A Study of the Relationship between Secondary School Students' Computational Thinking Skills and Creative Problem-Solving Skills

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This research is based upon the master thesis titled "The Relationship between Secondary School Students Computational Thinking Skills and Creative Problem Solving Skills" which is authored by Muhammed PAF and supervised by Dr. Beste DİNÇER.

ABSTRACT
The primary goal of this research is to investigate the relation between computational thinking skills and creative problem-solving skills in secondary school students over the 2018-2019 academic year (5th, 6th, 7th, and 8th grades). The study's sample size is made up of 1098 secondary school pupils. The T-test, one-way ANOVA, and multiple linear regression analysis were used. As can be observed from the research findings, the students' numerical thinking abilities and creative problem-solving skills average scores were strong in terms of total scores and sub-dimensions. According to the results, the mean scores of students' numerical thinking skills and creative problem-solving skills differed considerably in favour of girls. As the pupils' grade level progressed, statistically significant disparities in their computational thinking abilities scores appeared. Another major conclusion from the study is that there is a substantial link between students' thinking skills, creative problem-solving skills, and their capacity to keep up with technological advances. Furthermore, a somewhat favourable and substantial connection between students' computational thinking skills and creative problem-solving skills was discovered. Due to the findings of multiple linear regression analysis, sub-dimensions of creative problem-solving skills highly predicted computational thinking skills.
Keywords: creative problem-solving computational thinking; 21st century skills

INTRODUCTION
Scientific, social, economic, and technical advancements in various sectors appear to be changing the individual traits required and the abilities that must be held correspondingly in the twenty-first century. It may be argued that, particularly in the 2000s, when information technology evolved fast, an education strategy based on knowledge transfer was insufficient for individual growth. Many different styles of thinking arise as a child's brain grows and new life experiences are gained (Relkin, 2018). Modern times require individuals with high-level skills instead of individuals who memorize the information transmitted to them (Saracaloğlu, Yenice & Karasakaloğlu, 2009).

It is an indisputable reality that information technologies have a direct influence on individual behavior and modify our requirements in many aspects of our life. These innovations have an influence on education systems, and many talents that people should acquire must be adjusted. As a result, persons in the twenty-first century can think creatively and critically, generate unique answers to issues they meet, and adapt these solutions to new contexts. Individual and social requirements change because of the great advancement of information technology, making it critical for individuals to acquire certain abilities, referred to as 21st century skills.

According to Pakman (2018), 21st century talents include computational and creative thinking, as well as algorithmic thinking. Kuleli (2018) noted that in the twenty-first century, students and instructors must be technologically literate, problem solvers, researchers, and collaborators. Individuals entering the corporate world nowadays are expected to have certain abilities such as digital literacy, entrepreneurship, creativity, problem solving, and critical thinking (Kölemen, 2017). As Tanrıöğen and Sarpkaya (2011: 5) mentioned in their book, the major approach to build the targeted society and lifestyle in the twenty-first century, which is defined as the era of science, technology, and innovation, is via education through qualified manpower. Individuals that can think and regulate their cognitive processes are considered to adapt better to this altering environment (Dinçer, 2009). Individuals who create information, find proper information, and use information efficiently are needed in this setting.

In the report published by OECD (2018), it is stated that certain jobs will be replaced by new occupational categories during the next ten years. According to recent studies, many occupational groups that exist today will not exist in the future, and other occupational groups will arise. Many occupational categories that exist today will not exist in the future, according to current research, and other occupational groups will arise. Therefore, along with fundamental qualities such as algorithmic thinking skill, inovative thinking skill, logical cause, and effect relationship, and being a productive individual, being able to develop individuals with 21st century abilities should be our major aims.

Furthermore, the primary goal of education has been to raise individuals who can create, criticize, determine, question, and solve issues, and in recent years, the importance of teaching methods for higher order thinking abilities has grown. As a result, it is recognized in educational institutions that it is critical for students to prepare for new situations that may develop and to gain the necessary skills. As a result, when newly updated curriculum is evaluated, it is stressed that the content of all courses is designed to create persons with high level thinking skills. In this perspective, it is an important issue how these important skills that are emphasized in the revised curriculum have an impact on students.

More than in previous years, the Ministry of National Education (MNE) made a major and dramatic modification in the programs in 2005. It was discovered in the Ministry of National Education's revised curriculum that fostering computational thinking of students was one of the objectives of computer science (MNE, 2018a) and information technologies and software classes (MNE, 2018b). In this context, it can be said that computational thinking and creative problem solving are among the skills that individuals should have. Wing (2016) states computational thinking as a key skill for children in the 21st century. Therefore, computational thinking skills should be among the basic skills that students should have in the 21st century (ISTE, 2016; Yıldız, Çiftçi & Karal, 2017).

