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A Comparison of Creative Problem Solving Features of Gifted and Non-Gifted High School Students

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Abstract

Creativity and creative problem-solving are seen as the most important components of education today. This situation reveals the need to identify students' creative problem-solving characteristics. This study, it was aimed to examine the creative problem-solving characteristics of gifted and non-gifted students in terms of giftedness diagnosis, gender, and grade level variables. The research used the descriptive research model and causal comparison design, which are among the scanning models. The sample was collected in Bursa and consists of 73 gifted students, and 302 non-gifted students from grades 9th to 12th. "Creative Problem Solving Features Inventory" was used as a data collection tool in the research. It has been observed that the creative problem-solving skills of the gifted and non-gifted students differ in divergent thinking, general knowledge and skills, and the general average in favor of the gifted. There was a significant difference in favor of girls in the general average scores and the mean scores of the environment sub-dimension among gifted students. A significant difference was found in favor of the gifted in the dimension of divergent thinking at the 9th-grade level, and in the dimension of divergent thinking and general knowledge and skills at the 11th-grade level.

Keywords: Creativity, Creative problem-solving, Gifted students, non-gifted students ,Mathematical creativity.

Introduction

Creativity and creative problem solving are as important in the development of society as the activities we do in our daily lives (Lin, 2017; Selby, Shaw & Houtz, 2005; Simonton, 2000). Creativity and creative problem-solving ability are seen among the 21st century basic skills that the future talent should have (Bellanca & Brandt, 2010; Newton & Newton, 2014; OECD, 2019; Runco, 2008; Sternberg & Williams, 1996; Trilling & Fadel, 2009). In this global age, individuals with creativity are needed to lead the changes. However, school mathematics focuses on tests with one correct answer rather than creativity and does not attach importance to students' creative problem-solving abilities (Lin & Cho, 2011; Mann, 2009; Sriraman, 2005). Research studies show that creative talent is not static but can be developed and taught through education (Balka, 1974; Newton & Newton, 2014; Renzulli, 1992; Runco, 2008; Sternberg & Williams, 1996).

Mathematical creativity has always been important because of the relationship of mathematics with other disciplines and ways of thinking (Ervynck, 2002). According to Sriraman (2005), creativity in mathematics at the school level is producing unusual (new, original) and/or reasonable solution(s) for problem(s), formulating new problems, or approaching old problems from a new perspective. The mathematical creativity process includes the entire problem solving process (Csikzentmihalyi & Getzels, 1971; Runco, 2004). Different measurement tools are used to measure mathematical creativity (Akgül & Kahveci, 2016; Amabile, 1983; Balka, 1974; Csikszentmihalyi, 1996; Guignard & Lubart, 2007; Haylock, 1984; Lin, 2010; Lin, 2017; Runco, 1986; Sak , 2011; Treffinger & Isaksen, 2005; Treffinger, Selby & Isaksen, 2008; Urban, 2003). Divergent thinking to examine, evaluate and measure creative ability in mathematics (Akgül, 2014; Akgül & Kahveci, 2016; Balka, 1974; Chamberlin & Moon, 2005; Guignard & Lubart, 2007; Haavold, 2013; Haylock, 1987; Kahveci & Akgül, 2019; Kwon, Park & Park, 2006; Leikin & Pitta-Pantazi, 2013; Mann, 2009; Runco, Dow & Smith, 2006; Shriki, 2010; Sriraman, 2005; Torrance, 1995; Urban, 2003) and convergent thinking (Balka, 1974; Guignard & Lubart, 2007; Urban, 2003) activities are used.

While divergent thinking is defined as the ability to generate knowledge from the information given, emphasizing the diversity of answers and the quality of the outputs (Balka, 1974; Guignard & Lubart, 2007; Runco, 2014), convergent thinking is generally defined as focusing all attention on the correct or most appropriate response (Runco, 2014). While divergent thinking includes open-ended questions with multiple answers and solutions, convergent thinking includes closed-ended questions that always have one correct

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or conventional answer (Guignard & Lubart, 2007; Kwon et al., 2006; Runco, 2014; Runco & Acar, 2012). Many researchers suggest using divergent production activities to examine and reveal creativity in mathematics (Balka, 1974; Haavold, 2013; Haylock, 1987; Kwon et al., 2006; Leikin & Pitta-Pantazi, 2013; Shriki, 2010). The most important feature of activities that require divergent thinking is that they have many different solutions (Akgül, 2014; Balka, 1974; Haavold, 2013).

Fluency, flexibility, and originality, which are also expressed as indicators of creativity, are taken into account in the evaluation of students' creativity in mathematics in divergent production activities that require problem-solving and problem-posing (Akgül, 2014; Balka, 1974; Haavold, 2013; Haylock, 1987; Shriki, 2010). Fluency is the number of acceptable (correct) answers, flexibility, the number of different types (category) answers (Balka, 1974; Haylock, 1987), originality is the solution (number of unusual or unique ideas) expressed by fewer people, considering the research group (Haylock, 1987; Runco & Acar, 2012). It is seen that open-ended problems are used to measure creativity in mathematics (Akgül & Kahveci, 2016; Balka, 1974; Haylock, 1984). In addition, divergent thinking tests generally lack comprehensive validity studies (Lin, 2010; Lin, 2017; Plucker & Runco, 1998; Runco et al., 2006). It is also stated that divergent thinking tests are not creativity tests but are predictors of creative problem-solving potential (Runco et al., 2006; Runco & Acar, 2012).

