When the relevant literature is reviewed, there are measurement tools that aim to determine the computational thinking levels of university (Korkmaz, Cakir, & Ozden, 2017) and secondary school students (Gulbahar, Kert, & Kalelioglu, 2019; Ozmen, 2016; Yildiz, 2021) in our country. However, it has been observed that there is no measurement tool to determine the computational thinking levels of primary school students. Therefore, with this study, it was decided to develop a scale that can reveal the computational thinking levels of primary school students.

In the first stage of the scale development process, information about computational thinking and the sub-dimensions of computational thinking was obtained by examining various sources (Barr & Stephenson, 2011; Grover & Pea, 2013; Kalelioglu, Gulbahar, & Kukul, 2016; Selby & Woollard, 2013; Wing , 2006; 2008; 2011). Based on the relevant literature and especially considering the classification of Wing (2008; 2011), who has many studies on computational thinking, the sub-dimensions of computational thinking were determined as abstraction, algorithm, automation, decomposition, generalization/evaluation. Then, an item pool of 33 items was created to include all these sub-dimensions and ensure content validity. While preparing the items in the item pool, attention was paid to write the items in accordance with the age group. In addition, all the items are written in a way that includes a single situation and is also clear and understandable. The scale was prepared in 3-point Likert type as “agree”, “no idea” and “disagree”. The scale was prepared in a triple Likert type because it is stated that scales with fewer choices are suitable for less educated or younger respondents (Koklu, 1995). Empirical studies reveal that participants do not perceive the difference between options equally in Likert-type questions (Hart, 1996). This situation causes a change in the number of participation levels and therefore affects the validity and reliability of the scale (Ozkan & Bindak, 2021).

Expert opinions were sought to ensure the content validity of the 33-item, 3-point Likert-type scale. The prepared scale was examined in terms of content validity by two faculty members working in the departments of computer and instructional technologies education and one faculty members working in the division of classroom instruction education. In addition, the scale was examined by 2 classroom teachers in terms of suitability for student level, language and intelligibility, and by an assessment and evaluation expert in terms of compliance with assessment and evaluation criteria. In line with the suggestions from the experts, it was decided to remove some items from the scale because they were not suitable for the assessment and evaluation criteria and the level of primary school students. Again, the scope of some items in the scale was narrowed down and the items were corrected to be simpler and more understandable. After these regulations, a draft scale consisting of 26 items was created. Since the age group of the participants is small and especially the students who are just learning to read, such as the first graders, are also included in the participant group, the draft scale with 26 items was thought to be appropriate.

In the pilot study of the research, the draft scale was applied to a total of 20 primary school students. As a result of the feedback obtained by the students while answering the scale, the items that were difficult to understand were revised again. As a result of this preliminary application, the application time of the scale was determined as 25 minutes. After this stage, exploratory factor analysis was started.

The draft scale, which was prepared in line with the opinions obtained from the experts and the preliminary application made to primary school students, was applied to a total of 287 students studying in primary schools in Ankara province Golbasi district. During this practice, including 135 female and 152 male students; 69 students in the 1st grade, 71 students in the 2nd grade, 73 students in the 3rd grade and 74 students in the 4th grade were reached. The data obtained from the application were analyzed in the SPSS 21 package program and the findings related to the scale were reached.

As a result of the analysis of the data, the Kaiser-Meyer-Olkin (KMO) value of the draft scale consisting of 26 items was calculated as .88. In addition, a significant difference was found in the Bartlett Sphericity test result of the scale ($p < .05$). As a result of the analysis, the significant difference in the Bartlett Sphericity test and the KMO value greater than 70 revealed that the data were suitable for factor analysis (Leech, Barrett, & Morgan, 2005; Tavsancil, 2010).

After the scale was found to be suitable for factor analysis, factor analysis was applied to the scale and after the analysis of the main components of the scale, 7 factors with eigenvalues greater than 1.00 emerged. However, the fact that the eigenvalue of the first factor was significantly higher than the eigenvalues of the other factors indicated that the scale had a single-factor structure. At this point, in order to determine the factor number of the scale, Cattel's "scree" test was performed (Kline, 1994) and a graph as below was obtained (Figure 1).