Being able to think in a computational way in daily life helps to learn the basic structure of the emerging problems and to perceive the repeated mistakes better. In addition, computational thinking skills can be taught with skills such as social interaction, communication, and working as a team. Problem solving and computational thinking are related skills and can be transferred to other numerical fields such as mathematics (Çiftçi, Çengel & Paf, 2018). As a result of this disclosed information, computational thinking has been an important skill to be examined in recent years. It is stressed in the literature that there is a continuous link between computational thinking, creative thinking, and problem solving, all of which are referred to be 21st century abilities. Individuals with creative thinking talents are also excellent problem solvers, according to this statement. Studies on 21st century abilities stress the need of developing students' creativity and innovative skills (Fox, 2011).

In the light of this information, computational thinking and creative thinking have become key skills of the 21st century. When the individuals, having creative thinking skills, encounter a problem in their daily lives, they can produce fast and creative solutions to this problem. For this reason, it is expressed as a requirement that students acquire higher order thinking skills since a young age.
In this context, answers to the following sub-problems were sought in the study:

(1) What level is the computational thinking skills of secondary school students participating in the research?
(2) Is there a substantial difference in computational thinking skills among secondary school pupils based on gender, class, or the degree to which they are following technology developments?
(3) What level is the creative problem-solving skills of secondary school students?
(4) Do creative problem-solving skills of secondary school students show a significant difference according to gender/class, the state of following the technological developments?
(5) Is there a correlation between creative problem-solving talents and computational thinking skills in secondary school students?
(6) Do sub-dimensions of creative problem-solving skills predict computational thinking skills in a meaningful way?

METHOD

RESEARCH DESIGN

The goal of this study was to examine the relation between computational thinking skills and creative problem-solving skills in secondary school pupils. This goal was achieved using a relational (correlational) model within the scope of the investigation.

POPULATION AND SAMPLE

The population of the study comprises of secondary students studying in the Germencik district of Aydn province during the 2018-2019 academic year. According to the theoretical sample size table in determining the number of samples, the research universe consisting of 2000 people should have 322 with levels of α = .05 significance and 5% tolerance; It is stated that it can represent 1661 people at the level of α = .01 significance and 1% tolerance (Can, 2014: 28). Accordingly, the number of samples in this study represents 49% of the universe. While selecting the sample, two classes (A-B) were taken from each school as a cluster to increase the possibility of the study population to represent the sample group and a single-stage cluster sample was made. In single-stage cluster sampling, the main population (schools) is first divided into clusters, and the desired number of clusters (classes) are drawn randomly from these clusters (İslamoğlu & Alnıaçık, 2016). Since the number of classes and students in each school is not equal, two classes from all schools were included in the sample except two village schools. In this way, the study's sample group consists of 1098 secondary school students chosen by proportionate cluster sampling from the Germencik district of Aydın province during the 2018 – 2019 academic year.

On analysis of the distribution of high school pupils volunteering in the study, 570 of them girls (51.9%), 528 of them were boys (48.1 %). 269 of the children in the research were in the fifth grade (24.5 percent), 282 in the sixth grade (27.5 percent), 348 in the seventh grade (31.7 percent), and 199 in the eighth grade (18.1%) as it was presented in Table 1.

Table 1. Demographic Features of the Students

Variable	Group	N	%
Gender	Male	528	48.1
	Female	570	51.9
Class level	5 th Class	269	24.5
	6 th Class	282	25.7
	7 th Class	348	31.7
	8 th Class	199	18.1
Status of Following Technological Developments	Yes	697	63.5
	No	381	34.7
	Unknown	20	1.8
	Total	**1098**	**100**

DATA COLLECTION TOOLS

The Computational Thinking Skills Scale (for Secondary School Students) developed by Korkmaz, Çakır and Özden, (2015) as well as the "Creative Problem-Solving Features Inventory" adapted to Turkish by Baran-Bulut, İpek, and Aygün (2018) were used to collect the data.

COMPUTATIONAL THINKING SKILLS SCALE

The scale, designed by Korkmaz, Çakır, and Özden (2015), and tested on secondary school students has a total of 22 items. Original scale developed in accordance with the university level, Korkmaz et al. (2015), validity and reliability at secondary school level were also examined.

In addition, because of confirmatory factor analysis, it was stated that the observed values of the scale model differed between .51 and .87 and showed an acceptable level of agreement. The validity and reliability of the scale were tested again with the data obtained within the scope of the research. As a result of the confirmatory factor analysis, it was observed that the standardized regression loads received different values between .52 and .73.

In accordance with the confirmatory factor analysis, fit indices were examined, and the values were determined as GFI = .995, AGFI = .947, CFI = .939, IFI = .939, NNFI = .927, RMSEA = .038, SRMR = .055. The model formed in this direction has been found to provide excellent fit indices. The Cronbach Alpha reliability coefficients calculated for the scale and its sub-dimensions are in the sub-dimension of "Creativity".62, in the sub-dimension of "Algorithmic Thinking".71, in the sub-dimension of "Cooperation".73, and "Critical

Thinking".69, "Problem Solving" sub-dimension.75, and across the scale.83. Accordingly, when the value related to the scale is examined, it is seen that the measurement tool has high reliability.