Researchers have shown that creativity is multifaceted and complex (Csikszentmihalyi, 1996; Kim, Cho & Ahn, 2003; Lin & Cho, 2011; Sternberg & Lubart, 1995; Urban, 2003). Amabile (1983) revealed that the social context and environment influence creativity. The creative problem-solving process is explained through many components such as divergent thinking, convergent thinking, motivation, general knowledge and skills, domain-specific knowledge and skills, and environment (Amabile, 1983; Csikszentmihalyi, 1996; Kaufman & Sternberg, 2007; Lin, 2010; Lin, 2017; Lin & Cho, 2011; Runco et al., 2006; Sternberg & Lubart, 1995; Tordjman, Besançon, Pennycook & Lubart, 2021; Treffinger, 1995; Urban, 2003). It has been revealed by many researchers that creativity is closely related to motivation (Cooper & Jayatilaka, 2006; Lin & Cho, 2011; Renzulli, 2005; Renzulli & Reis, 2014; Tordjman et al., 2021). It has been found that parents of creative children are consistently less authoritarian, more open to opportunities to nurture and develop their children's creative and critical thinking abilities, tolerate their children's failure, and there is a link between environmental influences and the development of creativity (Gute, Gute, Nakamura & Csikszentmihalyi, 2008; Tordjman et al., 2021). Lin and Cho (2011) in their study with fifth and sixth grade students; examined both the relationship between divergent thinking, convergent thinking, motivation, general knowledge and skills, and environmental factors, which are creative problem-solving features, as well as the relationship between the features of creative problem-solving ability and mathematical creative problem-solving ability. In the study, it was determined that divergent thinking and domain-specific knowledge and skills directly predicted mathematical problem solving ability, on the other hand, divergent thinking, convergent thinking, motivation, general knowledge and skills and environment indirectly predicted mathematical problem solving ability.

Creativity and Giftedness

Creativity is seen by many researchers as a fundamental component of giftedness (Guignard & Lubart, 2007; Krutetskii, 1976; Leikin, 2009; Maker, 1993; Pitta-Pantazi, Christou, Kontoyianni & Kattou, 2011; Renzulli, 2011; Renzulli & Reis, 2014; Sternberg, 1985; Sternberg & Grigorenko, 2002; Usiskin, 2000). Renzulli and Reis (2014) define two types of giftedness: schoolhouse giftedness and creative-productive giftedness. The first is manifested in the facility to take standardized tests, acquire knowledge, and good lesson learners in traditional school achievement, while the second refers to the ability to create new products or processes (Renzulli & Reis, 2014; Singer, Sheffield, Freiman & Brandl, 2016). Individuals with creative-generative giftedness are excellent knowledge producers, as opposed to being superior information consumers (Renzulli & Reis, 2014). Renzulli (2005) stated that giftedness arises from the interaction of being above the average in the development of general intelligence (talent), the ability to approach problems from different angles and produce creative solutions (creativity), and having a high motivation that can take a job from the beginning to the end (motivation). Sriraman (2005) stated that students with mathematical creativity also have mathematical superiority, but the reverse is not true. The importance of creativity in gifted students is emphasized by many researchers (Akgül, 2014; Maker, 1993; Renzulli, 2005; Sriraman, 2005; Treffinger & Isaksen, 2005). However, mathematical creativity is seen as one of the most critical skills to be developed in all students (Mann, 2006).

Related Studies

When the literature is examined, most studies have examined students' mathematical creativity through widely known cognitive characteristics (fluency, flexibility, originality, and elaboration) (Balka, 1974; Biçer, Lee, Perihan, Capraro & Capraro, 2020; Guignard & Lubart, 2007; Kahveci & Akgül, 2019; Kattou, Kontoyianni, Pitta-Pantazi & Christou, 2013; Kwon et al., 2006; Leikin & Lev, 2013; Levav-Waynberg & Leikin, 2012; Sak & Maker 2006; Schoevers, Kroesbergen & Kattou, 2020; Silver, 1997; Sriraman, 2009; Tan & Maker, 2020; Torrance, 1988; Tyagi, 2016), and few studies have examined other factors such as convergent thinking, motivation, environment, and general knowledge and skills (Lin, 2010; Lin, 2017; Lin & Cho, 2011). In addition, it is seen that there are studies on the comparison of gifted and non-gifted students in creative thinking (Guignard & Lubart, 2007; Hong & Aqui 2004; Hong & Migram, 2010; Kahveci & Akgül, 2019; Kattou, Kontoyianni, Pitta-Pantazi & Christou, 2011; Lin, 2010; Runco, 1987; Russo, 2004), on gender differences (Chan, Cheung, Lau, Wu, Kwong & Li, 2001; DeMoss, Milich & DeMers, 1993; Hong & Aqui 2004; Hong & Migram, 2010; Walia , 2012), and studies on class/age differences (Guignard & Lubart, 2007; Hong & Migram, 2010; Lin & Cho 2011; Sak & Maker, 2006).

