THE CONTRIBUTION OF PERSONALITY, MOTIVATION, ACADEMIC RISK-TAKING AND METACOGNITION TO THE CREATIVE ABILITY IN MATHEMATICS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

SELDÁ BAŞ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
SECONDARY SCIENCE AND MATHEMATICS EDUCATION

JULY 2012
Approval of the thesis:

THE CONTRIBUTION OF PERSONALITY, MOTIVATION, ACADEMIC RISK-TAKING AND METACOGNITION TO THE CREATIVE ABILITY IN MATHEMATICS

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ABSTRACT

THE CONTRIBUTION OF PERSONALITY, MOTIVATION, ACADEMIC RISK-TAKING AND METACOGNITION TO THE CREATIVE ABILITY IN MATHEMATICS

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July 2012, 143 pages

Creative people are most valuable treasures of a nation. In order to cope with the complicated problems of the rapidly changing and developing modern life and to ensure that the society makes progress via new breakthroughs and inventions, we need creative individuals. Thus, the research on creativity in the school environment where creativity takes its roots from is crucial. The purpose of the present study is to investigate the extent to which personality traits, motivation, academic risk-taking and metacognition explain the mathematical creative ability of high school students.

The study was carried out during the fall semester of 2011-2012 academic year at two science high schools and a private high school. A total of 217 preparatory and ninth grade students were involved in the study. The participants completed a set of measures about personality traits, motivation, academic risk-taking, metacognition and creative ability in mathematics. Standard multiple regression analysis was conducted to evaluate how well the independent variables predicted creative ability in mathematics. The results revealed that openness to experience and consciousness were significantly correlated with creative ability in mathematics. However, extraversion, agreeableness and neuroticism were not correlated with creativity.
scores. Moreover, intrinsic goal orientation followed by openness to experience was the most significant predictor of mathematical creative ability. Yet, academic risk-taking was not significantly correlated with creative ability. Although knowledge of cognition and regulation of cognition showed moderate correlations with creative ability in mathematics, they failed to predict creative ability in multiple regression equation.

Keywords: Creative Ability in Mathematics, Personality, Motivation, Academic Risk-Taking, Metacognition
ÖZ

KİSİLİK, MOTİVASYON, AKADEMİK RİSK ALMA VE ÜSTBİLİŞİN
MATEMATİK ALANINDA YARATICI YETENEĞE KATKISI

Baş, Selda
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Tez Yöneticisi  : Doç. Dr. Ayhan Kürşat Erbaş

Temmuz 2012, 143 sayfa

Yaratıcı bireyler bir ülkenin en değerli hazineleridir. Hızla değişen ve gelişen modern hayatın karmaşık sorunlarıyla başa çabuk bilmek, toplumun yeni buluş ve icatlarla ilerlemesini sağlabilme için yaratıcı bireylere ihtiyaç vardır. Bu nedenle, yaratıcılığın, temellerinin atıldığı okul ortamında araştırılması son derece önemlidir. Bu çalışmanın amacı kişiliğin, motivasyonun, akademik risk almanın ve üstbilişin lise öğrencilerinin matematik alanındaki yaratıcı yeteneklerini ne ölçüde açıkladığını araştırmaktır.

içsel motivasyon, onu takiben de gelişme açıklık, matematiksel yaratıcı yeteneği en iyi tahmin eden değişkenler olarak belirlenmiştir. Ama akademik risk alma yaratıcı yetenek ile ilişkilendirilememiştir. Bilişin bilgisi ve bilişin düzenlenmesi matematiksel yaratıcı yetenek ile orta derecede ilişki gösterse de çoklu regresyon eşitliğinde yaratıcı yeteneği açıklamada başarısız olmuşlardır.

Anahtar Kelimeler: Matematik Alanında Yaratıcı Yetenek, Kişilik, Motivasyon, Akademik Risk Alma, Üstbiliş
ACKNOWLEDGMENTS

I would like to take this opportunity to thank Assoc. Prof. Dr. Ayhan Kürşat Erbaş for his guidance, advice, criticism, encouragements and insight throughout the research. Without his extensive suggestions, continuous encouragement and constructive criticism, this study would not have reached to its present condition.

I would like to thank my committee members Prof. Dr. Behiye Ubuz and Assoc. Prof. Dr. Erdinç Çakıroğlu for their suggestions, comments, feedback and insight.

I also would like to thank to The Scientific and Technological Research Council of Turkey for financial support during the formation of my thesis.

I would like to thank the administrators, teachers and students of the schools participated in the study for their contribution.
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<td>Agreeableness</td>
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<td>ART</td>
<td>Academic Risk-Taking</td>
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<td>CAMT</td>
<td>Creative Ability in Mathematics Test</td>
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<td>CONSC</td>
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<td>EGO</td>
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CHAPTER I

INTRODUCTION

This chapter provides an insight into the rationale for studying creativity and selection of the variables. In the first part, background of the study is analyzed. Purpose and significance of the study along with the research questions are presented in the second and the third sections, respectively. Finally, definitions of important terms are stated in the last section.

1.1 Background of the Study

The life in 21st century has become more complicated and diverse compared to the past. Even if having better living conditions by the help of new developments and discoveries, people also face new problems and encounter more challenges. From home life to the working life, everything in human life has been rapidly changing compared to the old days. The new technologies or habits in human lives take the places of old ones almost as rapidly as they are presented (Stenberg, 2006a). In order to deal with these rapid changes, people have to have 21st century skills. Creativity skills are extremely essential ones among them (Piirto, 2011). Creativity skills allow people to solve complicated problems, to develop original ideas, to make innovations and to be flexible.

Creativity can be regarded as one of the most significant factors that influence individual achievement in several fields of life. It is one of the essential driving forces for change and innovation. Creative individuals are valuable treasures of a nation because of the fact that society makes progress via new breakthroughs and inventions of these people. Therefore, creativity has an essential role not only for the individual life but also for the progress of the society. Identifying and
encouraging the creative potential existing in each individual will lead to an increase in the welfare level of a society and will provide the developments in several domains such as science, technology and economy.

Understanding the nature of creative thinking is an international issue which has been investigated by researchers from a variety of fields. Starko (2010) stated that researchers from different domains submitted fundamental questions to get information on the basic issues of creativity: What is creativity? Where does it originate? What experiences allow individuals to become more creative? What forces motivate individuals to be creative? According to Starko, as the understanding about the nature of creativity develops, the more questions rather than answers will arise.

Creativity researchers suggested that creativity of the individuals relied on several factors (Batey & Furnham, 2006; Guilford, 1950; Lubart & Guignard, 2004; Runco, 2004). Understanding of creativity requires considering it from various perspectives (Rhodes, 1961; Runco, 2004). Studies, theories, and models of creativity usually center on three areas. Some of the researchers investigate characteristics of the creative individuals and the creative processes. On the other hand, other researchers analyze the creative products.

Expression of creativity varies depending on the domain of endeavor. It has field specific and field general elements (Tan, 2007). Research literature differentiates general and specific creativity (Leikin, 2009). Specific creativity refers to having a special skill to create in one domain such as in art or in mathematics. Creativity is generally associated with arts, however, educators have begun to carry studies on creativity in schools in recent years. Mathematical creativity is a relatively unexplored area in mathematics and mathematics education (Sriraman, 2009). Mathematical creativity is different from creativity in arts in terms of creative personality, the creative process, and the creative product (Runco, 2004). Although mathematical creativity has several components, the present study focused on personality traits, motivation, academic risk-taking and metacognition. These variables were selected because mathematical creativity was aimed to be investigated from different perspectives.

Creativity studies that focus on personality try to identify the general and specific traits of creative people. In these studies, creativity is investigated from the perspective of personal attributes such as personality, motivation, thinking styles, or
intelligence (Batey & Furnham, 2006; Kaufman, Plucker & Baer, 2008). Researchers, who see creativity as a property of people, focus on individual differences in people’s creativity or on the distinctive characteristics of creative people (Stenberg, 1999). These researchers adopt a person centered approach for understanding the creative process.

There are many personality traits that have been used to identify creative people. Although many of the lists of creative personality studies have some common characteristics, some of the results vary and even tend to conflict (Selby, Shaw, & Houtz, 2005). The Five Factor Model, which is the newest model in the modern psychology, provides a systematic framework for differentiating and ordering characteristics of individuals (John & Srivastava, 1999). The model allows researchers to analyze specific attributes of human personality. Therefore, in the present study, Big Five Factors were used to model the personality characteristics of high school students to observe their relation to students’ creative ability in mathematics. By this way, distinguishing personality characteristics of high school students, who were creative in mathematics, would be identified.

Motivation is an important concept which is used a lot in daily life. Performance of a worker, success of a student or moral level of a patient is all based on how that person is motivated. Motivation is a driving force for people to reach their goals. It starts, controls, and maintains individuals’ behaviors. In addition, it affects choices people make, quality of the effort they invest, and persistence in the face of hardship. Moreover, motivation is also one of the most significant factors affecting creativity. A number of researchers have emphasized the essential role of motivation on the creative process.

According to Hennessey (2003), there is a direct connection between motivational orientation of a student and possibility of her being creative on a task. Social psychological studies of motivational orientations have developed the Intrinsic Motivation Principle of Creativity (Amabile, 1996). Amabile (1996) claimed that intrinsic motivation encouraged creativity, whereas extrinsic motivation was usually harmful. Hennessey (2003) stated that intrinsic motivation was an essential force that initiated the creative behavior. On the other hand, the research regarding the relation between extrinsic motivation and creativity is complex. There has been no agreement on the effects of extrinsic motivators on creativity. Amabile’s idea on the importance
of intrinsic motivation and detrimental effect of extrinsic motivation on creativity can be challenged. Biographies of exceptional scientists and mathematicians showed that rewards generally increased creativity (Eisenberger & Shanoc, 2003). Hennessey (2003) wonders if the Intrinsic Motivation Principle of Creativity would hold true for other cultures. Hennessey recommends studying the relation between motivational orientation and creative behavior of people from all cultures. By identifying the relation between motivational orientation and mathematical creativity, this study would have important implications for mathematics teachers in their use of intrinsic and extrinsic motivators in the classroom.

