Vol. 14(15), pp. 518-532, September, 2019
DOI: 10.5897/ERR2019.3790
Article Number: FA5F5D861911
ISSN: 1990-3839

http://www.academicjournals.org/ERR

ACADEMIC JOURNALS
expand your knowledge

Educational Research and Reviews

*Full Length Research Paper*

# Analysis of the relation between creativity level and problem solving skills of gifted and talented students

**Hasret Nuhoğlu[1*] and Savaş Akgül[2]**

[1]Department of Special Education, Faculty of Education, Maltepe University, Istanbul, Turkey.
[2]Department of Special Education, Faculty of Education, Biruni University, Istanbul, Turkey.

Received 24 July, 2019; Accepted 4 September, 2019

**The aim of this study is to analyze the relationship between intellect and creativity level of students with gifted, and to understand the relationship between their creativity level and creative problem solving skills. The target group of this study consists of a total of 20 primary school students between the ages 7 and 10; it is determined by the counseling and research center that the students involved in the study have gifted and talented. The study is carried out in Nezahat Gökyiğit Botanical Garden in Turkey; the Botanical Garden presents a natural living and learning environment to students who voluntarily participated in this study. A and B forms of The Test for Creative Thinking–Drawing Production TCT-DP is used in the study to determine the creativity levels of students. Students carried out extensive discussions about building hydroelectric power plants on the basis of Six Thinking Hats method and creative problem solving stages. The students wrote down their thoughts about each step to the study guides specifically designed for this purpose. After completing the answering and application processes, semi-structured interviews are held with students and data are collected. The obtained data indicates that there is not a meaningful difference between IQ score and creativity levels of students. According to the study results, there is a relationship between Urban Creativity test scores and creative problem solving skills. It is observed that students with high scores create more ideas (fluency), they have more ideas in different categories (flexibility) and their ideas are more extraordinary (originality). On the other hand, it is determined that there is no difference between groups in terms of detailing thoughts (elaboration).**

**Key words:** Gifted and talented education, relationship between creativity and intellect, creative problem solving-creativity relationship.

## INTRODUCTION

When we take a look at the skills that are necessary in the New Age, it can be seen that an individual should know how to learn, should have the skills of listening and speaking, have the responsibility to take part in teamwork and be cooperative, have high self-respect and motivation besides the abilities of creative thinking and problem solving. We can say that there has been an increase in the need for creativity and problem solving

*Corresponding author. E-mail: hasretnuhoglu@maltepe.edu.tr.

skills in the modern world. Quote source of information.

It can be said that there is an attempt to analyze and explain the notion of creativity in the related literature in a wide perspective; creativity is analyzed in the scope of different disciplines and specialties (Amabile, 1996; De Bono, 1995; Stacey, 1996; Sternberg, 1999). When the information about gifted children and their education in the related literature are researched, it is seen that the literature presents some patterns to researchers; studies in the field are mostly about the relationship between creativity and intellect (Getzels and Jackson, 1962; Sternberg, 2003; Silvia, 2015), about defining, assessing and developing creativity in general or about domain-specific creativity (Adams and Hamm, 2010; Akgül, 2014; Ayas and Sak, 2014; Balka, 1974; Kanlı, 2014; Mann, 2006; Moravcsik, 1981).

The question about the relationship between intellect and creativity is an important issue not only for the studies about personality, but also for researches and studies about gifted children (Getzels and Jackson, 1962; Renzulli, 1990). According to the research and study results of some researchers, there is a relationship between intellect and creativity (Sternberg and O'Hara, 1999). This relationship can be conceptualized on the basis of the possible relationship between two basic sets; for instance, while some researchers claim that creativity is a subset of intellect, some claim that intellect is a subset of creativity. Different from these two viewpoints, some researchers believe that these two groups are overlapping or discrete sets. Studies on the relationship between intellect and creativity are especially important for defining and analyzing the notion of 'being gifted' (Sternberg and O'Hara, 1999; Renzulli, 2016; Sak, 2016).

It can be said that Marland (1972) report is the first official document which clearly emphasizes creativity as an inseparable part of being gifted. Giftedness and creativity literature involves various studies focusing on the association of creativity with intellect, and defining and developing general and domain specific creativity types. Besides, separate from its relationship with intellect, creativity is a highly important notion in the education of gifted children; it is assumed that creativity is as important as intellect in education process. There is a great deal of emphasis on developing creative abilities in program developing studies. The issue of general creativity is analyzed in the first studies and curriculums are based on improving this ability. On the other hand, it can be seen that domain-specific creativity has become more important in recent studies. According to Sternberg et al. (2004), "a general skill or aspect could actually be specific to a domain or sometimes to a duty" (p. 13). Domain-specific creativity studies are extended in a way that they now involve science and mathematics education in these domains.

Despite the fact that there has been an increase in the interest about creativity in specific domains such as science and mathematics, it is yet impossible to say that there is sufficient number of study or research data about the relationship between creativity and intellect; and the same goes for the studies in Turkey.

It can be said that it is crucial to give importance to the projects of education in the nature which prioritize finding solutions to the problems of nature. Using creative techniques in these processes will not only reveal the solution suggestions of gifted children, but also give us the chance to analyze their viewpoints and original assessments; this is why, in depth and explanatory studies are important to obtain valuable data. There are some contradictory results in the literature about intellect and general creativity. The goal of this study is to find some proofs about the creativity of gifted children who received science education in the nature in the scope of the understanding of 'education in nature'.

## Creativity and education of creativity

There is a variety of definitions about creativity and unfortunately it is not possible to say that there is a specific and common definition about the notion. On the other hand, there are some aspects that are commonly attributed to the notion of creativity by many researchers. Sak (2016) says that "When all of the theoretical studies in the field of creativity are combined to reach a reliable definition, we reach this result: When a product is new and proper, it involves creativity" (p.14). We can say that it is necessary to satisfy the criteria of innovation and appropriateness to reach something "creative" (Sak, 2016). At this point, it is important to note that innovation and appropriateness are necessary, but not sufficient. Qualification and importance of creative products are other determinants in assessment of creativity level of a product (Sternberg and Lubart, 1995 cit. Sak, 2016).

Although there was the belief that creative abilities of individuals were transmitted through genetic aspects, this belief has changed in years; today, it is believed that there are individual differences in creative abilities and creativity can be supported and developed when proper education is given. It is believed that when students have the chance to get proper learning opportunities, when they have proper conditions and teaching practices in education process, they will learn 'creativity' and develop their potential in this respect (Sak, 2016; Tok, 2008; Tezci, 2002; Johns, Morse and Morse, 2000; Singer and Singer, 2008; Torrance, 1995, 1968; Shalley, 1991). Results of researches about developing creativity indicate that qualification of education about developing creative thinking is highly important (Tezci, 2002; Johns et al., 2000; Singer and Singer, 1998; Torrance, 1995, 1968; Shalley, 1991; Karataş and Özcan, 2010).

On the basis of these data, it can be said that every individual has some level of creativity (Runco, 2004); but various factors such as family, educational environment, socio-cultural and socio-economic environment have important effects on the emergence and development of creativity. People living in societies that don't put

individuality at the center have lower chance to discover their creativity. On the other hand, creativity can be developed through special education programs and techniques. Importance of discovering and supporting creativity is emphasized in various disciplines. Covington et al. (1967) stated that developing creative thinking skill should be the primary goal of educational programs. Taylor and Barron (1963) mentioned that teachers should know that students aren't simply learners; they are thinkers, producers and creators at the same time.