When the studies on gender differences in creative thinking are examined, in some studies, boys (DeMoss, Milich, & DeMers, 1993) scored higher, while in some studies, girls (Chan et al., 2001; Hong & Aqui, 2004; Jensen, 1973) scored higher. In addition, there are also studies in which no significant difference can be determined according to gender (Hong & Migram 2010; Walia, 2012). Walia (2012) concluded that there is no significant difference between male and female students regarding achievement levels and mathematical creativity. This situation reveals that the results of studies on gender differences in creative thinking are inconsistent. In addition, there are inconsistent results in terms of class/age differences (Charles & Runco, 2000; Guignard & Lubart, 2007; Sak & Maker, 2006). Sak and Maker (2006) stated that between the 1st and 5th grades, upper-grade students scored higher in divergent thinking than lower-grade students, while Charles and Runco (2000) stated that fourth-grade students peaked in divergent thinking compared to fifth graders. Hong and Migram (2010) examined general and specific creative thinking ability in terms of gender, age, class, ethnicity, and learning disability over three different groups (college, elementary students, preschool children). At the same time, it was found that gender did not significantly differ on general and specific creative thinking ability in the high school group. It was found that grade level had a significant effect on specific creative thinking ability in academic problem-solving. It was stated that the higher the grade level, the higher the special creative thinking scores. Hong and Aqui (2004) compared the cognitive and motivational characteristics of 90 10th and 11th-grade high school students who were academically gifted in mathematics, creatively talented in mathematics, and non-gifted students. There was no significant difference between these three groups in terms of beliefs about ability. In addition, it was found that academically gifted female students spent more effort than academically gifted male students. In addition, gifted men exerted significantly more effort than those with high academic achievement. It was concluded that male and female students with mathematical creativity developed better strategies than the other two groups.

Guignard and Lubart (2007) compared the divergent and convergent thinking of 5th and 7th grade gifted and non-gifted students. There was no significant difference between gifted and non-gifted students in convergent thinking. In divergent thinking, there was a significant difference in favor of gifted students in the 5th grade between gifted and non-gifted students. Still, no significant difference was observed in the 7th grade. Runco (1987) conducted a study on the generality of creativity with 114 gifted and 114 non-gifted people. The results showed that the differences in creative performance between gifted and non-gifted children were minimal. Lin (2010) compared the creative problem-solving abilities of 59 gifted and 350 non-gifted fifth and sixth-grade students in Taiwan with their creative mathematical problem-solving abilities. As a result, a significant difference was found in favor of gifted students in mathematical problem-solving ability. In addition, it was determined that while there was a significant difference in favor of the gifted in terms of divergent thinking, motivation, environment, and general knowledge and skills in terms of creative problem-solving characteristics, it did not differ significantly in convergent thinking. Kattou et al. (2011) compared the creativity of 9 gifted and 12 normal students in mathematics in terms of fluency, flexibility, and originality components. The results revealed that gifted students gave more accurate answers, integrated more complex mathematical ideas, and suggested more complex and original solutions than normal students. Kahveci and Akgül (2019) examined the relationship between intelligence and creativity of 176 gifted and 176 general education 5th, 6th, 7th, and 8th-grade students. As a result of the research, it has been revealed that there is a statistically significant difference between gifted and general education students in favor of gifted students in terms of fluency, flexibility, originality, and creativity in mathematics.

When the literature is examined, it is seen that more than one factor affects students' creativity in mathematics (Csikszentmihalyi, 1996; Kim, Cho & Ahn, 2003; Lin, 2010; Lin, 2017; Lin & Cho, 2011; Mann, 2006; Sternberg & Lubart, 1995). To develop students' creative problem solving skills, it is necessary and important to understand and measure creative problem solving from a comprehensive perspective, including all components of creative problem-solving. In the context of Turkey, there is a need for research on how students' creative problem-solving characteristics differ through divergent thinking, convergent thinking, motivation, general knowledge and skills, and environmental components. By evaluating the creative problem-solving characteristics of the students, the strengths and weaknesses of the students are determined, and important clues are obtained to improve the students' strengths and improve their weaknesses. It is one of the most important goals of today's educators to enable each student to develop their potential. In order to achieve this, it is necessary to understand the creative problem-solving characteristics of students better and take measures to organize an appropriate educational environment. This study differs from other studies in that it was conducted with students with higher cognitive maturity in terms of grade level.

In this study, it was aimed to examine the creative problem solving characteristics of gifted and non-gifted high school students in terms of giftedness diagnosis, gender and grade level variables. For this reason, the problem of the research is "How do the creative problem-solving characteristics of gifted and non-gifted high school students differ according to the variables of giftedness diagnosis, gender and grade level?" has been determined. Because many variables such as students' gender and grade level affect creative problem solving skills. Within the scope of this purpose, the sub-problems of the research are as follows;

1. What are the creative problem-solving skill levels of gifted and non-gifted high school students?
2. Is there a statistical difference in creative problem-solving characteristics among students according to the diagnosis of giftedness?
3. Is there a statistically significant difference in creative problem-solving characteristics of gifted and non-gifted high school students according to gender?
4. Is there a statistically significant difference in creative problem-solving characteristics of gifted and non-gifted high school students according to grade levels?

Method

Research Design

In this study, a descriptive research model, one of the survey models, was used because it aims to compare the creative problem-solving skills of gifted and non-gifted high school students. The causal comparison design was also used in this study since the research problem was analyzed separately in terms of variables such as gender and grade level (Fraenkel & Wallen, 2006). Causal comparisons allow comparing two groups in the same population that differ in a critical variable (Çepni, 2018). Causal comparison is a type of research aimed at determining the variables that affect the causes of an emerging or existing situation or the results of the effect (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2016).

Participants

In the 2020-2021 academic year, 375 students, 73 of who were gifted and 302 of whom were not diagnosed as gifted, attended the 9th, 10th, 11th and 12th grades. Data on gifted students were collected from two Science and Art Centers (SACs) in Bursa, and data on students who were not diagnosed as gifted were collected from five different high schools, two Science High Schools and three Anatolian High Schools, located in the same province. These schools accept students through the central examination within the scope of the High School Entrance Exam System, and their percentages are between 0.01 and 6 (MEB, 2018a).