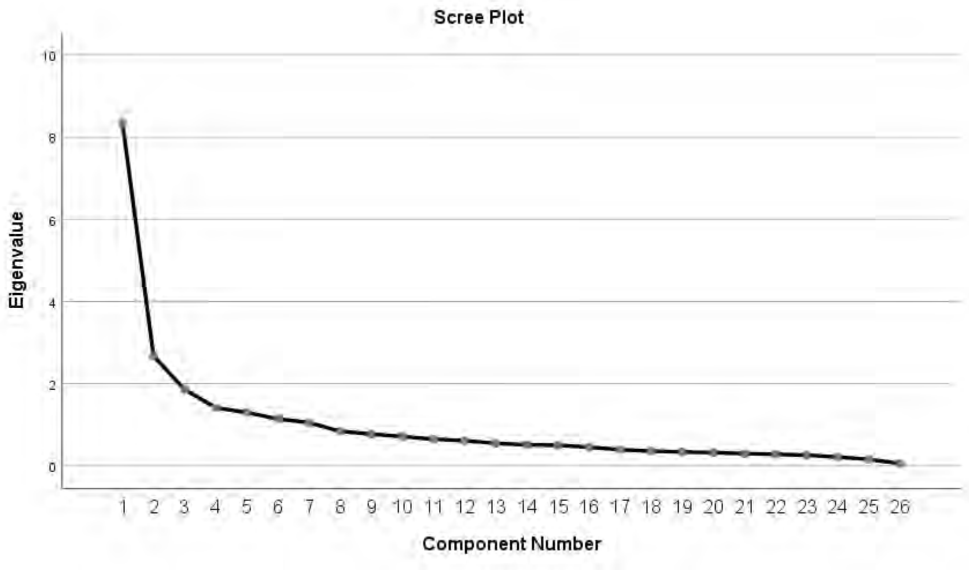

Figure 1. Computational Thinking Scale line chart

The sharp decline points in the graph determine the factor number of the scale (Singh, 2007). When the Scree plot graph in Figure 1 is examined, it is seen that there is only one sharp decline point. This showed that the scale measures a single factor structure and it was decided to have a single factor scale. The results obtained regarding the variance value of the single factor scale are given in the table below (Table 2).

Table 2. Findings related to a factor as a result of factor analysis

Factor	Eigenvalue	Percentage of Variance	Percentage of Total Variance
1	8.14	46.49	46.49

When Table 2 is examined, the eigenvalue of the single factor in the scale was found to be 8.14, and the total variance percentage of this factor was found to be 46.49. The single factor in the scale explains 46% of the total variance. According to Kline (1994), the acceptable rate is 41%. The fact that the value obtained from the relevant scale is above 41% allows the scale to be used as a scale consisting of a single factor. In scale development studies by researchers, it is considered sufficient that the variance explained, especially in social sciences, is between 40% and 60%. The height of the explained variance is accepted as an indicator of how well the relevant structure is measured (Buyukozturk, 2012; Scherer, Wiebe, Luther, & Adams, 1988).

Factor analysis was also used to examine the factor structures measured by the scale items. At this stage, it is stated that the factor load values of the items in the scale should be above .30 and the difference between two high factor loads should be at least .10 in order to ensure the construct validity of the scale (Bryman & Cramer, 2001; Buyukozturk, 2012). At this point, experiments were carried out by removing scale items from the scale in order to ensure that the factor loads were in accordance with the referenced values. Items with a factor load less than .30 and under more than one factor at the same time were excluded from the scale (M4, M5, M6, M8, M9, M10, M12, M17, M19). As a result of the analyses, a total of 17 items remained in the scale. As a result of removing the relevant items from the scale, the factor loads of the items in the scale were found to be between .56 and .86. The factor load values of the remaining 17 items in the scale are given in Table 3.