Creative working requires implementation and balancing of three abilities: Synthetic, analytic and practical (Sternberg, 1985; Sternberg and Lubart, 1995; Sternberg and O'Hara, 1999; Sternberg and Williams, 1996). All these abilities can be supported and developed (Gelman and Gottfried, 2006; Moran et al., 2003; Runco, 2004).

Synthetic ability is considered as the feature of 'creativity'. Man, described as 'creative' by others, is a qualified synthetic thinker who is able to make connections between issues that aren't immediately perceived by others. Analytic ability on the other hand is generally considered as the ability of critical thinking. Man who has this ability analyzes different ideas and assesses them; even the most skillful person has thoughts that can be defined as 'better' and 'worse'. A creative thinker can have good and bad ideas without a well-supported analytic ability. Creative individual uses this ability to analyze the content of a creative idea and to test it. Practical ability is used to turn theory into practice, to turn abstract ideas into practical success. Content of investment theory in creativity is based on the argument that 'great ideas don't sell themselves'. A creative man uses his practical ability to pursue others that he has a great idea. For instance, each organization determines some rules to conduct its affairs. When an individual presents a new procedure, he has to pursue others that this new idea is better than the previous one. Practical ability is at the same time used to promote ideas that have potential listeners (Sternberg et al., 2008).

Guilford in his theory of the 'Structure of the Intellect", argues that intelligence consists of numerous intellectual abilities. His theory has been an inspiration to a variety of researches, studies of test developing, and educations for developing creativity. He states that, as a part of operation dimension in his theory, intellect is a composition of convergent and divergent thinking (Sak, 2016). Divergent production/thinking can be considered as creativity. Guilford (1967) defines divergent thinking as a structure made of the dimensions of fluency, flexibility, originality and elaboration.

**Fluency:** It can be defined as the skill to produce great number of ideas that are believed to increase creativity.

**Flexibility:** It can be defined as the state of getting rid of the monotony in thinking, to be able to simultaneously propose different approaches to problems, to think in the frame of a variety of categories and adapt to different situations.

**Originality:** It is extraordinariness and originality in producing an innovative product; it can be said that originality is the most developed feature of creativity. It is the state of being able to think what others cannot in the process of generating ideas.

**Elaboration:** It is the ability to explain ideas in a detailed, enriched and elaborated manner.

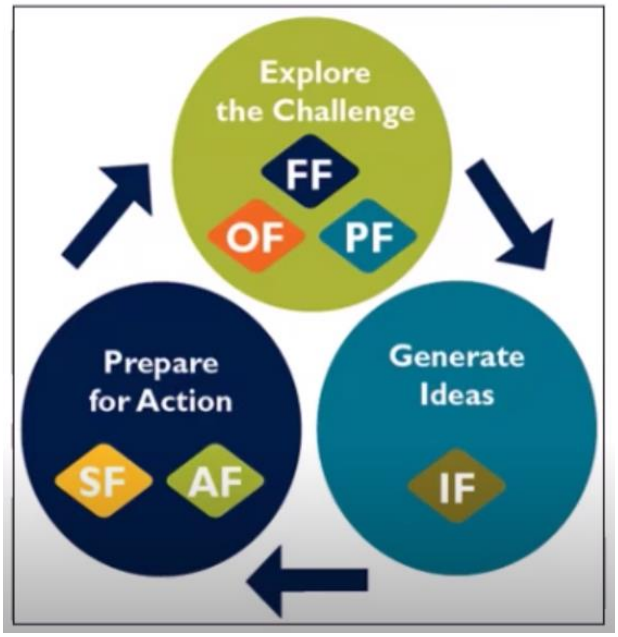
Creative Problem solving and Six Thinking Hats techniques/methods, which are believed to be efficient in developing fluency, flexibility, originality and elaboration dimensions of creative thinking, are used in this research. Information about their relations with creativity and their application methods are presented subsequently.

## Creative problem solving

Modern Educational approaches give importance to support and develop student problem solving skills rather than uploading knowledge. Freire (2003) defines this as a transition from banking education concept to problem based education model. Similarly, according to Gagne (1980), the real, basic reason of education is to teach students how to think and enable them become better problem solvers. If the notion of 'problem' is shortly defined as the difference between a current state and the desired one, then 'problem solving' can be defined as the entire cognitive, emotional and dynamic processing/ processes used for eliminating this difference.

There are different techniques and approaches for problem solving. One of this is the technique called creative problem solving technique. This method, which has been analyzed and developed in variety of conceptual, theoretical and practical studies, was first shaped created and introduced by Osborn (1953) and Parnes (1967). Osborn (1953) defines creative problem solving as the process of approaching a problem and finding a new solution to it by using imagination and judgment; according to Osborn, every individual can learn this process. Creative problem solving technique, which has evolved and changed in time, was finally shaped as a concept involving six different stages (Isaksen and Treffinger, 1985). The first stage involves an active divergent thinking (fluency, flexibility, originality and elaboration). Sak (2016) calls this process as "production". Innovative, frantic and different thoughts are accepted and brainstorming is the basic process of this stage. It can be said that the so called synthetic ability by Sternberg (1985) is put into practice in this process.

The second stage involves a process of decreasing alternative ideas that are produced in the first stage, through elimination on the basis of personal judgment; in other words, the ability of convergent thinking it put into




**Explore the Challenge**
OF: Objective Finding
FF: Fact Finding
PF: Problem Finding

**Generate Ideas**
IF: Idea Finding

**Prepare for Action**
SF: Solution Finding
AF: Acceptance Finding

**Figure 1.** Osborn-Parnes (1966) Creative Problem Solving Model.

practice. This stage can be called “focus” (Sak, 2016). Analytic thinking ability is active in this stage; besides, the goal is to reach especially elaborated and original thoughts through divergent thinking skills. Creative problem solving is made of a total of 6 stages; 3 main and 3 sub-stages. The definitions of creative problem solving stages is presented in Figure 1. Creative Problem Solving model was first developed by Osborn and Parnes in 1966; the model was developed and finalized by Treffinger and Isaksen after 1980s. It is based on 6 stages: objective finding, fact finding, problem finding, idea finding, solution finding, acceptance finding.

Firstly, all of the thoughts, questions and feelings are analyzed without making any judgments; this process requires a divergent thinking based study. Another study that requires convergent thinking is carried out as the next step; the ideas that are produced in the first stage are analyzed in this process. Students have the chance to use fluent, flexible, elaborated and original thinking skills in all of the stages of creative problem solving.

## 6 thinking hats method

One of the most reliable and proper teaching techniques that can be used in schools is six thinking hats model developed by De Bono Edward (1985); the technique supports synthetic, analytic and practical abilities in terms of creativity. Six thinking hats method gives students the chance to improve all these abilities. It is highly practical and easy to use in schools. It aims at putting six different thinking styles into practice under six different hats in order to develop parallel thinking skill. Each hat requires a different type of thinking and individuals generate thoughts required by that hat. This process enable students look at an incident or problem from different dimensions. The ways of thinking and questions to be asked at each hat are presented thus (Carl III, 1996).

**White Hat (Neutral hat):** Information and facts about a topic are collected, there is no judgment. Questions such as: “What do I know right now? What do I want to find out? How can I reach the information I need?” are asked. It is especially necessary to use fluent and elaborated thinking abilities.