Risk-taking is not commonly associated with educational practices and academic achievement (House, 2002). Risk-taking researchers prefer to study games, betting tasks, puzzles, chance events, hypothetical situations, and physical skill activities (Clifford, 1991). Therefore, the studies, which relate risk-taking to education, are underrepresented in the literature. Clifford (1991) says:

*If most economic and social behavior can be explained by risk-taking models, why shouldn’t learning, a social process by which knowledge and skills are acquired, be explained by such models? What implications and benefits might there be if learning were perceived as a risk-taking event? If there were benefits, what might they be, and what level of risk would maximize these benefits? (p. 266)*

Differences in the risk-taking quality of individuals have important implications for creativity. According to Getzel and Jackson (1962), creative people enjoy the risk, uncertainty of the unknown and unfamiliar experiences. Risk-taking requires courage because there is a possibility of making errors and failure. In Turkish education system, teachers are trying to minimize failure and error making by which they think they would maximize academic success in schools. Therefore, students are not allowed to take risks, experiment and try unfamiliar approaches. An investigation of the relationship between mathematical creativity and academic risk-taking will shed some light on the learning process of students. Clifford (1991) suggests that learning through risk-taking activities affect every aspect of educational activities. Therefore, relation between academic risk-taking and educational practice need to be explored.
Metacognition is one of the significant aspects of human cognition. It is generally defined as “thinking about thinking” and “cognition about cognition.” Thinking processes, which students use in mathematical creative process, have attracted researchers’ interests. They investigated the role of important mental representations, processes, and mechanisms that led to creativity (Baer and Kaufman, 2006). Many of the researchers inquired about the relevance of metacognition to creative thinking (Armbruster, 1989; Fasko, 2000-2001; Feldhusen, 1995; Runco & Chand, 1995).

Some of the researchers associated creativity with mathematical problem solving ability. Armbruster (1989) states that creative process includes knowledge and skill acquisition, the transformation of knowledge into new forms and, as a result, giving a product. Each stage in the creation process involves cognition. Highly developed metacognitive skills are recognized as one of the essential characteristics of good problem-solvers (Darling-Hammond, Austin, Cheung, & Martin, 2003; Schoenfeld, 1992). Armbruster (1989) emphasized the key role of metacognition in the creative activities, and concluded that creative individuals might be more creative because of their metacognitive skills. Therefore, the metacognitive processes that are important contributors of mathematical problem solving performances can be regarded essential for creative acts, as well. Creativity requires both metacognitive knowledge and metacognitive skills to generate novel ideas, to solve complex mathematical problems or to make innovations. For that reason, the relation of mathematical creativity to metacognitive knowledge and metacognitive skills need to be identified in the classroom environment.

1.2 Purpose of the Study

Creativity in mathematics is often considered existing in professional mathematicians, however, a few studies examined mathematical creativity of students in the classroom (Sriraman, 2004). Everyone has some creative skills (Haefele, 1962). Having a clear understanding of the nature of mathematical creativity in the school level would allow educators recognize and facilitate creativity among all students. Therefore, it is vital to explore factors contributing to students’ mathematical creativity. Many factors come into play when one thinks about what
factors are related to students’ mathematical creativity. In this research, several such factors and their relationship to mathematical creativity of the high school students were examined. Although mathematical creativity is a complex construct to define, the present study focused on four general factors that were related to mathematical creativity: personality traits, motivation, academic risk-taking and metacognition.

The objective of the present study is “to investigate the extent to which personality traits (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism), motivation (intrinsic and extrinsic goal orientation), academic risk-taking, and metacognition (knowledge of cognition and regulation of cognition) explain the mathematical creative ability of the high school students.”

The present study intends to address the following problem: “How well creative ability in mathematics can be explained in terms of personality traits (openness, conscientiousness, extraversion, agreeableness, and neuroticism), motivation (intrinsic and extrinsic goal orientation), academic risk-taking, and metacognition (knowledge of cognition and regulation of cognition)”.

Based on the given theoretical perspective and assumptions, the following four questions are formulated to examine the factors associated with creative ability of students:

a) Which personality traits (openness, conscientiousness, extraversion, agreeableness, and neuroticism) are related to the mathematical creative ability of the high school students?

b) What is the relationship between academic risk-taking and mathematical creative ability of the high school students?

c) What is the relationship between motivational orientation (intrinsic and extrinsic goal orientation) and mathematical creative ability of the high school students?

d) What is the relationship between metacognition (knowledge of cognition and regulation of cognition) and mathematical creative ability of the high school students?

In order to examine the research problem, the following hypotheses were stated in the null form and tested at a significance level of .05.
1) The personality traits (openness, conscientiousness, extraversion, agreeableness, neuroticism) do not explain a significant amount of variance in students’ mathematical creative ability.

2) The motivational variables (intrinsic and extrinsic goal orientation) do not explain a significant amount of variance in students’ mathematical creative ability.

3) Academic risk-taking does not explain a significant amount of variance in students’ mathematical creative ability.

4) The metacognitive variables (knowledge of cognition and regulation of cognition) do not explain a significant amount of variance in students’ mathematical creative ability.

It is crucial to explore the factors contributing to Turkish students’ mathematical creativity. To answer the general research question, a standard multiple regression analysis was conducted. This method was chosen because it predicted the dependent variable (creative ability in mathematics) from a linear combination of the independent variables (openness, conscientiousness, extraversion, agreeableness, neuroticism, intrinsic and extrinsic goal orientation, academic risk-taking, knowledge of cognition and regulation of cognition).

1.3 Significance of the Study

Mathematical creativity is a relatively unexplored area in mathematics and mathematics education (Sriraman, 2009). One of the motivations to conduct this research is the lack of mathematics literature on mathematical creativity. As Runco (2004) listed the topics that were important for future research in creativity, creative behavior, motivation, personality and giftedness were the topics among them.

Many of the students have the potential to become highly creative individuals. Uncovering the hidden creative potentials of students is essential for the advancements in many areas. Bringing out and developing the creative potential existing in each student will lead to an increase in the welfare level of society and will provide the developments in several domains such as science, technology and economy. The nature of mathematical creativity is extremely complex, as a result, it is very difficult and time consuming for teachers to administer and score the
creativity instruments to identify and take steps to develop creativity. Therefore, it is very crucial to identify the constructs that have a relation with students’ creativity. If any significant relationship comes out between mathematical creativity and any predictor variables of the current study, educators can focus on these constructs to develop and facilitate creative behavior among students and can provide remedial steps for low creative students.

It is very important to uncover particular personality traits in order to explain and predict creativity (Batey & Furnham, 2006). The results of studies on creative personality generally showed common personality characteristics for creative people from various fields (Feist & Baron, 2003). If we know which personality traits are related to the mathematical creativity of students, then parents as well as the teachers can be good role models of these personality traits from the early ages of students to encourage creativity.

Motivation has a key role in the process of creativity. In this study, the role of two motivation types, i.e. intrinsic and extrinsic motivation, is investigated in the explanation of the mathematical creativity. In a traditional Turkish classroom, external rewards and competition are used a lot. However, intrinsic motivation is usually undermined. This research was conducted to see whether Intrinsic Motivation Principle of Creativity would hold true for Turkish students.

In Turkish education system, teachers are trying to minimize failure and error making by which they think they would maximize academic success in schools. Mistakes are not seen as an important part of learning and a natural part of the inquiry process. Therefore, students are not allowed to take risks, experiment and try unfamiliar approaches. Making mistakes and fear of failure make most of the students afraid of asking questions in the classroom, engaging in class discussions, sharing opinion or answering the questions. However, in creativity literature the essential role of risk taking is emphasized a lot. If any significant relationship is found between mathematical creativity and academic risk-taking, teachers will question their use of conservative approaches to learning and teaching.

The study of metacognition will provide educators with insight about the cognitive processes involved in creativity. It also suggests several implications for teachers, such as teaching students how to be more aware of their learning processes as well as how to monitor those processes for creativity.
To sum up, knowledge from this study will help educators understand the relationship of mathematical creativity to personality, motivation, academic risk-taking and metacognition and further clarify the theoretical knowledge. The results of this research will guide mathematics educators to review educational practices. Consequently, new ideas for educational practices can be emerged to promote student creativity and related constructs on the basis of the relationships in this study.

1.4 Definition of Important Terms

The definitions of the terms and variables used in this study are given below to reveal the meanings and avoid possible misconceptions.

Divergent Thinking: The ability to generate knowledge from the presented knowledge where the variety and quality of responses are important (Balka, 1974).

Fluency of thinking: The ability to generate ideas where the quantity and not the quality of ideas are emphasized (Balka, 1974).

Flexibility of thinking: The ability to produce a diversity of ideas or categories of ideas (Balka, 1974).

Originality of thinking: The ability to produce remotely associated or uncommon responses (Balka, 1974).

Mathematical Creativity: Balka’s criteria to measure creative ability in mathematics were taken as the basis to define mathematical creativity. These criteria are as follows:

1) Ability to formulate mathematical hypotheses concerning cause and effect in mathematical situations (divergent thinking);
2) Ability to consider and evaluate unusual mathematical ideas, to think through the possible consequences for a mathematical situation (divergent thinking);
3) Ability to sense what is missing from a given mathematical situation and to ask questions that will enable one to fill in the missing mathematical information (divergent thinking);
4) Ability to split general mathematical problems into specific sub-problems (divergent thinking). (Balka, 1974, p. 110)
Openness to Experience: Individuals who are open to experience has been characterized as imaginative, sensitive to aesthetics, curious, independent thinkers, and open to new ideas, experiences, and unusual perspectives (George & Zhou, 2001).

Extraversion: Extraversion refers to “the degree to which a person is outgoing, sociable, talkative, and comfortable meeting and talking to new people” (Daft & Lane, 2008, p. 98).

Agreeableness: Agreeableness refers to “the degree to which a person is able to get along with others by being good-natured, cooperative, forgiving, compassionate, understanding, and trusting” (Daft & Lane, 2008, p. 99).

Conscientiousness: According to George and Zhou (2001), “Individuals who are high on conscientiousness have a strong sense of purpose and will; are dependable, reliable, and self-controlled; work hard to achieve their goals; obey rules and conform to norms; desire to achieve; and are responsible and scrupulous” (p. 515).

Neuroticism: The personality trait of neuroticism “refers to personality dimension characterized by anxiety, moodiness and lack of emotional balance and stability” (Martin & Fellenz, 2010, p. 83).


Extrinsic goal orientation: Engaging in a task for the sake of grades, rewards, performance, evaluation by others or competition (Pintrich, Smith, Garcia & McKeachie, 1991).

Metacognition: Metacognition comprises not only the knowledge of one's own cognitive and affective processes and states but also the ability to consciously control and regulate those processes and states (Hacker, 1998).