Table 3. Factor loading values of the items in the scale

Item no	Factor load
M3	.86
M26	.83
M23	.81
M16	.79
M2	.79
M24	.71
M25	.69
M11	.65
M7	.65
M14	.61
M13	.61
M20	.59
M21	.59
M15	.58
M22	.58
M1	.57
M18	.56

In the next step, to determine the reliability of the scale, the internal consistency coefficient Cronbach alpha was calculated and found to be .92. A Cronbach alpha coefficient greater than .70 is considered sufficient, and greater than .90 is indicated as excellent. The scale was found to be highly reliable (Kilic, 2016.) After the validity and reliability analyzes, a 17-item scale was reached. The distribution of the items in the scale according to the computational thinking sub-dimensions is given in Table 4.

Table 4. Distribution of items according to computational thinking sub-dimensions

Sub-dimension	Sub-dimension
Abstraction	3, 8, 14, 17
Algorithm	4, 5, 11, 15
Automation	1, 10, 13
Decomposition	2, 9, 16
Generalization/ Evaluation	6, 7, 12

The lowest score that can be obtained from the scale is 0 and the highest score is 51. In the scale, reverse items were determined as M2, M5, M8, M10, M12 and M14 items. The response time of the scale is approximately 15 minutes.

Data Collection Process

Within the scope of this research, a valid and reliable computational thinking scale consisting of 17 items and one dimension was developed. After the development of the scale, an answer was sought for another problem statement of the research. At this stage the scale was applied to primary school learners and it was examined whether the computational thinking levels of primary school students changed according to the grade level and daily computer usage time. At this stage, the scale was applied to a total of 96 primary school students attending the primary school classes of a private school in order to investigate whether the computational thinking levels of primary school students differ according to the grade level and daily computer usage time variables.

Data Analysis

Microsoft Excel spreadsheet program and SPSS 21 statistical analysis program were used in the analysis of the data of the research. The Shapiro Wilk test was used to determine whether students' responses to the scale were normally distributed. One-Way ANOVA, one of the parametric analysis techniques, was used to determine whether there was a statistically significant difference between the mean scores of the students in different groups. In case of significant difference as a result of the analysis, Bonferroni test, one of the multiple comparison tests, was used to determine between which groups the difference was. The significance level was accepted as .05 in all analyzes.

FINDINGS AND INTERPRETATION

Before proceeding to the analysis of the data, the statistical method to analyze the data collected through the Computational Thinking Scale was examined. In order for the data collected during the study to be analyzed with parametric tests, all of them should show a normal distribution. For this reason, first of all, the data should be analyzed by choosing the appropriate normal distribution test, and it should be decided whether the normality assumption is provided and parametric or non-parametric tests should be used in the analysis of the data (Ghasemi & Zahediasl, 2012; Sim & Wright, 2002). The Shapiro Wilk test was applied to all data obtained from the Computational Thinking Scale, which was also used as a data collection tool in this study. The Shapiro Wilk test is generally preferred in cases where the number of participants is less than 50 (n<50) (Ghasemi & Zahediasl, 2012). The Shapiro Wilk test results of the study group's Computational Thinking Scale scores according to grade level, daily computer use time and gender variables are given in Table 5.

Table 5. Shapiro Wilk Test results regarding grade level and daily computer use time variables

Variable	Group	statistics	df	p
Grade level	1st grade	,94	24	,13
	2nd grade	,94	24	,17
	3rd grade	,97	24	,66
	4th grade	,95	24	,33
Daily computer usage time	Less than 2 hours	,95	22	,26
	2-4 hours	,97	34	,55
	4-6 hours	,93	21	,15
	More than 6 hours	,96	19	,60

When the Shapiro Wilk test results in Table 1 are examined, it is seen that the significance level of the Computational Thinking Scale scores is greater than $p > .05$ according to the variables of class level and daily computer usage time of the study group. The p values obtained show that the scale scores show a normal distribution according to the variables of grade level and daily computer use time. Parametric tests were used in the analysis of the data obtained from the Computing Thinking Scale as a result of the normal distribution of the data obtained from the scale in terms of all variables. After the data showed normal distribution, One-Way ANOVA was applied to the data in order to determine whether there was a statistically significant difference between the scale mean scores of the students according to the grade level. The obtained results are given in Table 6.