CREATIVE PROBLEM-SOLVING INVENTORY

The Creative Problem-Solving Inventory, designed by Lin (2010) and converted to Turkish by Baran-Bulut, İpek, and Aygün (2018), has 40 items and five variables. The inventory has dimensions for convergent and divergent thinking, motivation, environment, general knowledge, and skills. As a result of the analysis, it is claimed that the 40-item inventory translated to Turkish meets the goal. The scale's validity and reliability were once again assessed using data collected as part of the study. Confirmatory factor analysis showed that standardized regression loads received different values between .31 and .76. In accordance with the confirmatory factor analysis, the fit indices were examined, and the values were determined as GFI = .891, AGFI = .878, CFI = .888, IFI = .888, NNFI = .876, RMSEA = .045, SRMR = .071.

The model formed in this way has been found to have acceptable fit indices. The Cronbach Alpha reliability coefficients calculated for the scale and its sub-dimensions are as follows: "Divergent Thinking".80, "Convergent Thinking".76, "Motivation".74, "Environment" sub-dimension.87, "General Knowledge and Skills" sub-dimension.76, "for the whole scale was .93. In this direction, when the value related to the scale was analysed, it was seen that the measurement tool has a very high reliability.

DATA ANALYSIS

A statistical package application was used to analyze the research data. When interpreting the data, $p<.05$ significance level was taken as the basic criterion. More than one parameter was taken as a basis for the examination of the normal distribution of data.

In the examination of the test result, the degree of closeness of the average, mode and median values of the data; skewness and kurtosis coefficients, normal distribution (histogram), Normal Q-Q graphs were examined, and it was concluded that the data showed normal distribution. If it is examined in more detail; the average, mode and median values of the data were found to be very close to each other. Since this is a feature stated in the normality assumptions (Leech, Berrett & Morgan, 2005), it was accepted among the normality parameters within the scope of this research. Altman and Bland (1995) argued that when the sample is above certain limits, the assumption of normality can be neglected and when the size of the sample within the scope of this study is analyzed (N = 1098), it is seen that this assumption is sufficient to be fulfilled. In addition, according to George and Mallery (2019: 211) and Hair, Black, Babin and Anderson (2014: 39), it is acceptable for the normality assumption to be within the ± 1 range of skewness and kurtosis values. The scale's skewness and kurtosis values of the mean scores for the computational thinking skills scale -.276 to -.523; for creative problem-solving skills inventory -.142 to -.524. In this context, it was seen that the data were in the range of ± 1. and the skewness and kurtosis coefficients, which were accepted as the biggest indicator for normality assumption, were accepted as another important parameter. In addition to this situation, normal distribution graph (histogram) and Normal Q-Q graph were examined, and the data was found to have a distribution that is acceptable as near to normal.

Considering the meeting status of the normal distribution assumptions described above and the size of the sample number (N = 1098), it was accepted that the data used in this study showed a normal distribution. As a result, parametric statistical approaches were used for data processing activities. The sample t-test, ANOVA, and Pearson correlation test were used to analyse the data in this way. Five-point Likert-type grading intervals were used to evaluate students' computational thinking and creative problem-solving abilities. As a result, the ranges 1.00 - 1.79 are considered "very low," 1.80 - 2.59 are considered "low," 2.60 - 3.39 are considered "mid," 3.40 - 4.19 are considered "high," and 4.20 - 5.00 are considered "extremely high."

FINDINGS

Table 2 displays descriptive data connected to the students' computational thinking ability levels in relation to the research's first sub-problem.

Table 2. Descriptive Statistics of Average Scores of Students' Computational Thinking Skill Levels and Sub-dimensions

Sub-Dimensions	N	$\bar{X}$	SS
Creativity	1098	4.07	.72
Algoritmic thinking	1098	3.70	.81
Collaboration	1098	4.08	.87
Critical thinking	1098	3.67	.87

Problem solvin	1098	3.53	.95
Computational Thinking(total)	1098	3.78	.58

Table 2 shows that the average scores of the students' computational thinking ability levels are typically high (X‾ = 3.78). Furthermore, when the scores on the computational thinking abilities sub-dimensions were investigated, it was discovered that the greatest score was in the cooperation dimension (X‾= 4.08), and the lowest score was in the problem-solving dimension (X‾=3.53).

THE DIFFERENCE IN COMPUTATIONAL THINKING SKILL LEVELS AMONG SECONDARY SCHOOL STUDENTS BASED ON GENDER VARIABLE

In accordance with the first variable of the second sub-problem of the research, a t-test for unrelated samples from parametric tests was performed to evaluate whether the computational thinking skills of secondary school pupils varied significantly by gender. Table 3 contains information on the test findings obtained in this context.