In Turkey, a gifted student/person is defined as "an individual who learns more rapidly than his/her peers, has an advanced capacity in terms of creativity, art and leadership, possesses special academic ability, can understand abstract ideas, enjoys acting independently in his/her areas of interest, and displays a high level of performance" (Ministry of National Education [MoNE], 2019). Gifted students receive education at SACs on weekdays and/or weekends, apart from their formal education hours, regardless of their official schools (MoNE, 2019). In SACs, gifted students receive education in science, social sciences, mathematics, and informatics courses in the field of general mental ability and the fields of music and visual arts talent in their own fields (MoNE, 2019). In SACs, project-based, interdisciplinary, enriched, and differentiated education programs suitable for students' abilities are implemented, and educational activities are organized in order to realize original products, projects, and productions (MoNE, 2019). By supporting the development processes of gifted students, it is expected that these students will create added value both in their individual lives and in the growth of the country in the long run (MoNE, 2018b). Necessary permissions and approvals were obtained to conduct the research. Participants participated in the study voluntarily. In Table 1, demographic characteristics of the students participating in the research regarding gender, class level, and diagnosis of giftedness are given.

As seen in Table 1, a total of 223 (59.5%) female students and 152 (40.5%) male students participated in the study. Of the gifted students, 45 (61.6%) are female, and 28 (38.4%) are

Table 1: Descriptive statistics on the number of students participating in the research

	Grade		*9th*	*10th*	*11th*	*12th*	*Total*
Gifted Students	Gender	Female	7	6	20	12	45
		Male	11	5	5	7	28
		Total	18	11	25	19	73
Non-Gifted Students	Gender	Female	40	68	47	23	178
		Male	39	40	34	11	124
		Total	79	108	81	34	302

male. It is understood that 178 (59%) of the non-gifted students are girls, and 124 (41%) are boys.

Data Collection Tools

In the research, the "Creative Problem Solving Characteristics Inventory", which was adapted to Turkish and whose validity and reliability study was carried out by Baran-Bulut, İpek, and Aygün (2018), was used in order to determine the creative problem-solving characteristics of the students. This scale consists of five likert-type, convergent thinking, divergent thinking, motivation, environment, general knowledge and skills, and 40 items. The scale was evaluated as 1 (Never), 2 (Rarely), 3 (Sometimes), 4 (Often), 5 (Always).

The inventory developed by Lin (2010) based on the 'Dynamic System Model of Creative Problem Solving Skills' developed by Cho (2003) was initially 49 items, and then it was reduced to 40 items with the changes made. Turkish adaptation studies were carried out by Baran-Bulut et al. (2018) on 856 secondary school students in different provinces. Of the 40 items in the inventory; 10 items (items 1 to 10) under the Divergent Thinking dimension, 8 items (items 11 to 18) under the convergent thinking dimension, 6 items (items between 19 and 24) under the motivation dimension, 11 items (items between 25 and 35) under the environmental dimension and five items (items between 36 and 40) were gathered under the general knowledge and skills dimension. The Cronbach alpha reliability coefficients, which are the internal consistency coefficients in determining the reliability of the inventory, were determined by Baran-Bulut, İpek, and Aygün (2018) as 0.79 for the divergent thinking dimension, 0.78 for the convergent thinking dimension, 0.73 for the motivation dimension, 0.88 for the environment dimension and general knowledge dimension. And the skill dimension was obtained as 0.77.

In this study, Cronbach's alpha reliability coefficient of the whole scale and according to the components was recalculated, and Cronbach's alpha reliability coefficient of the whole scale was found to be 0.92. This number in sub-dimensions; Divergent thinking dimension was 0.84, convergent thinking 0.79, motivation dimension 0.81, environment dimension 0.92, and general knowledge and skill dimension 0.80. Since scales with a reliability coefficient of 0.90 and above are considered highly reliable (Can, 2013), it can be said that this scale (0.92) is quite reliable.

Data Analysis

The data obtained from the research were analyzed using the SPSS 23.00 package program. In the evaluation of students' creative problem solving characteristics, 5-point Likert-type grading intervals were taken into consideration. According to this; 1.00-1.79 range is "Very Low", 1.80-2.59 range is "Low", 2.60-3.39 range is "Medium", 3.40-4.19 range is "High" and 4 The range of .20-5.00 was evaluated as "Very High". In addition, analyzes were made on whether the creative problem-solving characteristics of gifted and non-gifted high school students differ according to independent variables through the causal comparison model in the research. For these analyses, firstly, the skewness coefficients were examined to determine whether the data showed a normal distribution or not. When the skewness coefficient is between -1 and +1, it is accepted that the data show a normal distribution (Büyüköztürk, 2012). Considering this situation, the skewness coefficients of the whole scale were calculated as 0.703 for creative problem solving, 0.434 for divergent thinking, 0.716 for convergent thinking, 0.27 for motivation, 0.78 for environment, and 0.332 for general knowledge and skills. It was observed that the data were normally distributed. Comparison statistics (independent groups t-test) were used to analyze the data of the study. The significance level was taken as .05 in the study.