Table 6. ANOVA results of Computing Thinking Scale scores according to grade level variable

Variable		Sum of Sq	df	Mean Sq	F	p
Grade level	Between groups	3860,12	3	1286,71	196,90	,00*
	Within groups	601,22	92	6,54		
	Total	4461,33	95			

*p < .05

When Table 6 showing the results of the ANOVA test according to the grade level variable of the scale scores is examined, it is seen that there is a statistically significant difference between the grade levels of the students and their computational thinking scores [$F_{(3, 92)}$= 196.90, $p < .05$] . Post-hoc test was needed in order to find out from which grade level or levels this statistical difference between grade levels originates. At this point, the Bonferroni Test was preferred because it is a multiple comparison test that does not require the principle of equal sample size (Miller, 1969). The Bonferroni Test results regarding the multiple comparison of scores are given in Table 7.

Table 7. Multiple comparison test results according to grade level variable

(I) group	(J) group	Mean difference (I-J)	Std error	p	95% Confidence interval Lower bound	Upper bound
1st grade	2nd grade	-5,26	,72	,00*	-7,21	-3,31
	3rd grade	-6,42	,75	,00*	-8,45	-4,38
	4th grade	-17,42	,74	,00*	-19,41	-15,43
2nd grade	1st grade	5,26	,72	,00*	3,31	7,21
	3rd grade	-1,15	,74	,74*	-3,15	,84
	4th grade	-12,15	,72	,00*	-14,11	-10,20
3rd grade	1st grade	6,42	,75	,00*	4,38	8,45
	2nd grade	1,15	,74	,74*	-,84	3,15
	4th grade	-11,00	,75	,00*	-13,03	-8,97

4th grade	1st grade	17,42	,74	,00*	15,43	19,41
	2nd grade	12,15	,72	,00*	10,20	14,11
	3rd grade	11,00	,75	,00*	8,97	13,03

*p < .05

The results of the Bonferroni Test, which was used to investigate the source of the significant difference between the grade levels of the students and the Computational Thinking Scale point averages, are given in Table 7. When the table is examined, it is seen that there is a significant difference between the mean scores of the 1st grades and the mean scores of the 2nd, 3rd and 4th grades in favor of the 2nd, 3rd and 4th grades (p < .05). There was no significant difference between the mean scores of the 2nd graders and the mean scores of the 3rd graders (p > .05). Again, looking at the data in the table, a significant difference was found between all grade levels and 4th graders in favor of 4th graders (p < .05).

In the study, it was also aimed to examine whether the Computational Thinking Scale scores of the students differ according to the daily computer use time. One-Way ANOVA was applied to the data in order to determine whether there is a statistically significant difference between the scale mean scores according to the daily computer usage time variable of the students. The obtained results are given in Table 8.

Table 8. ANOVA results of Computing Thinking Scale scores according to daily computer use time variable

Variable		Sum of Sq	df	Mean Sq	F	p
Daily computer usage time	Between groups	1353,19	3	451,07	68,24	,00*
	Within groups	608,14	92	6,61		
	Total	1961,33	95			

*p < .05

The ANOVA test results according to the daily computer use time variable of the Computing Thinking Scale scores are given in Table 8. A statistically significant difference was found between the time spent in front of the computer during the day and the computational thinking scores of the students in the study group [$F_{(3, 92)}$= 68.24, p < .05]. The Bonferroni Test was applied to the data in order to determine between which hour intervals the significant difference found in the daily computer usage time of the students was. The results of the multiple comparison of the scores are given in Table 9.