Table 3. The t-Test Results Related to the Differentiation Status of the Students' Computational Thinking Skill Levels and Sub-Dimensions According to the Gender Variable

Sub-Dimensions	Gender	N	$\bar{X}$	SS	t	Sd	P
Creativity	Female	570	4.18	.63	-5.32	1096	.000*
	Male	528	3.95	.79			
Algoritmic Thinking	Female	570	3.74	.76	-1.80	1096	.073
	Male	528	3.65	.85			
Colloberation	Female	570	4.22	.80	-5.74	1096	.000*
	Male	528	3.92	.92			
Critical thinking	Male	570	3.73	.87	-2.37	1096	.018*
	Female	528	3.60	.86			
Problem Solving	Male	570	3.68	.95	-5.39	1096	.000*
	Female	528	3.37	.94			
Computational Thinking in General	Male	570	3.89	.56	-6.31	1096	.000*
	Female	528	3.67	.59			

***p<.05**

When the test results given in Table 3 were examined, that the average computational thinking scores of female students (X‾= 3.89) were significantly higher than those of male students (X‾= 3.67) was found. There was a significant difference in favour of girls (t (1096) = -6.31, p<.05). In this case, it can be stated that the gender variable has a significant effect on students' computational thinking skills generally.

Apart from the average scores of algorithmic thinking (*t* (1096) =1.80, *p*>.05) sub-dimension; creativity ($t_{(1096)}$ = -5.32, *p*<.05), collaboration (*t* (1096) = -5.74, p<.05), critical thinking ($t_{(1096)}$ = -2.37 It is observed that, *p*<.05) and problem solving (*t* (1096) = -5.39, p<.05) sub-dimensions made a significant difference in favor of girls.

DIFFERENTIATION OF SECONDARY SCHOOL STUDENTS' COMPUTATIONAL THINKING SKILL LEVELS BASED ON CLASS VARIABLE

In accordance with the second variable of the second sub-problem of the research, one-way analysis of variance, which is one of the parametric tests, was done to evaluate if the computational thinking skills of secondary school pupils varied significantly by class. Information on the test findings obtained in this context was presented in Table 4.

Table 4. ANOVA Results Regarding Differentiation of Average Scores of Students' Computational Thinking Skill Levels and Sub-Dimensions by Class Variable

Sub-Dimensions	**Groups**	**Sum of Squares**	**df**	**Mean Squares**	**F**	***p***	**Difference**
Creativity	Between Groups	3.088	3	1.029	1.984	.115	
	Within Groups	567.559	1094	.519			
	Total	570.647	1097				
Algoritmic Thinking	Between Groups	.521	3	.174	.265	.850	
	Within Groups	715.773	1094	.654			
	Total	716.294	1097				
Colloberation	Between Groups	10.682	3	3.561	4.732	.003	5-7* 5-8*
	Within Groups	823.169	1094	.752			
	Total	833.851	1097				
Critical thinking	Between Groups	1.114	3	.371	.495	.686	
	Within Groups	820.657	1094	.750			
	Total	821.771	1097				
Problem Solving	Between Groups	30.705	3	10.235	11.569	.000	5-6* 5-7* 5-8*
	Within Groups	967.828	1094	.885			
	Total	998.534	1097				
Computational Thinking in General	Between Groups	6.571	3	2.190	6.568	.000	5-7* 5-8*
	Within Groups	364.856	1094	.334			
	Total	371.426	1097				

p< .05

As it was shown in table 4, the average scores of the secondary school students studying at different 4 grade levels regarding their computational thinking skills were compared with the One-way variance analysis for unrelated samples according to the class variable (5^{th}, 6^{th}, 7^{th} and 8^{th} grades). The results showed that the averages of students in 5 th grade is as (x̄ $\boldsymbol{\bar{X}}$= 3.66), averages of students in 6^{th} grade is (x̄ $\boldsymbol{\bar{X}}$= 3.77), averages of students in 7^{th} grade (x̄ $\boldsymbol{\bar{X}}$= 3.85) and averages of students in 8^{th} grade have (x̄ $\boldsymbol{\bar{X}}$= 3.86) statistically significant differences between at least two ($F_{(3\text{-}1094)}$ = 6.56, *p*<.05). The effect size (η 2 = .02) calculated that this difference is low. As a result of the Tukey multiple comparison test, it was observed that the difference was between the 5^{th} and 7^{th} grade students and the 5^{th} and 8^{th} grade students, and the differentiation was in favour of the 7^{th} and 8^{th} grades, respectively.

When the analysis results given in Table 4 were examined, creativity ($F_{(3\text{-}1094)}$= 1.99, p>.05), algorithmic thinking ($F_{(3\text{-}1094)}$= .27, p>.05) and critical thinking mean scores ($F_{(3\text{-}1094)}$= .50, p >.05) subscales did not make a significant difference according to the class variable; collaboration ($F_{(3\text{-}1094)}$= 4.73. p< .05) and problem solving ($F_{(3\text{-}1094)}$= 11.57, p< .05) it was found that there was a significant difference. As a result of the Tukey multiple comparison test, the problem solving sub-dimension between the 5^{th} grades (x̄= 3.96) and 7^{th} (x̄= 4.17) and 8^{th} grades (x̄= 4.18) in the collaboration sub-dimension of the significant difference It was observed that it was between 5^{th} grade (x̄= 3.26) and 6 th (x̄= 3.53), 7^{th} (x̄ = 3.66) and 8^{th} grades (x̄= 3.68). When the average scores were analysed in this direction, it was seen that the differentiation occurred in favour of the upper classes.