Academic Risk-Taking: A preference for challenging tasks, a tolerance for failure, and the ability to use strategies flexibly when facing obstacles (Clifford, 1988).
CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter involves the review of the literature concerning the creative ability in mathematics and its relationship with personality, motivation, academic risk-taking and metacognition.

2.1 What is Creativity?

Creativity researchers from different domains have derived several studies to understand the nature of creative thinking at least since Guilford’s influential speech about creativity (Kaufman & Baer, 2004). Since creativity is a complex and multi-sided construct, there is a debate about the nature of it. To arrive at consistent notions of what creativity is creativity researchers have developed different theories and used different approaches to study creativity. Each approach has its own theories, methods, and investigative paradigms (Batey & Furnham, 2006).

Starko (2010) indicated that the creative process was discussed by early psychologist such as Plato and Aristotle who described the process of creativity with different approaches. According to Starko, Plato, who emphasized a mystical way and external source of inspiration, argued that creative activities were coming from beyond the control of the individual. For example, the beauty of Mozart’s music is attributed to divine intervention by most of the people. In contrast, Aristotle emphasized the clear understanding of natural law as the source of creative activities. Aristotle did not believe that creative product came from mystical intervention. Starko further claimed that these two complex views have still being debated in psychology. Whereas some researchers stress inspiration, insight, or other processes
unique to creativity, other researchers focus on the similarities between creativity and other cognitive processes (Starko, 2010).

At the beginning of the ninth century, three branches of psychology, which are psychoanalysis, behaviorism, and humanistic psychology, hold different views on the nature of creativity, its source and purpose. Starko (2010) discussed the differences among these views in the book named Creativity in the Classroom. Firstly, psychoanalytic theorists think that human behavior, development and personality traits are shaped by unconscious processes. The unseen needs motivate individuals’ actions. Freud, a psychoanalytic theorist, indicated that creativity could be explained from the continuing conflict between conscious and unconscious thinking processes. The creative outcome is a form of manifesting unconscious drives in a socially acceptable ways. Behaviorists, on the other hand, consider human behavior as the result of stimuli and responses. Skinner, who was the father of behaviorism, believed that the more activities approaching creativity were reinforced, the more they should occur. Furthermore, humanist theorists see creativity as the normal growth and development of mental health. Contrary to psychoanalytic and behavioristic psychologists, human nature was perceived by humanists as a conscious, self-directed, and self-actualizing process. According to Maslow (1968), a pioneer in humanist psychology, creativity is “a fundamental characteristic, inherent in human nature, a potentiality given to all or most human beings at birth, which most often is lost or buried or inhibited as the person gets enculturated” (p. 138). Maslow distinguished two types of creativity: special talent creativity and self-actualizing creativity. The special-talent creative person has an extra-ordinary skill in a specific domain, but may not have normal psychology like Van Gogh. The self-actualized creative individual, on the other hand, approaches all aspects of life creatively. This type of creativity manifests itself commonly in the ordinary cases of life, for example, in a creative cooking done by a housewife.

In The Handbook of Creativity, Sternberg (1999) reviewed all studies of creativity available at that time. Stenberg suggested six categories to cluster the approaches that were adopted by creativity researchers: mystical, pragmatic, psychodynamic, psychometric, social-personality and cognitive. According to the researchers, who adopt mystical approach, creativity is an expression of spiritual process. The pragmatic approach, on the other hand, deals with encouraging
creativity. Using several heuristics to solve mathematical problems and brainstorming are examples for pragmatic approaches (as cited in Sriraman, 2009). The psychodynamic approach views creativity as the result of the conflict between conscious and unconscious thinking processes. Moreover, the psychometric approach to studying creativity involves assessing creativity with the help of instruments such as the Torrance Tests of Creative Thinking. Furthermore, personality characteristics and motivational variables as well as the sociocultural environment are important with regard to creativity for the social-personality approach. Finally, the cognitive approach emphasizes understanding of cognitive processes in producing original and new ideas.

Craft (2001) stated that, at the beginning of the twentieth century, four major traditions influenced systematic study of creativity: the psychoanalytic tradition, the cognitive tradition, the behaviorist tradition, and the humanistic tradition. Nevertheless, the increase in the number of creativity studies was witnessed during the 1950s. Guilford, who was the president of the American Psychological Association, was the most influential figure in the development of creativity research (Stenberg, 2006b). His speech in 1950 could be regarded as the beginning of the researchers’ interest in creativity as a measurable construct (Piirto, 2011). Guilford tried to attract the researchers’ attentions to the neglected domain of creativity. He emphasized the significance of divergent thinking abilities in the creative processes. Therefore, his idea of divergent production has influenced the assessment of creativity. Another important figure in creativity research was Paul Torrance. Torrance Tests of Creative Thinking (TTCT), which was based on divergent thinking, has dominated the field of creativity research (Baer & Kaufman, 2006). TTCT includes a variety of verbal and figural tests that require problem-solving and divergent thinking abilities. Based on the results of one expansive study of creativity research, nearly 75 percent of creativity studies with elementary and high school students and 40 percent of creativity studies involving college students and adults, used the Torrance Tests of Creative Thinking (as cited in Kaufman, Kaufman, Beghetto, Burgess, & Persson, 2009).

Runco (2004) argued that considering creativity from different perspectives leads to a better understanding of creativity. In a review of research, Runco firstly discussed creativity from person, process, product, and press approaches, but he
noticed that there were some researches that did not fit into these categories. Then, he employed a disciplinary groundwork systematized by behavioral, biological, clinical, cognitive, developmental, historiometric, organizational, psychometric, and social perspectives to understand creativity studies. Runco suggested researchers to be flexible and avoid adopting only one perspective while studying creativity. Similar to Stenberg and Runco, Lubart and Guignard (2004) suggested using a variety of approaches in conducting studies on creativity. They stated that creativity was to a certain extent a generalized ability, to a certain extent a set of domain-specific abilities, and to a certain extent a set of task-specific abilities.

Each approach to study creativity has its own theories, methods, and investigative paradigms (Batey & Furnham, 2006). Hennessey and Amabile (2010), who also supported the interdisciplinary investigation of creativity, asserted that although the developments in creativity literature, the fragmentation has been increasing. They emphasized that researchers in one field were unaware of the investigations carried out in another field. Therefore, they offered a system view of creativity which required several interconnected forces operating at multiple levels.

Understanding of creativity requires a multidisciplinary approach. Therefore, theorists have adopted confluence approaches to understand the nature of creative behavior. The confluence approaches put multiple views together to understand creativity. According to confluence approaches, several factors must come together to realize creativity potential (Amabile, 1996; Stenberg & Lubart, 1999). There are a number of confluence theories in the literature to better understand the process of creativity (Freiman & Sriraman, 2007), but one of them was explained because of its relevance to the present study.

Amabile (1996) emphasized the importance of three factors for the production of creative work: domain-related skills (knowledge and abilities), creativity-related skills (styles, personality characteristics, and idea generation heuristics), and motivation (intrinsic motivation). Amabile offered three part model which focuses on the antecedents of creative performance. These three factors must come together to produce a creative solution, to develop an original idea or to generate a new product. Domain-related skills include knowledge, technical skills, or particular domain-related talents that are important in particular domains, but not in others. Before producing an original work, an individual need to take extensive
education in a particular field. Studies indicate that one has to work in a domain for at least ten years if he wants to contribute anything new to the domain (Piirto, 2011). One can find several cases in the history of science to sustain this claim. For example, Andrew Wiles studied seven years to prove Fermat’s Last Theorem and Kepler spent twenty years to formulate the laws of planetary motion (Freiman & Sriraman, 2007). On the contrary, this claim can be challenged by some counter-examples such as the discovery of penicillin, whose discovery was attributed to chance. The second component of creativity, creative relevant skills, includes creative thinking and working skills. They are domain-transcending skills, which contribute to creative performance in all domains. The creative thinking skills are habits of mind, specific strategies and abilities which are regarded as creative thinking. Looking at the situations from different points of view, using metaphors, exploring or problem finding and brainstorming are among the creative thinking skills. This component also includes creative working skills. Concentration, focus, and tolerance for ambiguity allow individuals to preserve on a task over time. The third component in Amabile’s model is task motivation, especially the intrinsic motivation. The motivational orientation can change depending on the context. The perception of one’s own motivation depends on existence of extrinsic factors in the social environment. Hennessey (2003) says that intrinsic drives are essential for the initiation of the creative behavior.

Several approaches and perspectives to study of creativity have been discussed so far. Since each approach has its own theories, methods, and investigative paradigms, different definitions of creativity can be observed in the literature. Some of researchers have used related terms to describe creativity such as entrepreneurship, enterprise, or innovation (Craft, 2001).

There is no widely accepted definition of creativity in the literature (Yuan & Sriraman, 2010; Juter & Sriraman, 2011). The complex nature of creativity might cause the disagreement on the definitions of this construct. Plucker, Beghetto, and Dow analyzed ninety articles that have the title of creativity and were submitted to the two top creativity journals or a different peer-reviewed journal (as cited in Kaufman, Plucker, & Baer, 2008). Among these articles, the definition of creativity was explicitly given in only 38 percent of them. Creativity researchers suggested that creativity of the individuals relied on several factors (Batey & Furnham, 2006;
Understanding of creativity requires considering it from various perspectives (Rhodes, 1961; Runco, 2004). Creativity is defined as a multifaceted construct that involves convergent and divergent thinking (Runco, 2004; Guilford, 1967), originality (Davis, 1998; Guilford, 1959; Krutetskii, 1976; MacKinnon, 1978; Starko, 2010; Torrance, 1962), appropriateness for a given context (Amabile, 1996; Runco, 2004; Starko, 2010), problem finding (Krutetskii, 1976), problem solving, self-expression, intrinsic motivation (Amabile, 1996), and self-confidence. Haefele (1962) stated that creativity is “the ability to formulate new combinations from two or more concepts already in the mind” (p. 5). According to Haefele, every creation is a new combination of numbers, colors, notes, chemicals, mechanical elements, or words. After synthesizing numerous definitions of creativity, Juter and Sırıraman (2011) view creativity as giving original work to extend the body of knowledge, and allowing for others to pose new questions. Similarly, Sternberg and Lubart (1999) emphasized producing useful and adaptive original work as the core of creative activity. Sırıraman (2008) questioned “the usefulness” property of Sternberg and Lubart’s definition because in some occasions creative work might not be applicable in the real world. For example, proof of Fermat’s Last Theorem by Andrew Wiles is seen as creative by mathematical community, but it has no applicability. According to Sırıraman, it is sufficient to emphasize producing novel or original work in defining creativity.