**Black hat (Negative hat):** It is necessary to act like a prosecutor in an inquiry in this step. The topic is criticized, risks are calculated. Negative questions such as “What are the difficulties? What are the weaknesses? What kind of threats are there? Flexible and elaborated thinking skills are mainly used just like the process in white thinking hat.

**Red hat (Subjective hat):** This hat is about emotions. Intuitive reactions or expressions of feelings without the need of justification are significant. Individuals try to express their personal feelings and understand the feelings of others. Emotions and intuitions are important in this step and flexible and original thinking skills are more active.

**Yellow hat (Positive hat):** Students focus on positive points and advantages of the issue. Positive, happy

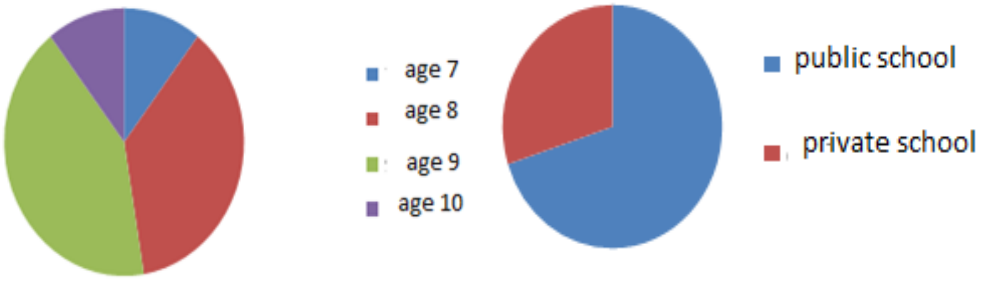



**Figure 2.** Study group graphics.

thoughts are generated. Questions such as: "What are the good points in this issue or incident? What are the benefits in this incident? Why do you think this idea or thought will lead a positive result?" should be asked.

**Blue hat (Decision maker):** It is the supervisor hat which regulates, organizes thinking. Students focus on thinking about thinking; cognitive skills are practiced in this step. Questions are about the generated thoughts. It is the hat that has the highest relations with other hats. Fluent, flexible, elaborated and original thinking skills are used in this thinking hat. Thinking is organized and action plan is prepared.

**Green hat (Creative hat):** Students focus on thoughts, alternatives and possibilities. This stage requires generating new ideas; precautions are calculated to prevent or remove negativities and drawbacks, which are determined in black hat stage. Original thinking skill is intensely used. It is important to note that hats are especially designed to ensure students generate a variety of thoughts in different categories; students are required to elaborate what they think. They are supported for finding solutions and answers to problems. On the basis of all these, it can be said that all of the sub-dimensions of divergent thinking are separately used in each hat. On the other hand, using six thinking hat technique in creative problem solving stages and applying it in each sub stage will contribute to reaching productive, clear and original results.

## MATERIALS AND METHODS

Case Study method is used in this research. A researcher carefully observes a child, a classroom, a school or unit in this study method. Various incidents are observed and analyzed in details to be able to make generalizations about the environment of a subject unit (Cohen and Manion, 1989). Case study analyses are especially proper for studies that are carried out personally as it gives opportunity to make detailed analysis about a dimension of the subject problem; it also enables researchers conduct a study in a short period of time. Case study method is preferred in this research in order to better understand subject students; the approaches preferred by them in finding alternative solutions to environment problems, generating ideas and making detailed analysis about these problems by using creative problem solving method are analyzed by researchers.

A specific case is researched, analyzed and tested in a case study process. Case is defined as a whole system with specific borders (Stake, 1995). Anything that has borders or is a unified whole is either a case or a subject of a case. Either a case whose borders are predetermined is chosen and researched or researcher personally determines the border of his/her research in case study method (Stake, 1995). This study is limited to a creative problem solving activity about environment problems (establishing of Hydroelectric Power Plants). Two different data are collected from students with this method. Data are collected on the basis of the student answers to the questions in the study guide specifically prepared for them and records of semi-structured interviews held with subject students.

### Study group

It is determined that there is not sufficient number of studies about the education of students with gifted and talented in the related literature. As these students are especially sensitive to environmental problems and they are skillful in finding creative solutions, they are chosen as research subjects. Counseling centers determined that the target study group involves students with gifted and talented. They are chosen on the basis of voluntariness; the group consists of a total of 20 students at 2$^{nd}$, 3$^{rd}$, 4$^{th}$ and 5$^{th}$ grades. Wisc-R scores of students vary between 130 and 160. 70% of students have education in public schools while 30% of students receive training in private schools. Written consents of student parents are received before the application process and they are required to fill in health information forms (Figure 2). Urban Creative Thinking Test A and B forms average score values and percentages of participant students are presented in Table 1. Students with 11-17 creativity scores are in the sub-group while the ones with 18-37 scores are in the super-group.

### Data collection tools and analysis of data

#### *Urban creative thinking test- drawing production*

The Test for Creative Thinking–Drawing Production (TCT-DP), originally developed by Urban and Jellen (1996) was adapted to Turkish by Yontar Toğrul (1998) and necessary reliability, validity analyses were carried out. The original test that was conducted in Hungary with a total of 1100 individuals could discriminate subjects with highest (25%) and lowest (25%) creative potential; so, the reliability of the test was quite high. The stability of scores in Turkish sample indicates that the result of this research is in parallel with the original one, in other words, it is reliable.

The Test for Creative Thinking–Drawing Production is an

**Table 1.** Urban creative thinking test scores.

| Groups | Creativity scores | f | % |
|---|---|---|---|
| Lower-Group | 11 | 1 | 5 |
| | 13 | 2 | 10 |
| | 14 | 3 | 15 |
| | 15 | 2 | 10 |
| | 17 | 2 | 10 |
| | 18 | 3 | 15 |
| | 19 | 2 | 10 |
| Super-group | 21 | 1 | 5 |
| | 22 | 1 | 5 |
| | 23 | 1 | 5 |
| | 25 | 1 | 5 |
| | 37 | 1 | 5 |

analysis tool that gives the opportunity to economically and simply assess creative potentials of individuals. The test can be conducted to any individual over five years old (5-95) and it possible to conduct it to individuals or groups. The assessment tool involves of two forms: A and B forms are successively presented to the participants. Administration duration is 15 minutes. There are six different fragments: A semi-circle, a dot, a big right angle, a curved line, a dashed line, a small open square outside a big square frame. “Big Square Frame” isn’t considered as a fragment piece. Each form is assessed right after the test application by taking the assessment standards into consideration (Urban and Jellen, 1996).

Assessment using the TCT-DP includes 14 criteria Creative Thinking Test (1) continuations (Cn), (2) completion (Cm), (3) new elements (Ne), (4) connections made with a line (Cl), (5) connections that contribute to a theme (Cth), (6) boundary breaking that is fragment-dependent (Bfd), (7) boundary breaking that is fragment-independent (Bfi), (8) perspective (Pe), (9) humor and affectivity (Hu), (10) unconventionality A (Uca); (11) unconventionality B (Ucb), (12) unconventionality C (Ucc), (13) unconventionality D(Ucd) (14) Speed (Sp) (Urban and Jellen, 1996; Urban, 2004; Urban, 2005).

These interactive criteria reflect the wholistic perspective about creative thinking. A score in one criterion doesn’t give information about creativity in statistical assessments; total score obtained from all of the criteria gives researcher data about the value of creative product. It is possible to reach a total estimated value about creativity skills of an individual through these criteria which are used for assessing a complete picture. This result is not considered as a conclusion about technical or artistic qualifications; it reflects a clear and flexible duty, a creative attitude and willingness for reaching extraordinary, original interpretations and solutions (Urban and Jellen, 1996).