DIFFERENTIATION OF SECONDARY SCHOOL STUDENTS' COMPUTATIONAL THINKING SKILL LEVELS BASED ON THE VARIABLE TO FOLLOW THE TECHNOLOGICAL DEVELOPMENTS

In accordance with the third variable of the second sub-problem of the research, a t-test was performed for unrelated samples from parametric tests to determine whether the computational thinking skills of secondary school students differ significantly depending on the state of the following technological developments. Data related to the test results carried out in this context are given in Table 5.

Table 5. T-Test Results Related to the Differentiation of the Average Scores of the Computational Thinking Skill Levels and Sub-Dimensions of the Students According to the Status of Following Technological Developments

Sub-Dimensions	Groups	N	$\bar{X}$	SS	T	sd	p
Creativity	Yes No	697 381	4.12 3.96	.68 .78	3.56	1076	.000*
Algoritmic Thinking	Yes No	697 381	3.76 3.58	.80 .81	3.55	1076	.000*
Colloberation	Yes No	697 381	4.12 3.97	.84 .92	2.62	1076	.009*
Critical thinking	Yes No	697 381	3.73 3.56	.89 .80	2.98	1076	.003*
Problem Solving	Yes No	697 381	3.57 3.46	.97 .92	1.75	1076	.080
Computational Thinking in General	Yes No	697 381	3.83 3.68	.57 .59	4.02	1076	.000*

***p<.05**

As it is shown in table 5, according to the state of following the technological developments, significant differences were observed in all dimensions apart from problem solving sub-dimension of students' computational thinking skills scores. A significant difference was observed in favour of the students who stated that they followed the technological developments between the mean scores of students who indicated ($\bar{x}$ = 3.68) ($t_{(1076)}$ =4.02, p<.05) in general. In this case, it can be said that the state of following technological developments had a significant effect on students' computational thinking skills.

Additionally, the average scores of problem solving ($t_{(1076)}$ = 1.75, p>.05) sub-dimension did not make a significant difference according to the state of following the technological developments; but creativity ($t_{(1076)}$ =3.56, p<.05) algorithmic thinking ($t_{(1076)}$ = 3.55, p<.05), collaboration (t (1076) = 2.62, p<.05) and critical thinking ($t_{(1076)}$ = 2.98, p<.05) sub-dimensions created significant differences in favour of students who state that they follow technological developments.

FINDINGS ON SECONDARY SCHOOL STUDENTS' CREATIVE PROBLEM-SOLVING SKILL LEVELS

In line with the third sub-problem of the research, descriptive statistics about students' creative problem-solving skill levels are given in Table 6.

Table 6. Descriptive Statistics of Students' Creative Problem-Solving Skill Levels

Sub-Dimensions	N	$\bar{X}$	SS
Divergent Thinking	1098	3.70	.78
Convergent Thinking	1098	3.86	.72

Motivation	1098	3.75	.81
Environment	1098	3.98	.78
General knowledge and Skills	1098	3.56	.86
Creative problem solving Skill in General	1098	3.81	.62

In Table 6, it was shown that the average scores of the students regarding their creative problem-solving skill levels were high ($\bar{x}$= 3.81). In this context, it could be stated that students' creative problem-solving skill levels were at high level ($\bar{x}$= 3.81). In addition, when the average scores of the creative problem-solving skills, sub-dimensions were examined, it was seen that the highest average score was in the environment ($\bar{x}$= 3.98), and the lowest average score was in the general knowledge and skills ($\bar{x}$= 3.56) dimension.

GENDER DIFFERENCE IN SECONDARY SCHOOL STUDENTS' CREATIVE PROBLEM-SOLVING SKILL LEVELS

In accordance with the first variable of the fourth sub-problem of the research, a t-test was performed on unrelated samples from parametric tests to evaluate if there was a significant difference in creative problem-solving skills among secondary school students based on gender. Findings related to the test results in this context are given in Table 7.

Table 7. t-Test Results of Differentiation of Secondary School Students' Creative Problem-Solving Skill Levels by Gender

Sub-Dimensions	Gender	N	$\bar{X}$	SS	t	sd	*P*
Divergent Thinking	Female Male	570 528	3.72 3.69	.78 .77	-.55	1096	.585
Convergent Thinking	Female Male	570 528	3.93 3.80	.71 .73	-2.98	1096	.003*
Motivation	Female Male	570 528	3.79 3.70	.81 .82	-1.85	1096	.065
Environment	Female Male	570 528	4.09 3.86	.76 .77	-5.04	1096	.000*
General knowledge and Skills	Female Male	570 528	3.53 3.60	.84 .87	1.30	1096	.193
Creative Problem Solving Skill İn General	Female Male	570 528	3.86 3.75	.61 .63	-2.91	1096	.004*

***p< .05**

When the test results given in Table 7 were examined, a significant difference was observed between creative solving average scores of female students ($\bar{x}$ = 3.86) and those of male students ($\bar{x}$= 3.75) ($t_{(1096)} = -2.91$. $p < .05$) in favour of female students. Additionally, divergent thinking ($t_{(1096)} = -.55$, $p>.05$), motivation ($t_{(1096)} = -1.85$, $p>.05$) and general knowledge and skills ($t_{(1096)} = 1.30$, $p>.05$) sub-dimension did not make a significant difference according to gender; but convergent thinking ($t_{(1096)} = -2.98$, $p<.05$) and the environment ($t_{(1096)} = -5.04$, $p<.05$) sub-dimensions had significant differences in favour of girls. In this case, it can be stated that gender variable has some significant effects on students' creative problem-solving skills.