Torrance (1962) defined creativity as a product of fluency (the number of ideas or solutions given), flexibility (the variety or diversity of the ideas), originality (the unusualness or uniqueness of the given ideas) and elaboration (ability to develop an idea). Torrance (1974) gave the following definition of creativity:

Creativity is a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results. (p. 8)
As it can be seen from the definitions, there has been no commonly accepted definition of creativity in the literature. However, most researchers agreed on the key attributes of creativity that were novelty, originality, value, effectiveness, appropriateness for a given context (Aralas, 2008; Beghetto, 2007; Hennessey & Amabile, 2010; Starko, 2010; Tan, 2007). The products in any domain, which are similar to those before them, are not regarded as creative. Moreover, appropriateness is determined by the social environment where the creativity is expressed (Starko, 2010). For example, Starko pointed out that paintings of Van Gogh were rejected by 19th century audiences, but they are considered masterpieces today.

Studies, theories, and models of creativity usually center on three areas. Some of the researchers investigate characteristics of the creative individuals and the creative processes. On the other hand, other researchers analyze the creative products. Rhodes (1961) suggested a scheme, called “Four P” model, for organizing research and definitions of creativity. According to this scheme, definitions of creativity can be categorized under four distinct possible research areas: (a) the creative person (b) the cognitive activities that are used in the creative process, (c) the press, in other verbs, the environment in which creativity is seen, and (d) the product that is the end product of creative performance. Watson (2007) used a similar scheme to identify the central ideas in the definitions of creativity. This scheme addressed the multi-faceted nature of creativity, which were individual, product, process, persuasion, and place.

Researchers, who study creative person, try to uncover the general and unique characteristics of creative people. In these studies, creativity is assessed in terms of personal characteristics such as personality, motivation, or intelligence (Batey & Furnham, 2006; Kaufman et al., 2008). Kaufman et al. (2008) explained each “P” in detail. According to them, the creative process examines the thinking operations that appear in the creative processes. For example, creativity tests and other measures of divergent thinking assess the creativity-relevant skills or processes. The third “P”, press, refers to the environment. Studies of press aim to change the environment in order to facilitate the creative behavior among people. Finally, the last “P”, the product, refers to the things people make, the ideas they express, and the responses they give. While some studies investigate one particular part of creativity such as the person, the process, the product, or the press, other methods consider more than one aspect of creative activity.
The relationship between intelligence and creativity has been disputed a lot in the literature. Whereas some researchers differentiate the constructs “creativity and intelligence”, others view creativity as a part of intelligence. Hennessey and Amabile (2010) asserted that creativity and giftedness should not be thought as the same. The personality characteristics and skills of creative people are different from the gifted people (Runco, 1999; Winner, 2000). Creativity has been referred to a trait separate and distinct from intelligence (Strum, 1971). The people, who have high intelligence, are not necessarily highly creative (Furnham & Bachtiar, 2008; Getzels and Jackson, 1962; Sriraman, 2008), and not all gifted children are creative (Leikin, 2009). Torrance (1974) offered “the Threshold Theory” to emphasize the distinction between creativity and intelligence. According to this theory, one must have a high degree of intelligence in order to be highly creative. Below a certain threshold, a strong positive relationship was observed between creativity and intelligence, but above the threshold level the relationship is weaker. In their review of research on intelligence and creativity relationship, Stenberg, Kaufman, and Pretz (2002) claimed that the relationship between intelligence and creativity depended on which aspects of intelligence and creativity was measured. Velikova, Bilchev, and Georgieva (2004) separated giftedness in mathematics into two; schoolhouse (academical) giftedness in mathematics and creative-productive giftedness in mathematics. Velikova et al. argued that schoolhouse gifted students have a high IQ, quickly adapt to the school environment, quickly solve the problems in competitions or Olympiads, and quickly assimilate ideas of others. Being academically gifted does not necessarily mean creatively gifted (Hoong, 2008). On the other hand, creative-productive gifted students’ thinking is not quick, but original. These students can concentrate on an interesting problem for a long period of time.

Hoong (2008) indicated that creative thinkers produce more creative solutions, and they are able to see complicated links between various things. They are the creators of knowledge. These students have three group of characteristic: above-average abilities, high level of creativity, and high level of task engagement (Renzulli, 1986). The identification of these students is difficult (Velikova et.al, 2004). Some of the students, who are talented in mathematics, may not show high academic success or display interest in school mathematics (Johny, 2008). Therefore, they may be overlooked by the practices in the schools. For example, teachers told
Thomas Edison that he was too stupid to learn anything. Isaac Newton was unsuccessful in school.

Some researchers differentiated everyday creativity from domain specific creativity. Using a tool in a different way and combining several ingredients to find a new recipe are examples of everyday creativity. On the other hand, domain specific creativity leads to fundamental changes in a particular area and only the experts in that domain can judge the creativity of the idea, process or the product (Juter & Sriraman, 2011). Some researchers think that only the ideas new to mathematics can be designated as creative. For them, creativity in mathematics is often considered existing in professional mathematicians. Therefore, a few studies examined mathematical creativity of students in the classroom. Sriraman (2005) said that normally nobody expected extraordinary creativity from the elementary or secondary school students. If students offered new vision for a problem or a new explanation to a historical work, then they could be called creative.

2.2 Creative Ability in Mathematics

Creativity in students is more often associated with domains other than mathematics. Students are thought to be creative in literature, arts, music or social studies. Most of the educators think that mathematics develops students’ logical reasoning skills, however, it is less likely accepted that mathematics also develops students’ creativity skills (Leikin, 2009). In recent years, educators have been getting interested in creativity in the school level.

Mathematics educators do not agree on a common definition of mathematical creativity (Mann, 2005; Sriraman, 2005). According to Haylock (1987), researchers should not begin with a well formulated definition of mathematical creativity, but they should consider ideas related to creativity and choose those ideas that are most related to school mathematics. Aiiken (1973) thinks that mental processes involved in creativity or the product are emphasized in the definitions of mathematical creativity. The early studies of mathematical creativity were seen in the works of professional mathematicians like Poincare and Hadamard (Sriraman, 2008). For Poincare (1948), mathematical creativity can be defined as the selection between questions that were productive. This definition of mathematical creativity is unclear because of the fact
that it ignores the novelty property of creative processes (Sriraman, 2008). According to Tammadge (1979), creativity in school mathematics includes the ability to find novel relations and to connect unrelated ideas. In a similar vein, Johny (2008) focused on the production of original and rational responses and also divergent thinking abilities of students in defining mathematical creativity. Originality of creative ideas is also emphasized by Singh (1987). For Singh, producing essential ideas, applying theory to practice, and transferring novel ideas from other fields to the new field are the processes of mathematical creativity. Moreover, according to Krutetskii (1976), mathematical creativity at the school is seen in “the independent formulation of uncomplicated mathematical problems, finding ways and means of solving these problems, the invention of proofs and theorems, the independent deduction of formulas, and finding original methods of solving nonstandard problems” (p. 68). For the identification of creative thinking in problem solving, Haylock (1997) suggested two approaches. These were overcoming fixation and deciding on the criteria that are signs of creative thinking such as flexibility, originality, and appropriateness.

Balka (1974) presented some criteria to measure mathematical creativity. Balka addressed both convergent thinking and divergent thinking in the criteria.

The criteria are:

1. Ability to formulate mathematical hypotheses concerning cause and effect in mathematical situations (divergent thinking);
2. Ability to determine patterns in mathematical situations (convergent thinking);
3. Ability to break from established mind sets to obtain solutions in a mathematical situation (convergent thinking);
4. Ability to consider and evaluate unusual mathematical ideas, to think through the possible consequences for a mathematical situation (divergent thinking);
5. Ability to sense what is missing from a given mathematical situation and to ask questions that will enable one to fill in the missing mathematical information (divergent thinking);
6. Ability to split general mathematical problems into specific sub problems (divergent thinking) (Balka, 1974, p. 110).

Henri Poincare was the first mathematician who introduced the term “mathematical creativity” in 1902 (Sriraman, 2004). Sriraman (2005) discussed the differences between mathematical creativity and mathematical giftedness by analyzing and synthesizing the literature on creativity and giftedness. In explaining the difference between the constructs of mathematical giftedness and mathematical creativity, Sriraman (2005) used the hierarchical model of Usiskin. Usiskin (2000) stated that not all mathematically gifted individuals are mathematically creative. This view leads Usiskin to propose an eight-tiered model to categorize mathematical talent. The model begins from Level 0 and ends at Level 7. Adults, who have very little mathematics knowledge, are at Level 0 (no talent). Level 1 (culture level) represents people who have basic number concept and the ability to reason arithmetically. The mathematical knowledge of people at Level 1 is similar to 6th through 9th grade students. It can be said that most of the people in the general population might be in the first two levels. Other people can be seen at Level 2 through 7 depending on their mathematics knowledge. Level 2 constitutes secondary school students who are majoring in mathematics as well as secondary math teachers. With Level 3, Usiskin began to describe exceptionality or talent. At this level, students became mathematics majors or graduate students. The individuals at Level 4 (the exceptional student) were somewhat devoted to mathematics, and participated in talent searches, summer programs, or special schools. These students not only perform mathematical proofs but also participate in the discussions about mathematics. The productive mathematician can be seen at Level 5. The students, who earn PhD degree in mathematics and are able to publish mathematics paper, are at this level (Sriraman, 2005). Level 6 represents exceptional mathematicians who have made essential contributions to their fields and recognized by their work. Finally, Level 7 represents geniuses like Leonard Euler, Karl Friedrich Gauss, and Bernhard Riemmann. In this model, mathematically gifted individuals are at Level 5; on the other hand, mathematically creative individuals are at Level 6 and 7. In this hierarchy, mathematically gifted or creative students are found at Level 3 and 4. With appropriate scaffolding, these students can be professional mathematicians (Usiskin, 2000). Sriraman (2008) stated that since professional mathematicians have
obtained a doctorate degree and conduct research in the field, they are gifted. However, there is a very small subset of creative mathematicians among them. Therefore, Sriraman concluded that mathematically creative people were mathematically gifted, on the other hand, mathematically gifted people are not necessarily creative.