Table 2: Descriptive statistics of creative problem solving skills and sub-dimensions

Type of students	*Vehicle and Dimensions*	*N*	$\bar{\chi}$	*SD*
Gifted students	Divergent Thinking	73	3.79	.64
	Convergent Thinking	73	3.83	.60
	Motivation	73	3.65	.76
	Environment	73	3.64	.82
	General Knowledge and Skills	73	3.72	.66
	Total	73	3.73	.53
Non-Gifted students	Divergent Thinking	302	3.50	.53
	Convergent Thinking	302	3.70	.60
	Motivation	302	3.52	.75
	Environment	302	3.57	.93
	General Knowledge and Skills	302	3.47	.63
	Total	302	3.57	.51

Findings

In this section, the comparison of creative problem-solving skills of gifted and non-gifted high school students; Findings for the overall scale are presented according to the diagnosis of giftedness, grade level, and gender of the students.

Findings Related to the First Sub-Problem

Descriptive data on creative problem-solving skills of gifted and non-gifted high school students are shown in Table 2.

As seen in Table 2, when the average scores of gifted students' creative problem- solving skill levels are analyzed from high to low, it is seen that there are convergent thinking, divergent thinking, creative problem-solving general, general knowledge and skills, motivation and environment. In line with these findings, it can be said that gifted students have high levels of creative problem solving in general and five sub-dimensions. When the average scores of non-gifted students' creative problem-solving skill levels are analyzed from high to low, it is seen that there are convergent thinking, creative problem solving general, environment, motivation, divergent thinking, general knowledge and skills. In line with these findings, it can be said that non-gifted students also have high levels of creative problem-solving in general and five sub-dimensions.

Findings Regarding the Second Sub-Problem

In order to examine whether there is a statistically significant difference in creative problem-solving skills among students according to the diagnosis of giftedness, an independent t-test is performed, and the findings are given in Table 3.

As a result of the analysis made to determine whether the creative problem-solving skills of the students differ according to the diagnosis of giftedness; As seen in Table 3, A significant difference is observed between gifted and non-gifted students in divergent thinking (t=-3.572, p<.05), general knowledge and skills (t=-3.025, p<.05), and the general average of the creative problem-solving scale (t=-2.356, p<.05) in favor of the gifted. There is no significant difference between the mean scores in the dimensions of convergent thinking (t=-1.529, p>.05), motivation (t=-1.267, p>.05) and environment (t=-0.579, p>.05). In addition, the average scores of gifted and non-gifted high school students according to five sub-dimensions are shown in Figure 1

Table 3: Independent samples t-test results on creative problem solving skills according to giftedness diagnosis

Vehicle and Dimensions	*Type of students*	$\bar{x}$	*SD*	*df*	*t*	*p*
Divergent Thinking	Gifted	3.79	.64	373	-3.572	.000*
	Non-Gifted	3.50	.53			
Convergent Thinking	Gifted	3.83	.60	373	-1.529	.127
	Non-Gifted	3.70	.60			
Motivation	Gifted	3.65	.76	373	-1.267	.206
	Non-Gifted	3.52	.75			
Environment	Gifted	3.64	.82	373	-0.579	.563
	Non-Gifted	3.57	.93			
General Knowledge and Skills	Gifted	3.72	.66	373	-3.025	.003*
	Non-Gifted	3.47	.63			
Total	Gifted	3.73	.53	373	-2.356	.019*
	Non-Gifted	3.57	.51			

*p<.05

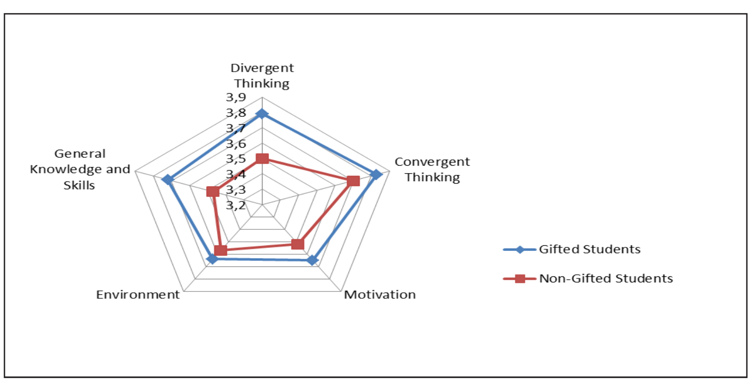

Fig. 1: Comparison of the average scores of creative problem solving features according to the diagnosis of giftedness according to the five dimensions

When Figure 1 is examined, it is seen that the average scores of gifted students in five sub-dimensions are higher than the averages of non-gifted students.

Findings Regarding the Third Sub-Problem

In order to examine whether there is a statistically significant difference between the creative problem-solving skills of gifted students and non-gifted high school students according to gender, an independent t-test is conducted, and the findings are given in Table 4.

Analyzes were made for general and five sub-dimensions. When the results in Table 4 are examined, among the gifted students; There is a significant difference according to the environment sub-dimension (t=2.278, p<.05) and the general mean (t=2.145, p<.05) according to the gender variable. This difference is in favor of female students. In other words, it is seen that the average scores of gifted female students regarding creative problem-solving skills are higher than the average scores of male students. Divergent thinking (t=1.693, p>.05), convergent thinking (t=1.931, p>.05), motivation (t=1.142, p>.05), and general knowledge and skills (t=-.196, p >.05) dimensions do not show a significant difference according to gender. Only the average of the general knowledge and skills sub-dimension is higher for male students. Considering the analysis results of non-gifted students, a significant difference is observed in the mean of motivation (t=-2,320, p<.05) and general knowledge and skills (t=-2.731, p<.05) sub-dimensions by gender. This difference is in favor of male students. Divergent thinking (t=-1.658, p>.05), convergent thinking (t =-1.472, p>.05), environment (t=1.818, p>.05), and overall mean (t=-.801, p>.05), it is seen that the mean scores of the dimensions do not make a significant difference according to gender. However, divergent thinking, convergent thinking, and general averages are higher than male students.