DIFFERENCE IN CREATIVE PROBLEM-SOLVING SKILL LEVELS AMONG SECONDARY SCHOOL STUDENTS BASED ON CLASS VARIABLE

In accordance with the second variable of the fourth sub-problem of the research, ANOVA, one of the parametric tests, was used to evaluate if the creative problem-solving skills of secondary school pupils varied significantly by class. Table 8 summarizes the findings linked to the test results in this context.

Table 8. ANOVA Results Regarding Differentiation of Average Scores of Students' Creative Problem-Solving Skills Levels and Sub-Dimensions by Class Variable

Sub-Dimensions	Groups	Sum of Squares	df	Mean Squares	F	*p*
Divergent Thinking	Between Groups	.655	3	.218	.363	.780
	Within Groups	658.568	1093	.602		
	Total	659.222	1097			
Convergent Thinking	Between Groups	.229	3	.076	.145	.933
	Within Groups	574.374	1094	.525		
	Total	574.602	1097			
Motivation	Between Groups	.919	3	.306	.462	.709
	Within Groups	725.039	1094	.663		
	Total	725.958	1097			
Environment	Between Groups	.516	3	.172	.285	.837
	Within Groups	661.306	1094	.604		
	Total	661.823	1097			
General Knowledge and Skills	Between Groups	3.059	3	1.020	1.394	.243
	Within Groups	800.386	1094	.732		
	Total	803.445	1097			
Creative Problem Solving Skill in General	Between Groups	.353	3	.118	.301	.825
	Within Groups	427.549	1094	.391		
	Total	427.902	1097			

When the analysis results given in Table 8 are examined, there were no statistically differences between divergent thinking ($F_{(3\text{-}1094)}$= .36, p>.05), convergent thinking ($F_{(3\text{-}1094)}$= .15. p>.05), motivation ($F_{(3\text{-}1094)}$= .46, p>.05), environment ($F_{(3\text{-}1094)}$= .29, p>.05) and general knowledge and skills ($F_{(3\text{-}1094)}$= 1.39, p >.05) of creative thinking scores and the class variable. It could be said that class level did not make significant effect on the students' creative problem-solving skills.

DIFFERENTIATION OF SECONDARY SCHOOL STUDENTS' CREATIVE PROBLEM-SOLVING SKILL LEVELS BASED ON TECHNOLOGICAL DEVELOPMENT STATUS

In accordance with the third variable of the fourth sub-problem of the research, a t-test was performed on unrelated samples from parametric tests to determine whether secondary school students' creative problem-solving skills make a significant difference based on the state of the following technological developments. Table 9 summarizes the findings relating to the test results obtained in this context.

Table 9. T-Test Results Regarding the Differentiation of the Average Scores of the Students' Creative Problem-Solving Skill Levels and Sub-Dimensions According to the Variable Follow-Up Technological Status Variable

Sub-Dimensions	Groups	N	$\bar{X}$	SS	t	sd	p
Divergent Thinking	Yes	697	3.81	.76	5.99	1076	.000*
	No	381	3.52	.77			
Convergent Thinking	Yes	697	3.92	.69	3.78	1076	.000*
	No	381	3.75	.77			

Motivation	Yes No	697 381	3.81 3.63	.81 .81	3.48	1076	.001*
Environment	Yes No	697 381	4.04 3.86	.77 .79	3.79	1076	.000*
General knowledge and Skills	Yes No	697 381	3.64 3.43	.84 .85	3.84	1076	.000*
Creative Problem Solving Skill in General	Yes No	697 381	3.88 3.67	.61 .63	5.39	1076	.000*

***p< .05**

When the test results given in Table 9 were examined, significant differences were found in all dimensions calculated as divergent thinking ($t_{(1076)}$ = 5.99, p<.05), convergent thinking ($t_{(1076)}$ = 3.78, p< .05), motivation ($t_{(1076)}$ = 3.48, p< .05), environment ($t_{(1076)}$ = 3.79, p< .05) and general knowledge and skills ($t_{(1076)}$ = 3.84, p<.05) of creative problem solving skills of the students according to following up technological developments. It could be said that significant differences were in favour of students who state that they follow technological developments in the sub-dimensions.

SECONDARY SCHOOL STUDENTS' COMPUTATIONAL THINKING SKILLS AND CREATIVE PROBLEM-SOLVING SKILLS: FINDINGS AND COMMENTS

In accordance with the fifth sub-problem of the research, Pearson moments multiplication correlation analysis was used to investigate the link between students' computational thinking skills and creative problem-solving skills and sub-dimensions. Table 10 presents the results of the correlation study.