2.3 Creativity in the Classroom

Creativity in mathematics is often considered existing in professional mathematicians. A few studies examined mathematical creativity of students in the classroom. Sriraman (2008) says that normally nobody expects extraordinary creativity from the elementary or secondary school students. In discussing the nature of mathematical creativity with Liljedahl, Sriraman differentiated the creative activities at the professional level and at the school level (Liljedahl & Sriraman, 2006). Sriraman defined mathematical creativity at the professional level as "the ability to produce original work that significantly extends the body of knowledge (which could also include significant syntheses and extensions of known ideas) or opens up avenues of new questions for other mathematicians" (p. 18). On the other hand, at the school level, Sriraman defined mathematical creativity as “the process that results in unusual (novel) and/or insightful solution(s) to a given problem or analogous problems, and/or the formulation of new questions and/or possibilities that allow an old problem to be regarded from a new angle” (p. 19).

When students show creativity in the classroom, they tend to question and challenge, make connections and see relationships, look at things from different viewpoints, search for ideas and options, criticize and make reflections on ideas, actions, and the results (Morris, 2006), and make conjectures and try to prove them. Similar to Morris, Starko (2010) also suggested some activities associated with creativity such as looking at problems in more than one way, asking questions, making hypotheses, and thinking flexibly.

Learner centered approaches are essential for the development of creativity. A constructivist approach to learning has become dominant in educational psychology during the past two decades. Learners build their own knowledge. Organizing information, linking new information to prior knowledge, and using metacognitive
strategies are the processes associated with constructive approach. Starko (2010) says:

*Learning in pursuit of a goal makes the learning purposeful. Tying information to prior knowledge, understanding, and affect make it meaningful. Because the ties created by each unique student must be original, and because goal-oriented learning must, by definition, be appropriate (if it meets the goal), the processes of learning themselves can be viewed as creative. In fact, some cognitive theorists studying creativity believe that creativity is only a special case of the same processes we used to construct new ideas- and even new sentences- daily. Each learner builds an individual cognitive structure different from all others and full of unique associations.* (p. 13)

Haylock (1987) argues that there is a problem in the way the subject of mathematics is taught and assessed in schools. School mathematics encourages children to think in narrow domains, to rely on routine processes and algorithms and to think convergently. The qualities of mathematical thinking, such as overcoming fixation or to think flexibly and divergently, are neglected. Haylock thinks that this neglect may be related to the little consideration of creativity within the area of mathematics education. Similarly, Tammadge (1979) argues that rote learning of existing knowledge have dominated mathematics teaching for a long time. Mathematical creativity is difficult to develop with the rule based and drill and practice applications. Rule based applications overshadow the essence of mathematics. Therefore, it limits the creative thinking of students. Haylock and Tammadge’s descriptions depict the picture of mathematics education in Turkey. Almost all mathematical problems have one correct answer, and they are solved by the methods prescribed by teachers. While the accuracy of the solutions and computational speed are stressed a lot in the school mathematics, creative thinking is ignored (Mann, 2005). Moreover, whereas students have good computational skills after the graduation, they are unable to apply these skills in their real life. This type of instruction eliminates key aspects of mathematics such as deep conceptual understanding, flexible thinking and exploring a problem from various viewpoints.

Everyone has some creative skills (Haefele, 1962). Having a clear understanding of the nature of mathematical creativity in the school level allows
educators recognize and facilitate creativity among all students. The role of teacher is crucial in developing creativity. Teachers motivate students and help them to uncover their hidden creative potentials. Teachers develop a classroom environment that facilitates the creative behavior of their students.

2.4 The Relationship between the Five Factor Model of Personality and Creativity

There are several different theories about the development of personality. The trait approach is regarded as one of the important personality theories in modern psychology (Corr & Matthews, 2009; Eysenck, 1991; McCrae & Costa, 1999). This theory claims that human personalities consist of broad dimensions (Eysenck, 1991). Five Factor Model (FFM) is a newest trait theory in psychology to describe the personality traits. According to FFM, five basic dimensions of this model describe the most personality traits (McCrae & Costa, 1997). Batey and Furnham (2006) pointed out that after the emergence of Five Factor Model, the scattered studies of creativity and personality have tended to converge into a uniform body of work. The model has allowed researchers to combine different conceptions and measures (McCrae & Costa, 1999).

According to John and Srivastava (1999), personality taxonomy provided an organized model for differentiating, ordering, types and traits of individuals. They stated that the taxonomy allowed researchers to study specific characteristics of human personality by integrating several different personality descriptions in a common framework. The Big Five does not indicate the reduction of personality differences to five traits. These dimensions represent broad personality characteristics and include a large number of personality traits under each dimension.

Researchers have reached an agreement on the dimensions of personality (John & Srivastava, 1999). The basic dimensions of Five Factor Model are extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience. After the acceptance of the Big Five Model, psychologists have begun to report their findings on the relationship between creativity and personality traits and explain the creativity in terms of individual differences (Chamorro-Premuzic, 2006).
George and Zhou (2001) stated that openness to experience has been defined as "the extent to which individuals are imaginative, sensitive to aesthetics, curious, independent thinkers, and amenable to new ideas, experiences, and unconventional perspectives; it distinguishes between those mendable to variety, novelty, routine, and familiar" (p. 514). Open individuals are generally curious, enjoy novel ideas and question the authority. The personality characteristics associated with extraversion include sociability, assertiveness, activity and talkativeness. Extroverts have more friends and energetic compared to introverts. People high on conscientious are described as careful, cautious, self-controlled, orderly, and reliable (Costa & McCrae, 1992). Feist (1998) stated that people, who were agreeable, were affiliative. The traits, which are related to agreeableness, are “courteous, flexible, trusting, good-natured, cooperative, forgiving, soft-hearted and tolerant (Barrick & Mount, 1991, p. 4). Finally, individuals, who have high neuroticism score, are generally anxious, depressed, angry, embarrassed, emotional, worried, and insecure (Kumar & Bakhshi, 2010). A high neuroticism score may indicate some kinds of psychiatric problems, on the other hand, a low score indicates emotional stability (Rothmann & Coetzer, 2003).

Various studies have been conducted on personality and creativity. Uniqueness of the individual was emphasized in the theory and research on both personality and creativity (Feist, 1998). The creativity studies, which focus on the individual, try to answer the general question of which characteristics of creative people are different from others. The literature shows many common characteristics for highly creative people, but not certainly all of them (Hennessey & Amabile, 2010). Barron and Harrington (1981) asserted that creative people had some slightly stable personality characteristics such as “broad interests, attraction to complexity, high energy, independence of judgment, autonomy, intuition, self-confidence, ability to resolve antinomies or to accommodate apparently opposite or conflicting traits in one’s self-concept, and, finally, a firm sense of self as creative” (p. 15). There are some differences in the nature of creativity among people in different fields (Wolfradt & Pretz, 2001). Therefore, it is really difficult to identify a list of personality characteristics unique to creative people.
After thirty years of observation of creative people, Csikszentmihalyi (1996) stated:

If I had to express in one word what makes their personalities different from others, its complexity. They show tendencies of thought and action that in most people are segregated. They contain contradictory extremes; instead of being an individual, each of them is a multitude. (p. 1)

According to Csikszentmihalyi, creative individuals tend to present opposite and contradictory personality characteristics at the same time. Csikszentmihalyi further claims that creative individuals are highly energetic, but also can be quiet and at rest. They have high intelligent and tend to be naive, as well. They combine playfulness and discipline. They fluctuate between fantasy and reality. They can be both extroverted and introverted and humble and proud of their achievements. They avoid the rigid gender role stereotyping. They appear to be both rebellious and conservative. They have passionate for their work and also view it objectively. Finally, their openness and sensitivity allow them to both suffering and enjoyment. Haller and Courvoisier (2010) shared the views of Csikszentmihalyi, when they emphasized the complex nature of creative personalities. According to them, the most creative individuals switch between contradictory poles such as introversion versus extraversion or selfishness versus altruism.

The early studies of creativity and personality were scattered because of the use of different definitions of personality and creativity and assessment of the constructs by using different tools (Batey & Furnham, 2006). As a result, it was difficult to determine common personality characteristics of creative individuals. The earliest researches of creative personality began with the analysis of several biographies of famous personalities (Vašašová, 2011). The purpose of those studies was to study the personal characteristics of creators that contribute to their creative performances.

King, Walker, and Broyles (1996) analyzed the relations among creative ability, creative accomplishment and the five-factor model of personality. The Pearson correlations indicated that extraversion and openness were positively correlated with creative ability. However, a negative relationship between
agreeableness and creative achievement was reported. The results were also supported by Kelly (2006) who found a positive relationship between creativity and the personality characteristics of extraversion and openness to experience. Thus, both of the studies showed that people, who showed high creativity, were more sociable and open to new experiences.

Sung and Choi (2009) conducted a research to investigate the potential trait-trait interaction between the Big Five personality traits and the individuals’ motivational orientations in forming their creative performance. The study was carried out with 304 undergraduate students at a business school. Parallel to King et al.’s (1996) findings, the results suggested that extraversion and openness to experience had a significant positive influence on creative performance. Moreover, when the individual had high extrinsic motivation, strong positive relationship was observed between openness to experience and creativity. Finally, agreeableness positively predicted creative performance only when the individual had low extrinsic motivation.

Feist and Barron (2003) carried out a longitudinal study into the creative personality with male graduate students. The results showed that personality variables at age 27 predicted originality and creative achievement at age 72 over and above the intellect and potential. Additionally, the student, who was more tolerant and psychologically minded, made more creative achievements during his life. Moreover, they identified the personality characteristics that were common to creative people. The personality characteristics of self-confidence, openness, tolerance, and psychological mindedness directly related to the creative behavior. In a similar vein, Ivcevic and Mayer (2007) conducted a research to identify the types of creative activities and investigate the personality difference among the identified creative types. The researchers reported openness to experience, trait hypomania, creative role, intellectual curiosity and persistence as the traits that were common in creative individuals. These attributes could be regarded as creativity general traits. Imagination, complexity, innovativeness, high energy, belief in self-uniqueness, great interest (hypomaniac traits), creative role, curiosity and attraction to complexity were regarded as the core description of a creative person.

According to Feist (1998), studies on creative personality can be categorized under two headings. The first one is the between-groups comparisons. In this line of
research, people from different domains are compared with each other, for instance, artists compared with scientists. In the second form, people in the same domain are compared with each other, for example, creative scientists are compared with less creative ones. The creative personality characteristics have been investigated in many fields and with many age levels. The studies involved elementary school students, high school students, undergraduates, young adults, graduate students, psychologists, inventors, mathematicians, chemists and engineers and research scientists (Baron & Harrington, 1981).