The Test for Creative Thinking–Drawing Production A and B forms of students with gifted and talented are scored according to assessment criteria by two independent researchers. After that, grades given by the researchers are compared. The number of consensus and dissensus are determined and reliability of the research is determined by Miles and Huberman formula (Reliability = consensus/consensus+ dissensus). Reliability study, specifically designed for this study, indicated that there is 80% *reconciliation* (reliability).

### *Qualitative assessment tools*

Qualitative data about the research are collected with study guide, observation forms and semi-structured interviews. A study guide is prepared for each participant student; activities are explained in details in study guides. All of the stages of creative problem solving are included in these creative problem solving forms which are adapted to environmental problems. The goal and topic of the activity are explained and necessary items are listed. On the other hand, there are specific spaces in which activity preliminary questions, student findings and interpretations are noted; there are post-application assessment questions in the form. Student views, data about the process and experiences about activities are collected with this guide and they are assessed as a part of data analysis. Semi-structured interviews are used to collect student views about the activity.

### *Application field of the study: Nezahat Gökyiğit Botanical Garden (NGBG)*

Botanical garden is a natural living and learning environment organized to protect and reflect the relationship between plant families. Nezahat Gökyiğit Botanical Garden (NGBG) is a place for social activity aimed at protecting, understanding, promotion of biological variety; the garden is supported and protected by Ali Nihat Gökyigit Foundation (ANG Foundation) (NGBG, 2013). NGBG is one of the most important out-of-school learning environments in Turkey; it is located in the middle of Istanbul, which is a significant metropolis, and it involves a variety of plant collections (Nuhoğlu, 2012).

Gifted and talented students carried out activities in Nezahat Gökyiğit Botanical Garden, which is a natural living and learning environment with the richest endemic species in Turkey. The activities are especially designed for improving creative problem solving skills in scope of the research.

## FINDINGS

### Findings about Intelligence test and urban creative thinking test-drawing production

Nanoparametric spearman correlation analysis is conducted to analyze the relationship between Scores of creative thinking test and Wisc-R intelligence test which is carried out by Student Counseling Center. Results of

**Table 2.** Results of the analysis of correlation between Intelligence, Creativity and Gender (Nonparametric Spearman).

| Variables | N | X | SD | r | p |
|---|---|---|---|---|---|
| Intelligence Scores (WISC-R) | 20 | 135.35 | 10.091 | 0.022 | 0.927 |
| Creativity Scores (TCT-DP) | 20 | 35.70 | 11.365 | | |

*p < 0.05.

**Table 3.** Creative problem solving stages and 6 thinking hats.

| S/N | Creative problem solving | 6 Thinking hats method |
|---|---|---|
| 1 | Determining preliminary information with preliminary questions | |
| 2 | Introduction of 6 thinking hats method | White Hat, Yellow Hat, Black Hat, Red Hat, Green Hat, Blue Hat |
| 3 | First step: Objective finding | White Hat |
| 4 | Second step: Fact finding | White Hat, Yellow Hat, Black Hat, Red Hat |
| 5 | Third step: Problem finding | White Hat, Yellow Hat, Black Hat, Red Hat, Green Hat, Blue Hat |
| 6 | Fourth step: Idea finding | Green Hat, Blue Hat |
| 7 | Fifth step: Solution finding | Green Hat, Blue Hat |
| 8 | Sixth step: Acceptance finding | White Hat, Yellow Hat, Black Hat, Red Hat, Green Hat, Blue Hat |

the analysis are presented in Table 2. When Table 2 is analyzed, it can be seen that there is not a meaningful relationship between student intelligence scores and creative thinking scores ($p < 0.05$).

## Creative problem solving application

Activities in scope of the study continued for 6 h. Students tried to solve a problem through experience by using 6 thinking hats method. They carried out discussions about hydroelectric power plants and environmental problems that they can cause. They suggested alternative solutions to the possible problems. Steps of creative problem solving method and content of 6 thinking hats method in scope of the application are presented in Table 3. Firstly, preliminary questions are asked to the participants to learn what they know about hydroelectric power plants and understand their thoughts about them.

## Preliminary knowledge of students about hydroelectric power plants

Almost half of the students stated that they have no information about hydroelectric power plants. Some of the students defined hydroelectric power plants as machines, some defined as facilities that produce electricity and some others said that they are facilities that produce electricity by using solar, water or wind energy. One student stated that Hydroelectric Power Plants uses recycled materials, animal and plant wastes to produce energy. The number of students who believe that it is necessary to establish hydroelectric power plants is equal to the number of students who believe that they shouldn't be established.

## Discussion: Should hydroelectric power plants be established or not?

Data obtained from students throughout the process of creative problem solving stages about hydroelectric power plants are presented subsequently.

**Step 1: Objective finding:** Discussion about the available energy resources.

Students stated the energy resources they know in the first step of creative thinking; they carried out discussions about the benefits and damages of hydroelectric power plants. Students stated that they know power resources such as wind, solar, carbon, water and petroleum. It is observed that preliminary knowledge of students before starting problem solving process changed and increased. Studies of students in the first step are presented in Table 4. When Table 4 is analyzed, it can be seen that students are divided into two groups on the basis of their

**Table 4.** Objective finding data (energy resources).

| Creativity Score Ranges | Creative problem solving stage 1 | | | |
|---|---|---|---|---|
| | Objective Finding – Energy resources | | | |
| | Fluency | Flexibility | Originality | Elaboration |
| Lower-group between 11-17 | Wind (9)<br>Solar (8)<br>Carbon (8)<br>Water (5)<br>Petroleum (4)<br>Hydroelectric Power Plants (2)<br>Natural Gas (3)<br>Wave (6)<br>Waste (6)<br>Nuclear (5)<br>10 ideas | Non-Renewable Energy Resources<br>(i) Carbon,<br>(ii) Petroleum,<br>(iii) Natural Gas,<br>(iv) Nuclear.<br>Renewable Energy resources<br>(i) Solar power,<br>(ii) Wind power,<br>(iii) Hydraulic Power,<br>(iv) Biomass power.<br>2 different categories 8 different categories | 0 different ideas | Medium level |
| Super- group Between 18-37 | Wind (10)<br>Solar (9)<br>Carbon (10)<br>Water (10)<br>Petroleum (9)<br>Hydroelectric power plants (8)<br>Natural Gas (7)<br>Wave (6)<br>Waste (6)<br>Nuclear (5)<br>Animal waste (4)<br>Plant waste (3)<br>Geothermal (3)<br>Biomass (3)<br>Renewable energy (1)<br>Natural resources (1)<br>16 ideas | Non-Renewable Energy Resources,<br>(i) Coal,<br>(ii) Petroleum,<br>(iii) Natural Gas,<br>(iv) Nuclear.<br>Renewable Energy resources<br>(i) Solar power,<br>(ii) Wind power,<br>(iii) Hydraulic power,<br>(iv) Geothermal power<br>(v) Wind power<br>(vi) Biomass power.<br>2 different categories 10 different sub-categories | 5 different ideas | Medium level |

creative thinking scores; students in the super group generated more ideas, they had more sub-groups, they generated a higher variety of ideas, and they elaborated the ideas they produced. Data about the benefits and damages of hydroelectric power plants, obtained from students are presented in Table 5; the data are collected as a part of objective finding process. When Table 5 is analyzed, it can be seen that students are divided into two groups on the basis of their creative thinking scores; students in the super group generated more ideas, they had more sub-groups, they generated a higher variety of ideas, and they elaborated the ideas they produced.