Table 9. Multiple comparison test results according to daily computer usage time variable

(I) group	(J) group	Mean difference (I-J)	Std error	p	95% Confidence interval Lower bound	Upper bound
Less than 2 hours	2-4 hours	-4,71	,70	,00*	-6,61	-2,81
	4-6 hours	-7,66	,78	,00*	-9,77	-5,54
	More than 6 hours	-10,97	,81	,00*	-13,14	-8,80
2-4 saat	Less than 2 hours	4,71	,70	,00*	2,81	6,61
	4-6 hours	-2,95	,71	,00*	-4,87	-1,02
	More than 6 hours	-6,26	,74	,00*	-8,25	-4,27
4-6 saat	Less than 2 hours	7,66	,78	,00*	5,54	9,77
	2-4 hours	2,95	,71	,00*	1,02	4,87
	More than 6 hours	-3,31	,81	,00*	-5,51	-1,12
Morethan 6 hours	Less than 2 hours	10,97	,81	,00*	8,80	13,14
	2-4 hours	6,26	,74	,00*	4,27	8,25
	4-6 hours	3,31	,81	,00*	1,12	5,51

*p < .05

When the data in Table 9 were examined, it was observed that there were significant differences in daily computer usage times between all time zones (p < .05). Computational thinking mean scores of students who spend less than 2 hours a day at the computer and 2-4 hours, 4-6 hours and more than 6 hours in front of the computer show a significant difference in favor of increasing the time spent in front of the computer (p < .05). Again, there is a significant difference between the mean scores of the students who spend 2-4 hours in front of the computer and those who spend less than 2 hours in front of the computer in favor of the students who spend 2-4 hours in front of the computer (p < .05). The mean scores of students who spend 2-4 hours on the computer and those who spend 4-6 hours or more than 6 hours a day differ in favor of students who spend 2-4 hours (p < .05). Similarly, the average score of the students who spent 4-6 hours on the computer and the averages of the students who spent more than 6 hours in front of the computer differ in favor of the students who spent more than 6 hours (p < .05). Finally, there is a significant difference between the mean scores of the students who spend more than 6 hours a day at the computer and the mean scores of the students who spend less than 2 hours, 2-4 hours and 4-6 hours in favor of the students who spend more than 6 hours on the computer (p < .05).

DISCUSSION AND CONCLUSION

With this research, it was primarily aimed to develop a valid and reliable Computational Thinking Scale for primary school students. When the measurement tools developed in our country on the subject are examined; it is seen that there is a computational thinking skills scale for university students (Korkmaz, Cakir, & Ozden, 2017). In addition, there are computational thinking skills test (Ozmen, 2016), computational thinking skills measurement tool (Yildiz, 2021) and self-efficacy perception scale for computational thinking skills (Gulbahar, Kert, & Kalelioglu, 2019) for secondary school students in the literature. However, as it was emphasized before, no measurement tool aimed at revealing the computational thinking levels of primary school students was found. However, it is stated by the researchers that there are problems in the acquisition of computational thinking skills by the students since there is no measurement tool to evaluate computational thinking skills. Therefore, it is emphasized that evaluation tools that can measure computational thinking skills should be developed without losing much time (Werner et al. 2012). In this context, a valid and reliable measurement tool for primary school students has been brought to the literature with this study.

The developed Computational Thinking Scale was then applied to primary school students and it was investigated whether students' computational thinking levels differ according to the grade level variable. As a result of the analyzes made, it was found that the computational thinking levels of the students differed according to the grade level variable. In general, it was found that as the grade level increased, the computational thinking levels of the students also increased. When the literature on the subject was examined, few studies were found that investigated the computational thinking level of learners, especially in terms of different variables. It has been seen that the results of the limited number of studies also support the result obtained from this study. Examining the computational thinking skills of secondary school students in terms of various demographic characteristics, Korucu et al. (2017), as a result of their studies, found that there is a difference between the students' computational thinking levels in terms of the grade level variable. The researchers stated that the computational thinking skill levels of the participants differed significantly according to their grade levels. Again, Seiter and Foreman (2013) aimed to determine the differences between the computational thinking skills of students of different ages in their studies and stated that it is necessary to create a research-based and age-appropriate curriculum for primary school students as a result of the study. In another study, Catana Kuleli (2018) examined the computational thinking skills of pre-service teachers according to grade level and found that there was a significant difference between the 4th grade and 1st grade pre-service teachers in favor of the 4th grade level. Contrary to the result obtained from this study, Korkmaz et al. (2015) concluded in their study that while the increase in the grade level is expected to increase along with the computational thinking skills, this skill gradually decreases with the increase in the grade level. As a result of the study, it was revealed that the level of computational thinking of individuals who are active in business life is high.