Table 10. Pearson Moments Product Correlation Analysis Results Related to the Correlation between Students' Computational Thinking Skills and Creative Problem-Solving Skills

Sub-Dimensions		**Divergent T.**	**Convergent T.**	**Motivation**	**Environment**	**GKS**	**CPS**
Creativity	Correlation	.473**	.478**	.446**	.382**	.365**	**.537****
	p	.000	.000	.000	.000	.000	.000
	N	1098	1098	1098	1098	1098	1098
Algoritmic Thinking	Correlation	.488**	.462**	.465**	.378**	.493**	**.558****
	p	.000	.000	.000	.000	.000	.000
	N	1098	1098	1098	1098	1098	1098
Colloberation	Correlation	.326**	.382**	.323**	.351**	.239**	**.417****
	p	.000	.000	.000	.000	.000	.000
	N	1098	1098	1098	1098	1098	1098
Critical thinking	Correlation	.567**	.492**	.538**	.410**	.458**	**.611****
	p	.000	.000	.000	.000	.000	.000
	N	1098	1098	1098	1098	1098	1098
Problem Solving	Correlation	.184**	.206**	.174**	.133**	.174**	**.213****
	p	.000	.000	.000	.000	.000	.000
	N	1098	1098	1098	1098	1098	1098
Computational Thinking Skills in General	Correlation	.554**	.553**	.529**	.448**	.474**	**.636****
	p	.000	.000	.000	.000	.000	.000
	N	1098	1098	1098	1098	1098	1098

**** p<0.01** **GKS =** General Knowledge and Skills, **CPS =** Creative Problem Solving Skills in General

Table 10 evaluated the Pearson Moments Product Association Coefficient in evaluating the correlation between secondary school students' computational thinking skills and creative problem-solving skills, because the variables matched the requirements of normalcy. As a result, a somewhat positive and significant association (r

=.636, p.01) was discovered between students' computational thinking skills and creative problem-solving ability.

When the relationship between the computational thinking skills and the sub-dimensions of creative problem-solving skills were examined in line with the findings, it was found that there was a moderate positive and significant correlation with divergent thinking sub-dimension ($r = .554$, $p<.01$), convergent thinking sub-dimension ($r = .553$, $p<.01$), motivation sub-dimension ($r = .529$, $p<.01$), environment sub-dimension ($r = .448$, $p<.01$), and with the general knowledge and skills sub-dimension ($r = .474$, $p<.01$) and computational thinking skills.

In other words, as students' creative problem-solving skills increase, their computational thinking skills also have tendency to increase. Similarly, between critical thinking and divergent thinking sub-dimensions of the highest relationship among sub-dimensions; the lowest relationship was observed between problem solving and environmental sub-dimensions ($r=.133$, $p<.01$).

MULTIPLE LINEAR REGRESSION ANALYSIS RESULTS IN SUB-DIMENSIONS OF COMPUTATIONAL THINKING SKILLS AND CREATIVE PROBLEM-SOLVING SKILLS

Multiple linear regression analysis was used to see if computational thinking skill can be predicted based on creative problem-solving sub-dimensions. The problem of multiple coupling is the most difficult condition in multiple regression analysis. By examining the tolerance and VIF values, it was determined that there would be no multi collinearity problem (Leech, Barrett, & Morgan, 2005).

Table 11. Multiple Linear Regression Model Summary on predicting Computational Thinking Skill with sub-dimensions of creative problem-solving skills

Sub-Dimensions	B	Std. Error	β
Constant	1.536	.084	
Divergent Thinking	.159	.026	.211
Convergent Thinking	.157	.028	.195
Motivation	.089	.025	.125
Environment	.089	.021	.119
General knowledge and Skills	.102	.020	.150

**** p<0.01**

The sub-dimensions of creative problem solving skills substantially predicted computational thinking skills, according to the analysis results ($F(5\text{-}1092) = 155.209$, p 0.01). All sub-dimensions contribute considerably to the model's development as well. According to the beta values in Table 11, divergent thinking is the most important contributor to the model's creation, followed by convergent thinking, general knowledge and skills, motivation, and environment sub-dimensions, in that order. The R2 value that has been modified based on the analysis results is 0.413. This demonstrates that the model explains 41% of computational thinking skills.

DISCUSSION AND CONCLUSION

In the study, students' computational thinking and creative problem-solving abilities were explored in connection to several factors (gender, class level, and computer ownership), and whether there was a significant relationship between variables was investigated. The computational thinking ability levels of the students were disclosed within the framework of the first sub-problem of the investigation. The average scores of the students' computational thinking ability levels and sub-dimensions were high, according to the results.

The highest mean score was found as collaboration and the lowest mean score was problem solving. In their study, Korkmaz, Çakır and Özden (2015) reached the conclusion that students' computational thinking skills are quite high, and the lowest average in terms of sub-dimensions is in the problem-solving dimension. Similarly, Oluk (2017) concluded that students' computational thinking skill levels were high Korkmaz et al. (2015), in another study, individuals' perceptions of computational thinking skill levels were half high and half medium; it was stated that the highest average was collaboration, and the lowest averages were algorithmic thinking and problem solving. Çakır (2017) concluded that students' computational thinking skills were above average, and the highest average was collaboration, and the lowest average was problem solving. In this context, the fact that students' computational thinking skills are at a high level and that students are computational thinkers is an important finding for modern days of the 21st century.