### Step 2: Fact finding

Fact about the specific, complicated case are collected and information about the state is increased in this step. Information, unknown points, problems, obstacles and necessary information are determined to explore and explain the case. All of the information to be collected in this step serves the purpose of solving complication and starting innovation. What, Which, Who, How, Where, When are some of the questions asked in this step; collecting data to better understand the problem, researching the accuracy of intuition, observation and emotion is important in this step. Students are asked to prepare some questions to collect data about Hydroelectric Power Plants. Questions are presented in Table 6.

When the Table 6 is analyzed, it can be seen that fluency scores of supergroup students in terms of questions generated in fact finding section are higher than that of lower group. Moreover, supergroup students created two different categories when compared to lower group students.

**Table 5.** Objective finding data (Benefits/damages of hydroelectric power plants).

| Creativity Score Ranges | Creative problem solving stage I | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fluency | | Flexibility | | Originality | | Elaboration |
| | Benefits of Hydroelectric Power Plants | Damages of Hydroelectric Power Plants | Benefits of Hydroelectric Power Plants | Damages of Hydroelectric Power Plants | Benefits of Hydroelectric Power Plants | Damages of Hydroelectric Power Plants | |
| Lower-group between 11-17 | Energy production (5)<br>Electric production (4)<br>Irrigation of lands (5)<br>Economic value (5)<br>Tourism (2)<br>Transportation (1)<br>Preventing flood (1) | Destruction of natural beauties (8)<br>Extinction of living creatures(5)<br>Destruction of historical artifacts(3)<br>Cutting down trees (3)<br>Extinction of animals (2)<br>Destruction of fertile lands (1) | Electrical power<br>Economic values<br>(i) Agriculture<br>(ii) Tourism<br>(iii) Transportation<br>(iv) Preventing flood | Destruction<br>(i) Natural beauties<br>(ii) Living creatures<br>(iii) Historical Artifacts | | | Medium level |
| | 7 ideas | 6 ideas | 2 categories 4 sub-categories | 2 categories 3 sub-categories | O different ideas | 0 different ideas | |
| Super-group between 18-37 | Energy production (10)<br>Electric production (8)<br>Fishing (6)<br>Irrigation of Lands (7)<br>Economic value (5)<br>Tourism (4)<br>Transportation (3)<br>Preventing flood (3)<br>Saving(2)<br>Long-lasting(1) | Destruction of natural beauties (10)<br>Extinction of living creatures(8)<br>Destruction of historical artifacts(7)<br>Cutting down trees(6)<br>Extinction of animals (5)<br>Destruction of fertile lands (2) | Electrical power Economic value<br>(i) Agriculture<br>(ii) Tourism<br>(iii) Transportation<br>(iv) Fishing<br>(v) Preventing flood<br>(vi) Savings | Destruction<br>(i) Natural beauties<br>(ii) Living creatures<br>(iii) Historical Artifacts | | | Medium Level |
| | 10 ideas | 6 ideas | 2 categories 6 subcategories | 1 categories 3 sub-categories | 2 different ideas | 0 different ideas | |

**Step 3: Problem finding**

Different ways about a complicated case are taken into consideration and the real problem that will reveal the problematic situation and reflect possibilities is determined in this stage. Students generate as many problems as possible. Problematic cases that are proper for the solution are defined and the most important problem is separated. There is the attempt to find the basic, real reason that causes the problem. The question "Why would establishing Hydroelectric Power Plants cause problems?" is asked. The problem is expressed with sub-problems. Each sub-problem is expressed with an open ended question starting with "In what ways …"

Sub-problems:

In what ways...?
Data obtained from students are presented in Table 7.

The problem sentences generated by students are presented as follows:

**Table 6.** Fact finding.

| Creativity score ranges | Creative problem solving stage 2 | | | |
|---|---|---|---|---|
| | Finding data | | | |
| | Fluency | Flexibility | Originality | Elaboration |
| Lower-group Between 11-17 | Where should they be established? (5)<br>Do they give any damage to natural resources and living creatures? (5)<br>How do they produce energy? (4)<br>How does the electricity produced with Hydroelectric Power Plants? (3)<br>How should we use natural resources? (2)<br>What kind of a procedure should be followed to enable them function better? (2)<br>How can we prevent energy resources from being wasted? (1)<br>7 ideas | Hydroelectric Power Plants<br>(i) The place they are established<br>(ii) Their damages to living creatures<br>(iii) The way they produce energy<br>(iv) The way they function<br>4 sub-categories | 0 different ideas | Medium level |
| Super group between 18-37 | What is the purpose of establishing Hydroelectric Power Plants? (2)<br>Where should they be established? (5)<br>Do they give damage to natural resources and living beings? (7)<br>How do they produce energy? (4)<br>How does the electricity produced with Hydroelectric Power Plants? (3)<br>How should we use natural resources? (3)<br>What kind of difficulties will we face if we don't have technological progress? (2)<br>What kind of a procedure should be followed to enable them function better? (2)<br>How can we prevent energy resources from being wasted? What will happen if Hydroelectric Power Plants aren't prevented?<br>10 ideas | Hydroelectric Power Plants<br>(i) The place they are established<br>(ii) Their impact<br>(iii) Their damages to living creatures<br>(iv) The way they produce energy<br>(v) The way they function<br>(vi) The impact of technological progress on environmental problems<br>6 sub-categories | 2 different ideas | Medium level |

(i) Does establishing Hydroelectric Power Plants destroy nature?
(ii) How can we prevent damages caused by Hydroelectric Power Plants?
(iii) How can we protect historical artifacts?
(iv) In what ways can energy necessity be decreased?
(v) In what ways can we eliminate the disadvantages of Hydroelectric Power Plants?
(vi) How can we prevent the destruction of natural resources?

**Step 4: Idea finding**

A variety of possible solutions that will answer problem question sentence are generated and promising solutions are chosen. Creativity scores are assessed in two different categories; solutions generated by students are presented as follows:

(i) Not cutting down trees
(ii) Creating new forests
(iii) Protecting natural resources
(iv) Finding natural energy resources
(v) Planting trees instead of building apartments
(vi) Establishing smaller Hydroelectric Power Plants
(vii) Protecting historical artifacts
(viii) Trees should be transferred to other places in cooperation with TEMA (the Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats)
(ix) Municipality can give financial support to people
(x) Financial aids can be provided to individuals who do farming/agriculture
(xi) They can be established in a way that they don't destroy natural lands
(xii) They can be built on places with no historical artifacts
(xiii) Historical artifacts can be moved
(xiv) Dams can be smaller
(xv) People can be directed towards conserving electricity instead of establishing Hydroelectric Power Plants
(xvi) Filters can be implemented to in Hydroelectric Power Plants to prevent damage to the nature.

**Step 5: Solution finding**

A list of criteria chosen for taking a step towards solving a problem, for preferring the best solution/solutions is used in this step. Ideas that are generated for finding solution, their impacts and validity are analyzed and carefully evaluated through new and different ways. The most proper and valid way for the solution of a specific problematic situation is chosen.