The first meta-analysis on creativity and personality, which underlined the personality differences between scientific and artistic creators, was derived by Feist (1998). The influence of personality on creative achievement in arts and science were investigated from 1950 to 1998. Three groups were compared: (a) scientists vs. non-scientists, (b) creative vs. less creative scientists, and (c) artists vs. non-artists. According to the results of the meta-analysis, creative people were “more autonomous, introverted, open to new experiences, norm-doubting, self-confident, self-accepting, driven, ambitious, dominant, hostile, and impulsive” (p. 299). However, artists and scientists did not possess the same personality characteristics. Artists were less emotionally stable, cold, and rejecting the group norms compared to scientists. Scientists were more conscientious than artists were. Extraversion and openness are the traits that distinguish the creative scientists from less-creative ones.

Wolfradt and Pretz (2001) studied the relationship between creativity and personality among college students from psychology, art and design, science and various other fields. Creativity was measured by written stories, list of personal hobbies, and scores on the Creative Personality Scale (CPS). The results of the study suggested that openness to experience was positively related to all three creativity measures. Extraversion was also positively related to creativity especially the one measured by CPS. Furthermore, neuroticism was not a predictor of any measure of creativity. Finally, story-writing was predicted by low scores on conscientiousness. Since the nature of creativity differs among people in different fields, Wolfradt and Pretz argued that the inclusion of individuals from several domains might affect the results of the study. In another study, McCrae (1987) also examined the relation between creativity, which was measured by divergent thinking tests and CPS, and multiple measures of five factors. Similar to findings of Wolfradt and Pretz, The CPS
scores were positively correlated with openness to experience. Additionally, the results suggested that CPS scores were positively related with extraversion and conscientiousness, and negatively related with neuroticism. No relation was found between CPS scores and agreeableness. Moreover, divergent thinking abilities showed a consistent relation with only openness. Based on the results of these two studies it could be reasonable to conclude that openness to experience seems to be a common characteristic of creative people.

Chamorro-Premuzic and Furnham (2005) investigated whether the Big Five personality traits are positively or negatively related to creativity. They found that neuroticism, extraversion, and openness to experience were positively related to creativity; on the other hand, agreeableness and conscientiousness were negatively related to creativity. These results were partially supported by Furnham and Bachtiar (2008) who derived a study to investigate the factors that determined creativity. Participants completed a personality measure, an intelligence measure and four measures of creativity. The findings suggested that intelligence did not play a role in predicting the creativity. On the other hand, extraversion was significantly correlated with all four measures of creativity. Moreover, openness to experience was only a significant predictor in one of the creativity measures.

The relationship between personality traits and creativity is far from clear. This variance could be because of the difference in personality characteristics across different fields and the variety of the instruments that were used to measure personality and creativity. Additionally, it could be because of the certain attributes that facilitate creativity in certain fields, on the other hand, inhibit it in others (Batey & Furnham, 2006). To begin with, only personality trait openness to experience seems to be positively related to creativity across a variety of samples and outcome measures (Furnham & Bachtiar, 2008, Kaufman, 2009), but it is no closed issue. A study of Martindale and Dailey did not find any association between openness and creativity as measured by DT tests or fantasy story writing in a small sample of 37 male American psychology students (as cited in Batey and Furnham, 2006). The relation of creativity with the other factors is little complicated. Extraversion appears to be fairly related to creativity, but there may not be a relation also (Kaufman, 2009). Wolfradt and Pretz (2001) found a positive relation between creativity and extraversion. On the other hand, the literature review derived by Batey and Furnham
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(2006) showed that extraversion is positively related to everyday creativity and negatively related to artistic and intellectual creativity. The relation between consciousness and creativity depends on the domain. Feist’s (1998) meta-analysis supported that creative scientists had a tendency to be more conscious compared to creative artists. This result was also supported by Batey and Furnham (2006) who reported a negative relation of consciousness with artistic creativity but a positive relation with scientific and everyday creativity. The agreeableness has a small relationship with creativity (Kaufman, 2009). King et al. (1996) suggested a negative relationship between agreeableness and creative accomplishments, but Batey and Furnham (2006) reported a small positive relationship between agreeableness and everyday creativity. The relation between neuroticism and creativity has been discussed by researchers for a long time (Xu & Brucks, 2011). Personality trait neuroticism seems to contribute artistic creativity, but detract from scientific performance (Feist, 1998). Therefore, the role of neuroticism on creativity could depend on the domain of endeavor (Batey & Furnham, 2006).

2.5 The Relationship between Motivation and Creativity

Motivation is one of the most crucial variables of creativity in any field. It is the fuel that starts, controls, maintains individuals’ behaviors. It increases individuals’ energy and task persistence. Motivated individuals’ interest, curiosity, and persistence lead them to work hard on unfamiliar or complex tasks, focus on the novel and original ideas. Motivational orientations influence the engagement of students in a task, the study strategies they adopt and influence academic achievement and creativity. Lepper (1988) stated that intrinsically motivated individuals present some desirable behaviors such as focusing on a task for a long time, persistence after the failure, selection of more difficult tasks, greater creativity and risk-taking. Amabile (1996) suggests that social environment plays a crucial role on creativity through the mechanism of motivation. There is a connection between motivational orientation of an individual and the creativity of his or her activity (Hennessey, 2003). The social or environmental factors facilitate or hinder the creativity of students. Therefore, students' success and quality of their learning are usually considered to be mostly determined by their motivation (Mitchell, 1992).
The lack of consensus on the definition of motivation has been a major difficulty in the psychology of motivation (Kleinginna & Kleinginna, 1981). Because of the fact that motivation is a complex and multifaceted phenomenon, there are several definitions and theories in the literature. No single theoretical interpretation of motivation explains all aspects of student motivation. Behavioral, Cognitive, and Humanistic Theories look at motivation from different perspectives. At first, drives and needs were investigated as key in determining students’ motivation. Later, there is a general shift in the study of motivation. Studies moved away from behavioral models to the social-cognitive perspective that emphasize individuals’ explanation of events and the importance of their beliefs, cognitions, emotions, and values that are essential for achievement (Pintrich & Schunk, 1996). In this research, social cognitive perspective was taken as the basis in analyzing the relation of motivation to creativity.

Social Cognitive theorists emphasize the interaction of social-contextual and personal factors that determine human motivation. They emphasize that since motivation is a multifaceted phenomenon, there are a variety of ways to motivate individuals and the important point is to understand how and why individuals are motivated. Social Cognitive Model views motivation as dynamic, contextual, and domain-specific. In other words, individuals’ motivation changes depending on the contextual factors. According to the Cognitive Model, there are three essential motivational constructs. These are a value component (intrinsic and extrinsic goal orientation, task value), an expectancy component and test anxiety (Pintrich, Smith, Garcia, & McKeachie, 1991). In this research, the study of motivation for creativity was classified under two headings: intrinsic and extrinsic goal orientation.

Ryan and Deci (2000) asserted "to be motivated means to be moved to do something" (p. 54). Biehler and Snowman (1997) argue that individuals are motivated if they choose goals and expend effort to achieve that goal. However, individuals are considered to be unmotivated when they feel no stimulus to reach a goal. For Biehler and Snowman, motivation is the forces that are responsible for the activation, selection, control, and persistence of behavior. A similar definition of motivation was provided by Mitchell (1982), who viewed motivation as the arousal, direction and continuation of voluntary actions.
In this study, motivation was classified into two types: intrinsic and extrinsic motivation. Most of the studies have associated intrinsic motivation with higher levels of creativity. However, the research regarding extrinsic motivation and creativity is complex. There has been no agreement on the effects of extrinsic motivators on creativity.

Individuals do not have only different level of motivation, but also different orientation of that motivation (Ryan & Deci, 2000). Orientation of motivation concerns with why individuals engage in a task. For example, a student could be motivated because of getting good grades or because of curiosity. Individuals’ engagement of a task is influenced by the type of the motivation such as their intrinsic or extrinsic motivation. Intrinsic motivation comes from internal desires within students. Intrinsically motivated individuals undertake a task for its own sake. Hennessey and Amabile (2010) defined intrinsic motivation as “the drive to do something for the sheer enjoyment, interest, and personal challenge of the task itself rather than for some external goal” (p. 581). According to Dev (1997), intrinsic motivation is (a) engaging in a task because of curiosity; (b) the desire to engage in a task for the purpose of participating in and finishing an activity and (c) the aspiration to contribute. Intrinsically motivated individuals put some effort on a task based on their interest, curiosity, and eagerness to learn rather than because of external pressures, or rewards. In contrast, extrinsically motivated individuals undertake a task for an external goal. For instance, if a student studies hard to pass a course or to receive appraisal from teacher then he is extrinsically motivated. Extrinsic motivation contrasts with intrinsic motivation (Ryan & Deci, 2000). When an extrinsic incentive is given to individuals to finish a task, it has observed to decline intrinsic motivation (Hoyenga & Hoyenga, 1984).

Amabile (1996) emphasized the antecedents of creative performance in the three part model of creativity. Amabile argue that the combination of several environmental and person variables is crucial for the realization of creativity. Therefore, to produce a creative work or to generate a creative solution or an idea, an individual must have domain relevant skills, creative relevant skills and task motivation. Domain-relevant skills and creativity relevant skills can be taught to individuals, but motivational state is variable and depends on the context. Social factors have major impact on the motivational orientation of individuals, and in turn,
it affects creativity. Motivational orientation is separated into intrinsic and extrinsic motivation. Over 25 years of investigation into the relation between intrinsic versus extrinsic motivation and creativity, Amabile found repeated evidence that the main driving force behind the creative process was intrinsic motivation. This result led to the development of Intrinsic Motivation Principle of Creativity. According to the Intrinsic Motivation Principle of Creativity, intrinsic motivation encourages creativity, on the other hand, extrinsic motivation is usually detrimental. Intrinsic motivation develops better problem solving skills and fosters deep conceptual understanding (Hennessey, 2007). People show high creativity when they are motivated by the interest, enjoyment, satisfaction, and challenge of the work (Hennessey & Amabile, 2010). Moreover, Hennessey and Amabile (1987) designated extrinsic motivators as the killing methods of creativity. They stated that using expected reward, competitive situations, focusing on expected evaluation, using plenty of surveillance and restricted-choice situations are five methods of how to kill creativity.