Table 4: *Independent samples t-test results on creative problem solving skills by gender.*

	Vehicle and Dimensions	*Gender*	$\bar{\chi}$	*SD*	*df*	*t*	*p*
Gifted students	Divergent Thinking	Female	3.89	.55	71	1.693	.095
		Male	3.63	.73			
	Convergent Thinking	Female	3.93	.50	71	1.931	.057
		Male	3.66	.71			
	Motivation	Female	3.73	.74	71	1.142	.257
		Male	3.52	.79			
	Environment	Female	3.81	.74	71	2.278	.026*
		Male	3.37	.89			
	General Knowledge and Skills	Female	3.71	.54	71	-.196	.845
		Male	3.74	.83			
	Total	Female	3.83	.42	71	2.145	.035*
		Male	3.56	.64			
Non-Gifted students	Divergent Thinking	Female	3.49	.49	300	-1.658	.098
		Male	3.60	.58			
	Convergent Thinking	Female	3.66	.60	300	-1.472	.142
		Male	3.77	.59			
	Motivation	Female	3.44	.69	300	-2.320	.021*
		Male	3.64	.82			
	Environment	Female	3.65	.91	300	1.818	.070
		Male	3.45	.94			
	General Knowledge and Skills	Female	3.38	.63	300	-2.731	.007*
		Male	3.58	.61			
	Total	Female	3.55	.51	300	-.801	.424
		Male	3.60	.51			

*p<.05

Findings Related to the Fourth Sub-Problem

In order to examine whether there is a statistically significant difference between the creative problem-solving skills of gifted and non-gifted high school students according to grade levels, an independent t-test was conducted and the findings were presented on a class basis.

First of all, independent t-test was conducted to examine whether there is a statistically significant difference between the creative problem-solving skills of gifted and non-gifted high school students compared to the ninth grade, and the findings are given in Table 5.

When the results of the independent samples t-test conducted to compare the creative problem-solving skills of gifted and non-gifted students according to the ninth-grade level are examined, As seen in Table 5, it is seen that there is significant differentiation in favor of the gifted (t=2.373, p<.05) in the dimension of divergent thinking. There was no significant difference in the dimensions of convergent thinking, motivation, environment, general knowledge and skills, and total score averages. However, the average scores of the students who are not gifted in motivation are higher than the average scores of the gifted students. However, at the ninth-grade level, it is possible to say that both groups have a high level of creative problem solving general average and five sub-dimensions.

In order to examine whether there is a statistically significant difference between the creative problem-solving skills of gifted and non-gifted high school students compared to the tenth grade, an independent t-test was conducted and the findings are given in Table 6.

Table 5: Independent samples t-test results on creative problem solving skills according to 9th grade

Vehicle and Dimensions	*Type of students*	$\bar{\chi}$	*SD*	*df*	*t*	*p*
Divergent Thinking	Gifted	3.76	.54	95	2.373	.020*
	Non-Gifted	3.40	.58			
Convergent Thinking	Gifted	3.75	.39	95	.404	.687
	Non-Gifted	3.69	.65			
Motivation	Gifted	3.35	.48	95	-.750	.455
	Non-Gifted	3.50	.85			
Environment	Gifted	3.91	.57	95	1.740	.085
	Non-Gifted	3.51	.92			
General Knowledge and Skills	Gifted	3.78	.48	95	1.151	.252
	Non-Gifted	3.60	.64			
Total	Gifted	3.74	.36	95	1.480	.142
	Non-Gifted	3.53	.57			

*p<.05

Table 6: Independent samples t-test results on creative problem solving skills according to 10th grade

Vehicle and Dimensions	*Type of students*	$\bar{\chi}$	*SD*	*df*	*t*	*p*
Divergent Thinking	Gifted	3.56	.33	117	.317	.752
	Non-Gifted	3.51	.53			
Convergent Thinking	Gifted	3.55	.44	117	-.554	.580
	Non-Gifted	3.66	.61			
Motivation	Gifted	3.56	.42	117	.579	.564
	Non-Gifted	3.43	.67			
Environment	Gifted	3.50	1.06	117	-.126	.900
	Non-Gifted	3.54	.89			
General Knowledge and Skills	Gifted	3.45	.66	117	.233	.816
	Non-Gifted	3.40	.60			
Total	Gifted	3.53	.33	117	.037	.971
	Non-Gifted	3.52	.49			

*p<.05

When the independent samples t-test results, which were conducted to compare the creative problem-solving skills of gifted and non-gifted students according to the tenth-grade level, were examined in Table 6, no significant difference was found in the dimensions of divergent thinking, convergent thinking, motivation, environment, general knowledge and skills, and general average score averages. Gifted students have higher average scores in the dimensions of divergent thinking, motivation, general knowledge and skills, and overall average score. However, at the tenth-grade level, it is possible to say that both groups have high levels of creative problem solving in general and five sub-dimensions.

In order to examine whether there is a statistically significant difference between the creative problem-solving skills of gifted and non-gifted high school students compared to the eleventh grade, an independent t-test was conducted, and the findings are given in Table 7.