**Table 7.** Problem finding data.

| Creativity score ranges | Creative problem solving stage 3 | | | |
|---|---|---|---|---|
| | Finding problem | | | |
| | Fluency | Flexibility | Originality | Elaboration |
| Lower-group between i-17 | (i) In what ways…<br>(ii) Can artifacts be protected? (4)<br>Can the use of electricity be decreased? (4)<br>(iii) Can Hydroelectric Power Plants be safer? (3)<br>(iv) Can the damage of Hydroelectric Power Plants on nature be prevented? (2)<br>(v) Can the necessity of energy be decreased? (2)<br>(vi) Can electricity production be increased? (2)<br>(vii) Can living beings in nature survive? (3)<br>(viii) Can we prevent Cutting down trees? (1)<br>(ix) Can we use Hydroelectric Power Plants more efficient? (1)<br>9 ideas | (i) Minimizing the use of electricity<br>(ii) Making Hydroelectric Power Plants safer<br>(iii) Preventing damage to living beings and nature<br>3 sub-categories | 0 different ideas | Medium level |
| Super group between 18-37 | (i) In what ways…<br>(ii) Can historical artifacts be protected? (5)<br>(iii) Can the use of electricity be minimized? (6)<br>(iv) Can Hydroelectric Power Plants become safer? (4)<br>(v) Can we safely locate dams on valleys? (3)<br>(vi) Can the damage of Hydroelectric Power Plants on nature be prevented? (3)<br>(vii) Can the necessity of energy be decreased? (3)<br>(viii) Can electricity production be increased? (2)<br>(ix) Can living beings in nature survive? (3)<br>(x) Can we prevent cutting down trees? (2)<br>(xi) Can we use Hydroelectric Power Plants more efficiently? (3)<br>(xii) How can we use natural resources?<br>12 ideas | (i) Minimizing the use of electricity<br>(ii) Making Hydroelectric Power Plants safer<br>(iii) Organizing the location of dams<br>(iv) Preventing damage to living beings and nature<br>4 sub-categories | 3 different ideas | Medium level |

Criteria are determined to analyze ideas about solutions, to define advantages, limits and specific features of each idea. Criteria determined by students for solution suggestions: Cost (8), Duration (8), Security (7), Ethics (5), Probability of Success (7), Risk (5), Aesthetics (4), Persistence (3), Legitimacy (2).

### Step 6: Acceptance finding

This step aim is to giving effort to accept the idea to find a solution, making decision about an action plan. Ideas for the action plan are developed and applied. The ways to make ideas or solutions more efficient, more acceptable, powerful, beneficial are sought in this step. Resources that can be beneficial in putting ideas into practice are researched, issues that may cause problems are determined. The ways that supportive resources or people can be beneficial in case of a problem are planned.

Cooperation with State+
Cooperation with public
Gaining the support of people who do farming/agriculture
Non-governmental organizations
Cooperation with Ministry of Environment and Urbanization
Cooperation with environment protection associations
I would explain that I do not want it as it is costly and takes a long time to be established
24 h: Brainstorming, researching and generating solutions, I discuss it with important figures
1 week: making agreement, interviewing with officers, I get approval and hold meetings
Long-term: Putting the project into practice, I gather signature, I would try anything to get rid of Hydroelectric Power Plants.

### Student views about activity

After the observations during application process in scope of the research and the semi-structured interviews with students, it is determined that students actively

participated in all of the activities. It is also determined that students felt comfortable in the nature, they ask more questions, they work in cooperation with their friends, which are significant results. It is observed that they try to give examples from the nature during activities, they continue to make discussions about trees and they talked about protecting endemic species. Students mentioned that they are excited about exploring the nature and it is a new experience for them; they also stated that they have fun in doing so.

Student views are formulated with $n(G/B)_x$. "n" stands for the grade of students, "G/B" stands for the gender and "x" stands for the line of the students.

Views of some students about activities are presented subsequently:

$5G_{10}$: "I used to hear about Hydroelectric Power Plants but I have learnt what they are used for today, in the activity. We wore hats with different colors and told what we were thinking. I don't want Hydroelectric Power Plants. I had discussions about this with my friends in my group. It was very good to be in nature."

5 $B_{17}$: "I am very interested in the issue of Hydroelectric Power Plants. I really like this topic. The questions were just made for me. I thought a lot about it, me and my friends generated a variety of ideas. Each one of my friends had the chance to express his/her ideas although we sometimes argued about the topic. That is my kind of a place. I wish we had such classes in our school."

$4G_{19}$: "We talked about Hydroelectric Power Plants in this activity. We learnt about the advantages and disadvantages of them. We created problems and tried to find solutions. I had the chance to think, make assessments. I liked finding new ideas."

$5G_{18}$: "We learnt new information about electrical energy. I liked being in nature and generating new ideas. Questions were interesting and we gave a great deal of effort for finding solutions to problems."

$5G_{16}$: "I would never get bored of such classes. I had new knowledge and talked about my ideas by wearing different hats. I spoke freely and didn't get any warning for telling my opinions; this is why, I never got bored of this activity."

$3B_{01}$: "I was abstaining from telling what I think at the beginning as I didn't have any knowledge about Hydroelectric Power Plants; but I saw that my friends told whatever they wanted, so I started talking about my ideas, asking what I want and answering questions. I told my feelings with red hat, I was very nice, I liked that."

$4B_{06}$: "I didn't know that solving a problem is this easy; but then I learnt how to find different solutions when I could think things through. I got a little bored, I had a little difficulty, but I felt that I understood the subject when the activity was completed."

## DISCUSSION

It is determined that there is not a meaningful relationship between intelligence scores and creativity levels of gifted students who participated in the study. This result is consistent with the results of a previous similar research whose goal was to determine the relationship between intellect and creativity on the basis of gifted students sampling (Barron, 1963, 1969; Tannenbaum, 1983; Runco and Albert, 1986; Yong, 1994; Ogurlu, 2014). Fox (1981) analyzed 14 different researches which are about the relationship between intellect and creativity and stated that there is a low relationship between these two variables.

It is possible to explain the result of this study with Spearman's (1927) "Law of Diminishing Returns (SLODR)". In terms of the law of diminishing returns, it is possible to say that the relationship between creativity and intellect in higher intellect levels is lower than the relationship of the same two variables in lower intellect levels. There are also some other research findings that don't conform with the results of this study. For instance Preckel et al. (2006) reported that according to their study, there is a meaningful relationship between creativity level and intelligence scores. Difference in age, education and talent groups used in different studies may lead to different results in terms of the relationship between creativity and intellect; size of the sampling, using different methods for assessing intellect and creativity can be some other reasons of differences in study results. On the basis of this data, it can be said that it is necessary to make more researches that involve bigger population and more studies that involve data collected from wide and different levels of skills with more than one intelligence and creativity scale.

It is seen that creative problem solving technique is used in education programs for enabling students create new and original solutions (Treffinger, 1995); moreover, the technique aims at creating enrichment activities designed for gifted children (Renzulli, 2016). Cramond et al. (1990), carried out a study about the generalizability of creative problem solving for daily life problems; they worked with a total of 75 gifted children in $6^{th}$, $7^{th}$ and $8^{th}$ grades. At the end of the study process, they found that there are meaningful differences in problem solving scores of the group who practiced creative problem solving skills along with the skill of transferring. It is emphasized that education on analogy and reasoning given besides problem solving education is efficient in solving real-life problems.