Amabile (1985) examined the effects of motivational orientation on creative writing tasks. She asked 72 young adults to write two poems. After writing the first poem, a list was presented to some participants and they ranked the importance of some reasons for writing. One group received a list that stressed intrinsic reasons for writing such as joy of playing with words, and satisfaction from self-expression. The other group received a list that stressed extrinsic motivators such as earning money and getting into graduate school. Participants in the control group did not take any list with reasons for writing. Although there were no difference between groups on the creativity of first poems, students given the extrinsic reasons were significantly less creative than other two groups on the creativity of second poems. No statistically significant difference was observed between the control group and the intrinsic-orientation group in the ratings of creativity. The findings were also supported by Moneta and Siu (2002), who analyzed the influence of intrinsic motivation on creativity, in an experimental creative writing task. The results suggested that intrinsic motivation correlated positively with creativity of the stories, whereas extrinsic motivation failed to correlate.

Western perspective of creativity has dominated the creativity research and psychological literature. Therefore, Oral, Kaufman and Agars (2007) conducted a
research to see whether creativity research findings of Western cultures would hold true for Turkish participants. They explored the relationship between creativity and motivation among undergraduate students in Turkey. The results of the study found that, among Turkish students, intrinsic motivation was highly correlated with creativity, and there was a significant gender and extrinsic motivation interaction. Only in the group of men, high creativity was observed when extrinsic motivation was higher. As a result, they concluded that their studies supported the previous studies on Western populations.

The research regarding the relation between extrinsic motivation and creativity is complex. There has been no agreement on the effects of rewards on creativity. Amabile’s idea on the importance of intrinsic motivation and detrimental effect of extrinsic motivation on creativity can be challenged. Biographies of exceptional scientists and mathematicians showed that rewards generally increased creativity (Eisenberger & Shanoc, 2003). For example, Mozart, Michelangelo and many other creators were highly motivated by external rewards. They frequently worked for contracts. Starko (2010) asserted that if intrinsic motivation was well established the reward may not be detrimental. So, it can be concluded that different stages of creative process requires different types of motivational orientation. In their review of the literature, Eisenberger and Shanoc (2003) reported that if rewards were used for new activities then they increased intrinsic motivation and creativity. On the other hand, if rewards were used for familiar activities then they decreased both intrinsic motivation and creativity. In another study, Rossman (1931) sent 710 creators a questionnaire in which they were asked to list the motives and incentives that caused them to invent. Then, Rossman listed the frequency of mention of creators’ motives. The most important motives of inventing were “love of inventing”, “desire to improve”, and “financial gain”. As it can be seen from the results, intrinsic motivators were emphasized a lot by the inventors, however, the role of the extrinsic motivator, i.e. financial gain, on creation cannot be underestimated.

Stenberg (2006a) thinks that creativity is a habit that is because it can be trained. Stenberg offered three ways to promote creativity: “(a) opportunities to engage in it; (b) encouragement when people avail themselves of these opportunities; (c) reward when people respond to such encouragement and think and behave creatively” (p. 1). For Stenberg, all of them are necessary for creation. If one of them
is taken then creativity is discouraged. Therefore, based on the views of Stenberg, it is reasonable to conclude that extrinsic motivation is also essential for the creative process.

As the investigations on the relation between creativity and motivation continued, Amabile noticed that not all kind of extrinsic motivation is harmful for creativity. Amabile distinguished two types of extrinsic motivators to explain different effects of extrinsic motivation on creativity: synergistic extrinsic motivation and non-synergistic extrinsic motivation (as cited in Collins & Amabile, 1999). While synergistic motivators inform the individual about his performance and support the intrinsic motivation, non-synergistic extrinsic motivators causes a feeling of being controlled and they conflict with intrinsic motivation. For example, when rewards are used to control on how well an individual is performing on a challenging task, they may weaken intrinsic motivation. On the other hand, if they are used for the purpose of giving information about the performance, they may increase individual’s intrinsic motivation. The distinction of the extrinsic motivators influenced Amabile to revise Intrinsic Motivation Principle of Creativity on the relationship between extrinsic motivation and creativity. Amabile (1996) stated “Intrinsic motivation is conducive to creativity; controlling extrinsic motivation is detrimental to creativity, but informational or enabling extrinsic motivation can be conducive, particularly if initial levels of intrinsic motivation are high” (p. 119).

Amabile’s revised form of Intrinsic Motivation Principle of Creativity was supported by Koestner, Ryan, Bernieri, and Holt (1984). They conducted a research to investigate whether the imposition of external constraints would reduce intrinsic motivation and creativity compared to informational style. First and second grade students were allocated to one of three experimental conditions to engage in a painting activity. First group received no limit-setting instructions, second group received informational limit-setting instructions, and the third group received controlling limit-setting instructions. The results revealed that informational limit-setting styles did not weaken intrinsic motivation compared to no-limits control group. On the other hand, controlling limit-setting instructions caused a significant decline in intrinsic motivation compared to the no-limits and informational limits conditions. Koestner et al. also investigated the creative quality of children’s
paintings. They reported that controlling limits significantly undermined quality and creativity of artistic production.

The results of another study derived by Selart, Nordstrom, Kuvaas and Takemura (2008) also suggested that not all kind of rewards are harmful for creativity. The effects of two types of rewards (the performance-contingent versus engagement contingent) on self-regulation, intrinsic motivation and creativity were examined. Forty-two undergraduate students were randomly allocated to three groups which were performance-contingent reward group, an engagement-contingent reward group and a control group. The results showed that students in control group and in engagement-contingent reward group scored significantly higher than students in performance-contingent reward group on measures of creativity. However, control group and engagement-contingent reward group students were not significantly different from each other on measures of creativity.

To sum up, the research regarding the relation between extrinsic motivation and creativity is complex. There has been no agreement on the effects of extrinsic motivation on creativity. The current study can add valuable information to mathematics education in relation to motivation and creativity connection. If the connection between motivational orientation and creativity is identified, then appropriate learning and teaching strategies can be used in the classroom to the promotion and maintenance of creative thinking.

2.6 The Relationship between Academic Risk-Taking and Creativity

Risk has always been a part of human life from the earliest days of recorded history (Trimpop, 1994). Every day willingly or not people take risk to satisfy their physiological or psychological needs related to their health, academic life, sports or financial situations. Early humans took physical risks to survive while hunting an animal, finding a shelter, or protecting themselves from the possible dangers in nature (Damodaran, 2007). Risk-taking acts has changed form from earliest days of history to the present. Today besides the physical risks, people have also exposed to risks related to economics, traffic, health, sports or education. Throughout the history, some people dramatically have changed human lives by their risk-taking behavior. While some of these risk-taking attempts have brought negative consequences to
human life like nuclear explosion at Chernobyl and atomic bombing of Hiroshima, others have brought positive consequences like smart phones and computers. Therefore, researchers from different fields have begun to study risk-taking behaviors of individuals.

Risk-taking behavior of people has been discussed a lot in the areas such as economics, sports, health care, technology, and insurance. Since individuals encounter with risk-taking behavior in every aspect of life, people have to learn the nature of risk-taking behavior. The rapid changes in the society and in the world require effective problems solvers and decision makers who have the courage to take a risk. Therefore, effective risk-taking is essential in managing life, in generating creative solutions to problems and challenges encountered in daily life. Since risk-taking is a prerequisite to become an effective problem solver and decision maker (Young, 1991), it is necessary to encourage individuals to take risks in their learning experiences.

Farley (1991) claimed “risk taking is at the core of human creativity, and that creative and productive risk taking is one of the great lessons that education, and the family, should be giving children” (p. 372). Risk-taking and innovation are essential variables of the creative process in the fields of science, business, and the arts (Taylor, 2010). Risk is a complex phenomenon, which is related to an unlimited number of factors. Different situations and perspectives generated different definitions of risk-taking (Trimpop, 1994). Therefore, there is no consensus on the definition of risk-taking (Renn, 1998; Tay, Özkan & Tay, 2009). Risk-taking behavior and its effects on people’s lives are studied in many areas such as science, law, medicine, social sciences and economics (Stalker, 2003). In the literature, researchers have focused on different aspects of risk-taking behavior. Most of risk-taking researchers have investigated the behavioral, cognitive, affective and perceptual patterns of individuals (House, 2002). Since risk-taking is contextual, there is no common conceptual model of risk-taking behavior appropriate for application across disciplines (Taylor, 2010).

The word “risk” comes from French word “risqué”. Risk-taking has a cluster of characteristics such as adventurousness, flexibility vs. rigidity, tolerance of ambiguity, and gambling (Strum, 1971). Some of the researchers look at risk-taking from a negative perspective, so they define it through loss or negative consequences.
Beyth-Marom and Fischhoff (1997) define risk behavior as an action or a non-action that causes a chance of loss to the actor. Yates (1990), who viewed risk-taking as a decision problem, identified the major components of risk as loss, significance of loss, and the uncertainty associated with loss. Instead of taking positive aspects of risk-taking, these researchers have focused on limiting exposure to negative consequences (Taylor, 2010). For example, while the researchers, who study on adolescence development, see the risk-taking as an important developmental step, they discuss risk-taking in terms of negative behaviors such as smoking, alcohol or drug use, sexual behavior, and reckless driving.

Viewing risk-taking as a positive construct is very important in understanding how it affects individuals’ personalities and growth (Taylor 2010). Strum (1971) referred to risk-taking as the tendency to guess even when there is a penalty. Renn (1998) postulated that risk is the possibility of human actions which cause consequences that influence what humans’ value. According to Trimpop (1994), risk is “any consciously or non-consciously controlled behavior with a perceived uncertainty about its outcome, and/or costs for the physical, economic or psychosocial well-being of oneself or others” (p. 9). In a similar vein, Rosenbloom (2003) described risk-taking as behavior which had no precision about its results. Based on the definitions, risk-taking behavior can be categorized as positive or negative. In supporting students in risk-taking, there must be some balance because risk-taking brings responsibility for consequences (Starko, 2010). Every risk situation has an uncertainty and possible negative effects. Therefore, besides encouraging students to take intellectual risks, students must also assess which risks are worth taking and which are not.

Academic risk-taking behavior describes the students’ courage and unwillingness in quarreling against difficulties and their learning situations (Korkmaz, 2002). It is the tendency to guess in a classroom situation, even when there is a penalty (Strum, 1971). Beghetto (2009) used the term intellectual risk-taking instead of academic risk-taking. According to Beghetto, intellectual risk-taking is “engaging in adaptive learning behaviors (sharing tentative ideas, asking questions, attempting to do and learn new things) that place the learner at risk of making mistakes or appearing less competent than others” (p. 210). For Clifford, Lan, Chou, and Qi (1989) academic risk-taking is the preference of school tasks that
varied in probability of success and were accompanied by feedback or the expectation of feedback. Academic risks students take include asking questions in the classroom, engaging in class discussions, sharing and expressing an opinion that differs from the teachers’ and friends’ or solving a problem from a different path, answering the questions in which student is uncertain of the answer (House, 2002). If students engage in these kinds of learning behaviors then they bear the risk of making mistakes and seeming less competent than others.