When the results of the independent samples t-test conducted to compare the creative problem-solving skills of gifted and non-gifted students according to the eleventh-grade level are examined in Table 7, it is seen that there is a significant difference in favor of the gifted in the dimensions of divergent thinking ($t=2.225$, $p<.05$), and general knowledge and skills ($t=3.712$, $p<.05$). There was no significant difference in the dimensions of convergent thinking, motivation, environment, and overall mean score. However, it is possible to say that both groups have high levels of creative problem solving in general and five sub-dimensions at the eleventh-grade level.

In order to examine whether there is a statistically significant difference between the creative problem-solving skills of gifted and non-gifted high school students compared to the twelfth grade, an independent t-test was conducted, and the findings are given in Table 8.

Table 7: Independent samples t-test results on creative problem solving skills according to 11th grade.

Vehicle and Dimensions	*Type of students*	$\bar{X}$	*SD*	*df*	*t*	*p*
Divergent Thinking	Gifted	3.89	.57	104	2.225	.028*
	Non-Gifted	3.63	.48			
Convergent Thinking	Gifted	3.90	.54	104	1.388	.168
	Non-Gifted	3.72	.56			
Motivation	Gifted	3.72	.79	104	.768	.444
	Non-Gifted	3.58	.79			
Environment	Gifted	3.71	.70	104	.323	.748
	Non-Gifted	3.64	1.02			
General Knowledge and Skills	Gifted	3.92	.55	104	3.712	.000*
	Non-Gifted	3.42	.58			
Total	Gifted	3.82	.44	104	1.899	.060
	Non-Gifted	3.62	.47			

*p<.05

Table 8: *Independent samples t-test results on creative problem solving skills according to 12th grade*

Vehicle and Dimensions	*Type of students*	$\bar{X}$	*SD*	*df*	*t*	*p*
Divergent Thinking	Gifted	3.84	.90	51	.706	.483
	Non-Gifted	3.71	.43			
Convergent Thinking	Gifted	3.96	.85	51	.547	.587
	Non-Gifted	3.85	.53			
Motivation	Gifted	3.90	1.00	51	.786	.436
	Non-Gifted	3.72	.64			
Environment	Gifted	3.38	.98	51	-1.081	.285
	Non-Gifted	3.66	.87			
General Knowledge and Skills	Gifted	3.55	.87	51	.405	.687
	Non-Gifted	3.46	.76			
Total	Gifted	3.71	.80	51	.078	.938
	Non-Gifted	3.70	.47			

*p<.05

When the independent samples t-test results, which were conducted to compare the creative problem-solving skills of gifted and non-gifted students according to the twelfth-grade level, were examined in Table 8, it was found that there was no significant difference in the dimensions of divergent thinking, convergent thinking, motivation, environment, general knowledge and skills, and general average score averages. The average scores of gifted students are higher in the dimensions of divergent thinking, convergent thinking, motivation, general knowledge and skills, and overall average. However, at the level of the twelfth grade, it is possible to say that both groups have high levels of creative problem solving, general and divergent thinking, convergent thinking, motivation, general knowledge, and skills. However, while the average of the non-gifted students in the environmental dimension is high, the average of the gifted students is medium.

Conclusion and Discussion

In this study, it was tried to compare the creative problem-solving skills of gifted and non-gifted high school students. According to the results obtained within the framework of the first sub-problem of the research, when the creative problem solving skills of gifted and non-gifted high school students were compared, it was seen that gifted students' divergent thinking, convergent thinking, motivation, environment, general knowledge and skills, and their general average scores were higher than the average scores of non-gifted students. In addition, it was determined that the averages of both groups were high. As Lin (2010) stated, this result supports that gifted students tend to use their creative thinking skills more frequently and more appropriately than their peers. Similarly, it is consistent with the results of the research that gifted students are better than non-gifted students in terms of divergent thinking (Guignard & Lubart, 2007; Kahveci & Akgül, 2019; Lin, 2017; Lin & Cho, 2011; Mann, 2009; Russo, 2004), motivation (Lin, 2010; Renzulli, 2005; Renzulli & Reis, 2014), and environment (Gute et al., 2008). It is noteworthy that the average of the creative problem solving skills of the students in both groups in the study was high. This indicates that the students in both groups have high levels of divergent thinking, convergent thinking, willingness to take risks, perseverance, parental support, and general knowledge and skills. The fact that the mean of the environment sub-dimension, which includes the items that describe the efforts of parents to develop their children's creative problem-solving skills, is high in both groups reveals that parents are effective in developing children's creative problem-solving skills. Sak and Maker (2006) stated that the environment plays an important role in the later stages of life. Cook, Wittig and Treffinger (2011), and Tordjman et al. (2021) stated that the role of the family, namely the environment, is important in nurturing children's creativity. Similarly, Gute et al. (2008) revealed that families are influential on children's creativity.

According to the results obtained within the framework of the second sub-problem of the research, it was observed that there was a differentiation in favor of gifted students in divergent thinking, general knowledge and skills, and overall average in creative problem-solving skills of gifted and non-gifted students. However, no significant difference was found between the mean scores in the sub-dimensions of convergent thinking, motivation, and environment. However, it was determined that the general average and the average scores of the five sub-dimensions of the gifted students were higher than the averages of the non-gifted students. According to Renzulli's (2005) three-ring theory, an individual's motivation, above-average talent, and creativity are important in terms of defining giftedness. In other words, it is expected that the average of gifted students will be high. These results overlap with the results of many studies (Guignard & Lubart, 2007; Kahveci & Akgül, 2019; Kattau et al., 2011; Runco, 1986; Runco et al., 2006). At the same time, it is in line with the results of the research that gifted students are more prominent than other students in the dimensions of divergent thinking (Kahveci & Akgül, 2019; Lin, 2010; Lin, 2017; Lin & Cho, 2011; Mann, 2009; Russo, 2004), convergent thinking (Lin & Cho, 2011; Mann, 2009), and general knowledge and skills (Mann, 2009; Runco et al., 2006). The fact that the general creative score averages of gifted students are high confirms that creativity is seen as a component of giftedness (Renzulli, 2005; Renzulli & Reis, 2014; Sriraman, 2005). In addition, it can be said that gifted students' receiving a different education in SACs in addition to their schools increases their creative problem-solving skills. It is also noteworthy that non-gifted students' creative problem-solving skills have high average scores in five sub-dimensions and in general terms. The high creativity scores of these students, which is among the 21st-century skills, is an important finding. The reason for this suggests that these students are in qualified schools, and initiatives that support creative problem solving are included in these schools.