Karabey (2010) conducted a study for determining the access level of gifted and talented students to creative problem solving in mathematics and their critical thinking skills. According to the study, there is a meaningful difference between $6^{th}$ and $7^{th}$ grade students' creative problem solving and critical thinking skills. In this respect, it is seen that critical thinking skills of students is higher than their creative problem solving skills. Studies of students carried out in the scope of creative problem solving activities are assessed on the basis of 4 dimensions of creativity (fluency, flexibility, originality,

elaboration). Creativity scores of Urban Creativity Test are analyzed in two categories; lower-group and supergroup. 10 students with scores ranging from 11 to 17 are included in the lower-group while 10 students with scores ranging from 11 to 17 are included in the supergroup. Data are obtained from gifted and talented students in the throughout the stages of creative problem solving and they are assessed in terms of the dimensions of creativity. At the end of the research process, it is determined that students in the supergroup are more creative than the ones in the lower-group in terms of generating more ideas, generating ideas in different categories and having more original ideas. Fluency has become a sub-dimension of creativity because of the close relationship between creativity and divergent thinking (Guilford, 1967). It can be said that creativity increases in line with the increase in the number of thoughts. On the other hand, it should be noted that although emerging a variety of ideas is important for creativity, it is not sufficient. At this point, emerging thoughts in different categories becomes another important dimension of creativity. If we assume that there are two students with the same number of ideas, but one student's ideas involve more concepts, fit into more fields, disciplines and categories, then we can say that this student has bigger creativity potential as he has the ability to think in a more flexible manner. Besides fluency and flexibility, elaboration of the emerged ideas is a significant dimension in terms of creative thinking. While fluency, flexibility and elaboration are important dimensions of divergent thinking, it is possible to say that this type of thinking is in close connection with thinking about being thought by others and being able to emerge ideas that cannot be emerged by others. Both the general creativity scales (Torrance, 1966; Urban and Jellen, 1996) and domain-specific creativity scales (Balka, 1974; Akgül; 2014) in the literature use a scoring system on the basis of fluency, flexibility, elaboration and originality dimensions. A similar method is used in this study and ideas created by students are scored on the basis of these dimensions. At the end of this process, it is determined that 1) students with higher creativity level generated more ideas, they thought in a more flexible manner, they could elaborate their ideas and generated more extraordinary ideas; 2) studying with a creative problem solving technique stimulated all of the students for thinking in a more fluent, flexible, elaborated and extraordinary manner.

Use of six thinking hats technique along with creative problem solving technique has been beneficial in preventing any possible conflict during idea-creation and determining valid thoughts. Efficient use of 6 thinking hats technique requires respect during activities; students have to be respectful to the viewpoints and thoughts of others; thus students are able to see that every different perspective is valuable (De Bono, 1995). This technique gives the opportunity to transform a process of sensibility and skepticism of students during thinking, into a normal and rational process; it also enables students use creativity during decision-making. There is the effort to make others accept the generated ideas, namely others should be convinced. In this respect, it can be said that practical ability is used in every hat. On the other hand, using six thinking hats technique in creative problem solving stages and in all of the sub-stages contributes to reaching more productive, clear and original results.

It is believed that divergent thinking and problem solving skills which are related with the issue of creativity, can be supported and developed just like creativity. Besides, it should be noted that increasing the creativity skills of students with only one lesson per week is not possible; education programs should be reorganized for this purpose and creativity activities should be involved in every field of education. Teaching techniques supporting creative thinking process should become a part of education. It is believed that supporting and developing this skill in traditional classroom environments is not possible; moreover, current education system decreases the creativity of students. Students should be the subjects of education programs instead of objects; they should be independent individuals who actively contribute to learning process. They should feel free to express their thoughts, ideas and knowledge. Learning environments should be organized in this respect, each one of students should be respected for their viewpoint and they should be taught that there is not always a single, correct solution for a problem. Although creating such classrooms/learning environments is not easy for teachers and school managers, results will be motivating; it's thus worth the effort.

## Suggestions

Students made some solution suggestions to the problems caused by hydroelectric power plants by using creative problem solving and six thinking hats techniques. Although students practiced these techniques for the first time in solving problems, they were able to bring some solution suggestions that were original and that could really be efficient in practice. Suggestions in the light of the findings obtained from this research are separated into two groups as "suggestions for primary school practices" and "suggestions for new researches". Suggestions on the basis of the research results are presented further.

### Suggestions about the Result of this Study

(1) Techniques and activities designed for the purpose of increasing creativity of students should be a part of teaching designs.
(2) Enriched and differentiated classes in which creative problem solving techniques are used to increase the

creativity levels of gifted and talented students should be designed.
(3) In-service trainings can be organized to increase the knowledge of teachers on how to support student creativity.
(4) Associating creative problem solving and six thinking hats technique and using them together in lessons will increase the creativity of students; it is thus important to follow this process in classes.
(5) Current education system mostly involves close-ended questions that direct students towards a single right answer. Presenting students open-ended questions/ problems that lead them towards multiple-thinking will give them the chance to make more fluent, flexible and original analyses; thus, they will be able to build interdisciplinary relations and work on the basis of a multidisciplinary process. On the other hand, their creativity will increase.
(6) Student motivation for focusing and generating creative ideas can be increased in learning environments out of school.

### Suggestions for future researches on the subject

There is not sufficient number of researches in the literature about understanding the nature of creativity in gifted children; it is necessary to conduct researches and studies on the basis of the relationship between the nature of creativity and different variables. The use of creativity in education programs of gifted and talented students increases the need for researches carried out in different teaching-learning environments.

(1) This research is conducted with primary school students between the ages of 7 and 10. New researches can involve students from different grades of education.
(2) Effects of creative problem solving and six thinking hats technique besides lesson activities can be analyzed on the basis of different disciplines.
(3) The same study can be conducted on students with normal intelligence level and data obtained from two groups of students with different intelligence levels can be compared.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

### REFERENCES


Adams D, Hamm M (2010). Demystify math, science, and technology: creativity, innovation, and problem-solving. R and L Education.

Akgül S (2014). Üstün yetenekli öğrencilerin matematik yaratıcılıklarını açıklamaya yönelik bir model geliştirilmesi [A model study to examine gifted and talented students' mathematical creativity]. Yayınlanmamış doktora tezi. İstanbul Üniversitesi, İstanbul.

Amabile TM (1996). Creativity in context: Update to the social psychology of creativity. Hachette UK.

Ayas MB, Sak U (2014). Objective measure of scientific creativity: Psychometric validity of the Creative Scientific Ability Test. Thinking Skills and Creativity 13:195-205.

Balka DS (1974). Creative ability in mathematics. Arithmetic Teacher 21:633-636.

Barron F, Harrington DM (1981). Creativity, intelligence, and personality. Annual Review of Psychology 32:439-476.

Barron F (1963). Creativity and psychological health. Princeton, NY: Van Nostrand.

Carl III WJ (1996). Six Thinking Hats: Argumentativeness and Response to Thinking Model. https://files.eric.ed.gov/fulltext/ED399576.pdf

Cohen L, Manion L (1994). Research Methods in Education (Fourth edition). London: Routledge.

Covington MV, Crutchfield RS, Davies LB (1967). Teacher's guide to the productive thinking program. Berkeley, California: Educational Innovation.

Cramond B, Martin CE, Shaw EL (1990). Generalizability of Creative Problem Solving Procedures to Real-life Problems. Journal for the Education of Gifted 13:141.

De Bono E (1995). Serious creativity. The Journal for Quality and Participation 18(5):12.