In the study, it was also aimed to examine whether the students' computational thinking levels differ according to the daily computer use time. The findings revealed that the mean score of the scale differed depending on the daily computer usage time. As students' daily computer use time increases, their computational thinking mean scores also increase. In the literature on the subject, it has been seen that there are a very limited number of studies investigating the effect of daily computer use time on computational thinking. The results obtained from these studies show parallelism with the results of this study. For example, Saritepeci (2017) found that participants with easy computer access had higher computational thinking scores than those without computer access. Again, in the research conducted by Yildiz Durak and Saritepeci (2018), it was found that computational thinking skills were predicted by the variables of information technology use experience and daily internet use time. In another study conducted by Qualls and Sherrell (2010), it was suggested that computational thinking is a problem-solving approach that consolidates logical skills with computer concepts. According to the researchers, computational thinking should be included in primary and secondary education programs, and pre-service teachers who will teach in these fields should be familiarized with computational thinking skills. Contrary to the results obtained from this study, Korucu et al. (2017) suggested in their study that there was no significant difference in computational thinking skills in terms of the variables of weekly internet usage time and mobile device usage abilities, however, their computational thinking skills differed in terms of having mobile technology. In another study conducted by Oluk and Korkmaz (2016), it was revealed that there was no significant difference in the level of computational thinking skills of the students according to the variables of computer usage time, but there was a significant relationship between the students' Scratch programming skills and their computational thinking skills.

Recent reports published in Europe reveal that children should be familiar with computer science concepts from the beginning of their education and gain computational thinking skills (Ozbey & Kucukoglu, 2018). For this reason, computational thinking skills should be taught to students from the earliest ages possible (Wing, 2006). In other studies, to be conducted on the subject, activities that will enable young age groups to acquire computational thinking skills can be developed. Again, it can be examined whether computational thinking skills vary in terms of different variables that were not studied in this study.

Limitations

This study has several limitations that should be addressed. First of all, only primary school students constitute the participant group of this study. Secondly, it is focused only on students' computational thinking levels according to different variables, and in this respect, it is quite difficult to reveal the causal relationships between the relationships. Finally, the data collection tool of the study is only the computational thinking scale.

DECLARATION

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Computational Thinking Scale Final Form: The final version of the developed scale in Turkish is presented in APPENDIX-1.

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APPENDIX-1: Computational Thinking Scale Final Form

BİLGİ İŞLEMSEL DÜŞÜNME ÖLÇEĞİ			
İfadeler	**Katılıyorum**	**Fikrim Yok**	**Katılmıyorum**
1. Bir problemle karşılaştığımda çözüm yolunu bilgisayarda ararım.			
2. Problem çözerken arkadaşlarımla görev paylaşımı yapamam.			
3. Problemi her zaman doğru tanımlarım.			
4. Çözüm için yapılması gerekenleri listelerim.			
5. Çözüm için gerekli adımları takip edemem.			
6. Benzer problemleri çözerken aynı çözüm yolunu denerim.			
7. Çözüm yolları içerisinden en pratik olanı seçerim.			
8. Problem çözerken tüm çözüm yollarını gözden geçiremem.			
9. Hafta sonu ödevlerimi günlere bölerim.			
10. Ödevlerimi bilgisayarda yazmakta zorlanırım.			
11. Problemin çözümü için uygun adımları oluştururum.			
12. Problemi çözdükten sonra sağlamasını yapamam.			
13. Dört işlemi hesap makinesinde yapmayı tercih ederim.			
14. Problem çözerken en uygun çözüm yolunu bulamam.			
15. Problem çözme basamaklarındaki hataları tespit ederim.			
16. Problemin hepsini tek seferde değil parça parça çözerim.			
17. Problem içerisinde verilenleri ve istenenleri bulurum.			