According to the results obtained within the framework of the third sub-problem of the study, it was revealed whether there is a statistical difference between the creative problem-solving skills of gifted and non-gifted high school students according to gender. There was a significant difference in favor of girls in the general average scores and the mean scores of the environment sub-dimension among gifted students. This shows that gifted female students are more sensitive. There was no significant difference according to gender in terms of divergent thinking, convergent thinking, motivation, and general knowledge and skill sub-dimensions. Among the non-gifted students, there was a significant difference in favor of males in the sub-dimensions of motivation and general knowledge and skills. No significant difference was found in divergent thinking, convergent thinking, environment sub-dimensions, and general average according to gender. When we look at the studies, it is seen that the results are in parallel with the results of the research, in which mathematical creativity is in favor of female students (Jensen, 1973). There are also studies in which gender has no effect on creative mathematical problem solving (Akgül, 2014; Amabile 1983; Kaufman & Sternberg, 2007; Lin, 2010; Walia, 2012). Akgül (2014) concluded that 5th, 6th, 7th, and 8th-grade gifted students' mathematics achievement, mathematics metacognitive, and mathematical creativity do not differ according to gender. Similarly, Lin (2010) did not find a significant difference by gender in the dimensions of divergent thinking, convergent thinking, motivation, environment, and general knowledge and skills in his study. This supports the conclusion that the results of studies on gender differences in creative thinking are inconsistent (Baer & Kaufman, 2008).

According to the results obtained within the framework of the fourth sub-problem of the study, when the creative problem-solving skills of gifted and non-gifted high school students according to grade levels are compared, there was no significant difference in the dimensions of divergent thinking, convergent thinking, motivation, environment, general knowledge and skills, and general averages at the 10th and 12th-grade levels. However, while there was a significant difference in favor of the gifted in the divergent thinking dimension at the 9th-grade level, there was no significant difference in the dimensions of convergent thinking, motivation, environment, general knowledge and skills, and general averages. However, the average of gifted students in motivation is lower than non-gifted students. Similarly, at the 11th-grade level, there was a significant difference in favor of the gifted in the dimensions of divergent thinking and general knowledge and skills, while no significant difference was found in the dimensions of convergent thinking, motivation, environment, and general averages. These results show parallelism with the results of many studies (Guignard & Lubart, 2007; Hong & Aqui, 2004; Runco, 1987). General knowledge and skill features show the academic performance of students (Lin, 2010). The fact that the general knowledge and skill features of both groups are above the average indicates that their academic performances are parallel. The fact that non-gifted group students are also in successful schools such as Science High School and Anatolian High School supports this finding. Guignard and Lubart (2007) stated that gifted students show less different thinking development in advanced grades compared to their peers in the same class. Beghetto and Kaufman (2007) revealed that creativity is more visible in children, and the potential for creativity decreases with age. They stated that this is due to the need to adapt to society and that this situation puts their creativity potential under pressure. While there was a significant difference between the groups in divergent thinking in the 9th and 11th grades and general knowledge and skills in the 11th grade, there was no difference in other grade levels and dimensions. It can be said that both groups exhibit similar behaviors in terms of convergent thinking, motivation, general knowledge, and skills. Again, it is seen that the students of both groups are affected by the environment at the same level. The support of the family is undeniable here. Therefore, the active participation of families in the education and training process can be ensured in order to develop and support students' creative problem-solving.

The results found also have some implications for the education and training environment. Teachers and parents should support the development of students' divergent thinking, convergent thinking, motivation, environment, and general knowledge and skills in a balanced way. Because if the academic success of the students in the mathematics course is below the average, it is thought that they cannot be very creative even if they have very high divergent and convergent thinking processes. Therefore, all stakeholders should aim to raise students to above-average levels in all aspects.

Suggestion

This study was conducted with Science High School and Anatolian High School students. In future research, the creative problem-solving characteristics of gifted and non-gifted vocational high school, middle school and primary school students can be compared. The relationship between the creative problem-solving characteristics of high school students in divergent thinking, convergent thinking, motivation, environment, general knowledge and skill sub-dimensions can be examined. Also, in future studies, the relationship between students' creative problem-solving skills and their non-routine problem-solving abilities can be examined.

Limitation

This study has two limitations. First, this study was conducted on 73 gifted and 302 non-gifted students. In Turkey, gifted students with intelligence scores of over 130, who are included in the 2% upper segment, are selected for SACs (MoNE, 2013). It is difficult to generalize because the number of gifted students is low. In order to reach more robust generalizations, this study can be repeated with the participation of gifted students from other provinces. The second limitation is that the scores of the creative problem-solving characteristics scale in the research are based on the participant students' own perceptions, which is one of the limitations of this research.

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