Fox MN (1981). Creativity and Intelligence. Childhood Education 57(4):227-232.

Freire P (2003). Ezilenlerin pedagojisi (Çev. D. Hattatoğlu, E. Özbek). İstanbul: Ayrıntı Yayınları.

Gelman SA, Gottfried GM (2006). Creative in Young Children´ s Thought. In Creativity and reason in cognitive development. Cambridge University Press.

Getzels JW, Jackson PW (1962). Creativity and intelligence: Explorations with gifted students.

Guilford JP (1967). The nature of human intelligence. New York, NY, US: McGraw-Hill.

Isaksen SG, Treffinger DJ (1985). Creative problem solving: The basic course. Buffalo, New York: Bearly Limited.

Johns GA, Morse LW, Morse DT (2000). Divergent production in gifted adolescents using timed vs. untimed stimuli with creative prompting. Roeper Review 22(3):165-166.

Kanlı E (2014). Yaratıcı bilimsel çağrışımlar testinin geliştirilmesi ve testin psikometrik özelliklerinin araştırılması. Yayınlanmamış doktora tezi. İstanbul Üniversitesi Eğitim Bilimleri Enstitüsü, İstanbul.

Karabey B (2010). İlköğretimdeki Üstün Yetenekli Öğrencilerin Yaratıcı Problem Çözmeye Yönelik Erişi Düzeylerinin ve Kritik Düşünme Becerilerinin Belirlenmesi. Doktora Tezi. Dokuz Eylül Üniversitesi, Eğitim Bilimleri Enstitüsü, İlköğretim Matematik Eğitimi Anabilim Dalı, İzmir.

Karataş S, Özcan S (2010). Yaratıcı düşünme etkinliklerinin öğrencilerin yaratıcı düşünmelerine ve proje geliştirmelerine etkisi. Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi 11(1):225-243.

Mann EL (2006). Creativity: The essence of mathematics. Journal for the Education of the Gifted 30(2):236-260.

Marland SP (1972). Report to the Congress of the United States by the US Commissioner of Education. Washington, DC: US Government Printing Office.

Moran S, John-Steiner V, Sawyer R (2003). Creativity in the making. Creativity and development pp. 61-90.

Moravcsik MJ (1981). Creativity in science education. Science Education 65(2):221-227.

NGBG (2013). Tarihçe. Erişim adresi: http://www.ngbb.org.tr/tarihce.html.

Nuhoğlu (2012). Fen Öğretiminde Okul Dışı Öğrenme Ortamları: Botanik Bahçeleri. Ankara: Pegem Akademi Yayıncılık. ISBN:978-605-364-176-6.

Ogurlu Ü (2014). Çocuklarda zeka ve yaratıcılık ilişkisi. Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi 11:27.

Osborn AF (1953). Applied Imagination, Scribners, New York.

Parnes SJ (1967). Creative behavior guidebook, Scribners, New York.

Preckel F, Holling H, Wiese M (2006). Relationship of intelligence and creativity in gifted and non-gifted students: An investigation of threshold theory. Personality and individual differences 40(1):159-

170.
Renzulli JS (1990). A practical system for identifying gifted and talented students. Early Child Development and Care 63(1):9-18.
Renzulli JS (2016). The three-ring conception of giftedness: A developmental model for promoting creative productivity. In: S. M. Reis (Ed.), Reflections on gifted education: Critical works by Joseph S. Renzulli and colleague. Waco, TX, US: Prufrock Press. pp. 55-90.
Stacey RD (1996). Complexity and creativity in organizations. Berrett-Koehler Publishers.
Runco MA (2004). Everyone has creative potential. In: R. J. Sternberg, E. L. Grigorenko, and J. L. Singer (Eds.), Creativity: From potential to realization. Washington, DC, US: American Psychological Association pp. 21-30.
Sak U (2016). Yaratıcılık, gelişimi ve eğitimi.(2. Baskı). Vize: Ankara.
Singer DG, Singer JL (2008). Make-believe play, imagination, and creativity: links to children's media exposure. The handbook of children, media, and development pp. 290-308.
Shalley CE (1991). Effects of productivity goals, creativity goals, and personal discretion on individual creativity. Journal of Applied psychology 76(2):179.
Spearman CE (1927). The abilities of man. London: Macmillan.
Stake RE (1995). The art of case study research. Thousand Oaks, CA: SAGE Publications.
Sternberg RJ (1985). Implicit theories of intelligence, creativity, and wisdom. Journal of personality and social psychology 49(3):607.
Sternberg RJ (2003). Wisdom, intelligence, and creativity synthesized. Cambridge University Press.
Sternberg RJ, Grigorenko EL, Singer JL (2004). Creativity: From potential to realization. American Psychological Association.
Sternberg RJ, Kaufman JC, Grigorenko EL (2008). Applied intelligence. Cambridge University Press.
Sternberg RJ, Lubart TI (1995). Defying the crowd: Cultivating creativity in a culture of conformity. Free Press.
Sternberg RJ, O'Hara LA (1999). 13 Creativity and Intelligence. Handbook of creativity P 251.
Sternberg RJ, Williams WM (1996). How to develop student creativity. ASCD.
Silvia PJ (2015). Intelligence and creativity are pretty similar after all. Educational Psychology Review 27(4):599-606.
Tannenbaum AJ (1983). Gifted Children Psychological and Educational Perspectives. New York Macmillan.
Taylor CW, Barron FE (1963). Scientific creativity: Its recognition and development.
Tezci E (2002). Oluşturmacı öğretim tasarım uygulamasının ilköğretim beşinci sınıf öğrencilerinin yaratıcılıklarına ve başarılarına etkisi. Yayımlanmamış doktora tezi, Fırat Üniversitesi, Elazığ.
Tok E (2008). Düşünme becerileri eğitim programının okul öncesi öğretmen adaylarının eleştirel, yaratıcı düşünme ve problem çözme becerilerine etkisinin incelenmesi. Yayımlanmamış Doktora Tezi, Marmara Üniversitesi Eğitim Bilimleri Enstitüsü, İstanbul.
Torrance EP (1966). Torrance tests of creative thinking: Norms-technical manual: Verbal tests, forms a and b: Figural tests, forms A and B. Personal Press, Incorporated.
Torrance EP (1968). A longitudinal examination of the fourth grade slump in creativity. Gifted Child Quarterly 12(4):195-199.
Torrance EP (1995). Insights about creativity: Questioned, rejected, ridiculed, ignored. Educational Psychology Review 7(3):313-322.
Treffinger DJ (1995). Creative problem solving: Overview and educational implications. Educational Psychology Review 7(3):301-312.
Urban KK, Jellen HG (1996). Test of Creative Thinking: Drawing Production: TCP-DP. Harcourt Assessment, Incorporated.
Urban KK (2004). Assessing Creativity: The Test for Creative Thinking-Drawing Production (TCT-DP) The Concept, Application, Evaluation, and International Studies. Psychology Science 46(3):387-397.
Urban KK (2005). Assessing Creativity: The Test for Creative Thinking-Drawing Production (TCT-DP). International Education Journal 6(2):272-280.
Yong LMS (1994). Relations between creativity and intelligence among Malaysian Pupils. Perceptual and Motor Skills 79(2):739-742. https://doi.org/10.2466/pms.1994.79.2.739
Yontar TA (1998). Yaratıcı Düşünme Testi- Çizim Ürünü'nün Türk Örneklemlerinde Kullanımı. X. Ulusal Psikoloji Konferansı, Ankara.