According to the results obtained in line with the second sub-problem of the study, a meaningful difference was found in favour of girls between the average scores of female students' computational thinking skills and the average scores of male students. When the average scores of the sub-dimensions were examined, that the average scores of the female students were higher than male students and a significant difference was observed in favour of the girls in all sub-dimensions except for algorithmic thinking.

Sarıtepeci (2017) stated that the computational thinking skill levels of women were higher, but this situation did not create a significant difference. According to a similar result, Oluk (2017) stated that the average of female students is higher than that of boys. Some studies in the literature differ with the results achieved. Gonzalez et al. (2017) concluded that their scores on computational thinking skills were higher in favor of men. Kuleli (2018) also found that the gender variable did not make any difference on the computational thinking skills. Oluk and Korkmaz (2016) and Turan (2019) found that the gender variable did not make a difference in computational thinking skills in their studies.

As a consequence of the results obtained in the context of the class variable, it was discovered that as students' grade levels grew, so did their mean scores for computational thinking skills and sub-dimensions, with a substantial difference between classes. According to Gonzalez et al. (2016), as students' grade levels improved, so did their computational thinking skills. According to Korucu et al. (2017), kids' computational thinking skills fluctuate considerably across grade levels. Some research provides outcomes that differ from those found in the literature. Korkmaz et al. (2015) and Oluk (2017) state that there was a decrease in their computational thinking skills as their grade levels progress.

The outcomes regarding the condition of following the technological improvements show that mean scores of the computational reasoning skills differ in favor of the pupils who express that they follow the accomplished technological improvements. It can be said that the state of following technological developments in this direction has a significant effect on students' computational thinking skills. Çiftçi et al. (2018) stated that in their study, there was a negative relationship between following technological developments and self-efficacy regarding programming, and prospective teachers with high skills follow the developments in the field less. This study compared to the other students who follow technological developments in the computational thinking skills were found to be higher. In addition, it is striking that the results obtained in the studies with different sample groups differ in the literature. It is thought that accessing and using technology correctly is an expected result that will have a positive effect on students' computational thinking skills, but the differentiation situation in some studies may be due to the profile of the sample group.

According to the results obtained in accordance with the study's second sub-problem, there was a substantial difference in favor of females between the average scores of female students and the average scores of male students in terms of creative problem-solving ability. Unlike the research findings, Toraman (2017) found that male students are more likely than female students to achieve a creative solution. Unlike previous research, Zeytun (2010) revealed that teacher applicants' judgments of creativity and problem-solving skills are not gendered. In this study, the fact that female students' computational thinking and creative problem-solving skills were statistically higher than men reveals that gender variable is a significant factor. Accordingly, it can be thought that skills affect each other positively.

The third sub-problem of the research focused pupils' innovative problem-solving abilities. According to the findings, the average scores of the students for their creative problem-solving ability levels and sub-dimensions were high. A high degree of creative problem-solving ability among students was attained in this study, which was a desirable conclusion. In this setting, students' high levels of creative problem-solving abilities are crucial in terms of giving innovative solutions to challenges faced by pupils.

According to the class variable, students' creative problem-solving skills increased on average within the framework of general and sub-dimensions. In the context of the variable of following technology advancements, it was discovered that the average scores for creative problem-solving skills differ in favor of students who claim to follow technical advances. It was shown that students that adhere to technology advances in their creative problem-solving skills and sub-dimensions scored higher on average. In this respect, it is possible to assert that the status of the following technical advances has a substantial impact on research.

The link between students' computational thinking ability levels and creative problem-solving talents was investigated in the study's fifth sub-problem. There is various research in the literature that look at the relation between problem solving skills and computing skills (Sarıtepeci, 2017; Gonzalez et al., 2017). However, no skills have been discovered that explicitly investigates the link between computational thinking and creative problem-solving. A somewhat favourable and substantial link was discovered between students' computational thinking skills and creative problem-solving skills in this setting. In other words, as students' computational thinking skills improve, so do their creative problem-solving abilities. The discovery that the two variables have a positive influence on each other lends credence to the idea that computational thinking talent is fundamentally articulated as a problem-solving process (Kalelioğlu, Gülbahar, and Kukul, 2016).

SUGGESTIONS

As a consequence of the research, the following recommendations for practitioners and researchers could be made.

- According to the findings, as pupils' grade levels improved, so did their computational thinking skills. To assist this development, it is formally recommended that computational thinking abilities be included into the curriculum beginning with preschool.
- It has been observed that having a computer is effective on students' skills. Accordingly, it can be suggested to increase / improve the technological equipment of educational environments.
- It may be suggested that courses such as information technologies and software, computer science, where computational thinking skills are directly related, should be taught from an early age.
- This study was carried out with learners on the secondary school level. By broadening the area of the study, it may be proposed that studies be conducted at the elementary, secondary, and university levels.

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