When one looks at the definitions of creativity, many references to risk-taking characteristics of creative people can be seen. Creativity encompasses many characteristics such as adventurousness, openness to experience, and growth, as opposed to safety, flexibility vs. rigidity, tolerance for ambiguity, and gambling (Getzel & Jackson, 1962; Strum, 1971). Definitions of creativity and risk-taking have much in common. Torrance (1962) postulated that adventurousness and willingness to take risks are characteristics which differentiate creative individuals from the others. The association between creativity and risk-taking emerged in the work of Haefele (1962), who considered every creative act as a risk. Anderson and Cropley (1966) reported risk-taking as one of the best nonintellectual elements of creative potential. Among others, who have confirmed this assertion, are Rossman and Horn (1972). Rossman and Horn characterized calculated risk-taking as one of the factors which were indicative of creativity. Clifford (1991) says that preference for tasks beyond an individual’s ability level is a kind of academic risk-taking, which promotes learning and cognitive development.

People are different from each other in their decision making style. While some people are cautious in making decisions, some of them bear risks in a decision situation under conditions of uncertainty (Pankove, 1967). Willing to take risk is essential for success in every area. Creativity requires eagerness to take chances, exploring the unknown, using unfamiliar approaches, and going through the untried paths. The outcome of the creative act is uncertain, and individuals may experience failure and loss, as a result. However, if the individuals are successful in their creative acts, then they take their places in the world history. Creative people are better able to calculate their risks (McClelland, 1963 as cited in Yudess, 1983). They take risks in which success or failure will depend on their own efforts rather than luck. These individuals enjoy the uncertainty of untried experiences and receive
some satisfaction while taking the risk. They want to go in new directions and leave the traditional habits. Because of the fact that risk-taking opens doors to use creativity skills, it can be regarded as a key element of creative behavior (Budge & Clarke, 2012). Therefore, understanding the nature of risk-taking behavior and why some individuals take chances and others do not have important implications in everything from work life to academic programs.

Young (1991) identified five levels of risk-taking behavior. The levels indicate the varying degrees of risk-taking behavior. Not all individuals progress through these stages and the stages are not ascribed an age appropriate range. Moreover, the risk-taker does not begin at the lowest level and progress through the levels until the highest level is reached. The first level of risk-taking behavior is The Uninhibited Risk-Taking. The Uninhibited Risk-Taker shows the highest level of risk-taking behavior. It is common in early childhood stages. The children, who are in this stage, are more enthusiastic to engage in new learning for its own sake. This behavior decreases as students begin to conform school and peer norms and because of the inappropriate educational practices. The Analytical Risk-Taking is the second level of risk-taking behavior and is seen through all early childhood years. The risk-taker in this stage analyzes the factors before beginning to a task. This level is more preferable to unlimited risk-taking in certain situations. The third level of risk-taking behavior, cautious risk-taking, is more common in later stages of early childhood. The cautious risk-taker is less willing to take risk in learning, but is willing to watch others take the initial risks. These children give importance to how others will evaluate their performance and focus on success and failure. The fourth level of risk-taking behavior is rarely seen in the early childhood years. The Inhibited Risk-taker wants guarantees, assurance of what is expected, and of what effect it will have. He tries to do everything “right”. The last level of risk-taking behavior, the non-risk-taker, is not often seen in young children. The Nonrisk-Taker at this stage takes no risk. Only routine learning tasks are attempted.

According to Clifford (1991), risk-taking is a decision situation that involves selection among different alternatives. Risk-taking theories are derived from decision making theories. Clifford argues that since mathematical models unable to fully explain decision making behavior, the risk-taking theories that emphasize individual differences and situational variables emerged. In order to maximize gain and
minimize losses, logical individuals select among carefully considered alternatives. The Normative decision theory underlines the steps the decision makers should take in a risk-taking situation (Beyth-Marom & Fischhoff, 1997). These steps are:

- **a) identify the possible options;**
- **b) identify the consequences that might follow from each option;**
- **c) evaluate the desirability of each consequence;**
- **d) assess the likelihood of each consequence, should each action be taken;**
- **(e) combine these steps according to a logically defensible decision rule.** (Beyth-Marom, Austin, Fischhoff, Palmgren & Jacobs-Quadrel, 1993, p. 549)

People’s actual decision processes are determined by adherence or departure from these normative standards.

An essential component affecting school performance is motivation. There are many motivation theories in the literature. One of the important ones among these theories is Atkinson’s (1957) Achievement Motivation Theory which helps researchers to understand why individuals engage in risk-taking behavior. With the introduction of this theory, researchers focused on not only the determinants but also the consequences of risk-taking behavior (Clifford, 1991). Achievement Motivation Theory is assumed to be appropriate in achievement situations, which require skill and competence (Maehr & Sjogren, 1971). Achievement theory assumes that individuals’ engagement in a task depends on the strength of their expectation about the consequence of their behavior (House, 2002). According to Atkinson’s Theory of Achievement Motivation, an individual’s need for achievement may influence the engagement of a person in risk-taking behavior. People will either approach to success or avoid failure in achievement situations. A person’s achievement oriented behavior is based on three parts: the first part being the individual’s achievement motive, the second part being the probability of success, and the third one, incentive value of success (Atkinson, 1957). Atkinson stated that people would hold the value of success to be higher on difficult tasks than on easy tasks. Similarly, people would have lower expectancies for success on difficult tasks than on easy tasks. These approaches affect a person's behavioral tendency to engage in a task. Moreover, the
theory asserts that achievement oriented individuals have more preference for moderately difficult tasks than failure threatened individuals (Maehr & Sjogren, 1971). Studies showed that if the probability of success is .50 on an achievement tasks then the individuals’ tendency to engage in the task will increase (Atkinson, 1957).

McClelland (as cited in Yudess, 1983) showed that high achievement motivation in the creative scientist encouraged them to take of moderate calculated risks essential to scientific discovery. Besides encouraging students to take intellectual risks, students must also assess which risks are worth taking and which are not. Clifford, Chou, Mao, Lan and Kuo (1990) discussed that moderate risk (.50 probability of success) maximizes ability information, success satisfaction, persistence after failure, and task engagement. Similar to Clifford et al., Tay et al. (2009) think that individuals’ performance, resistance against difficulties, ability toward risk taken event, his academic level and happiness gained as a result of the carrier are increased by academic risk-taking. Therefore, moderate risk-taking and optimal challenge came out to be important antecedents of social, motivational, and cognitive benefits (House, 2002). Clifford (1991) associated optimal challenge with Vygotsky's Zone of Proximal Development (ZPD). Vygotsky (1978) defined zone of proximal development as “the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving and adult guidance or in collaboration with more capable peers” (p. 86). To facilitate the cognitive development students must perform within this zone where challenge and skill are counter-balanced. Optimal challenges beyond students’ current ability level require them to take academic risks in their learning process (Clifford, 1991). While trying new approaches, exploring the unknown, and going through the untried paths, students engage in tasks which are above their current ability level. As the students stretch their boundaries with novel experiences, the likelihood of growth and development of creative skills increase.

In an investigation to identify developmental patterns and sex differences in children's academic risk-taking and tolerance for failure, Clifford (1988) gave the Academic Risk-Taking (ART) and the School Failure Tolerance (SFT) measures to fourth, fifth, and sixth grade students. The ART consists of mathematics, spelling and vocabulary problems in varying difficulty. Students selected problems from each
content area and anticipate getting fixed-payoff (the value of the response does not depend on the item difficulty). The results of the study demonstrated that participants at all grade levels selected questions remarkably below their ability levels. As grade level increases, students’ low risk-taking tendency steadily increased. Moreover, school failure tolerance declined significantly from grade four to grade six. Whereas educators are trying to maximizing academic success in the schools, they are trying to minimize failure and error making. Therefore, students have little tolerance to error making and failure on academic tasks (House, 2002) as they go through grade levels. Two follow up studies with American and Chinese elementary school children were conducted by Clifford et al. (1989) to examine developmental and cultural patterns in academic risk-taking. The subjects were given the same risk-taking and failure tolerance scales as the ones used in Clifford’s (1988) study. The researchers found that failure tolerance level decreased with grade. Academic risk-taking tends to increase with development under variable-payoffs condition rather than fixed-payoffs conditions. A similar result was provided by Clifford and Chou (1991) who found that variable pay-offs produced more risk-taking behavior compared to fixed-payoffs condition.

Pankove (1967) derived a research to investigate whether a relationship exist between creativity and risk-taking in fifth grade children. To measure creativity, Pankove used Alternate Uses Test in which students were required to think of as many uses as they can for a verbally specified object and Pattern Meanings Test in which the children were asked to respond to each of the abstract visual designs. Three risk-taking tasks, which were Draw a Circle, Clues and Shuffleboard Game, were used in the study. After the analyses, the researcher indicated that a positive relationship existed between creativity and risk-taking only for boys. The result was supported by Pankove and Kogan (1968) who investigated interrelationships among selected measures of creativity, intelligence and risk-taking in a sample of fifth grade children. The results revealed a significant positive relationship between creativity and risk-taking, but only in the case of boys. A similar conclusion was reported by Kurtzman (1967) who found creative students more adventurous than the less creative ones.

Moreover, Ramos and Lambating (1996) conducted a research to analyzed females' reluctance, and males' inclination to be risk-takers in their review of the
literature on the relationship between risk-taking and mathematics performance. They concluded that students, who were more inclined to risk-taking behavior, tended to do better on mathematics tests. According to Kaplan (1960), since the creative people have high self-confidence they like the uncertainty of untried experiences. Creative people have not only a desire to take risks but also they experience satisfaction from the risk-taking process (Pankove, 1967).

Strum (1971) conducted a study to determine the relationship of creativity and risk-taking among 291 fifth grade students. The Torrance Test of Creative Thinking, Figural form A, and The wide Range Vocabulary Test were used to measure creativity and academic risk-taking, respectively. Contrary to the findings of previous researchers, no significant relationship was found between creativity and academic risk-taking among boys, girls and the total sample. As a result, Strum concluded that students who guessed and took chances were not necessarily more creative than students who did not.

2.7 The Relationship between Metacognition and Creativity

According to Lories, Dardenne, and Yzerbyt (1998), humans have knowledge of their own cognitive states and the ability to reflect upon, monitor or regulate their states of mind, which are absent in other species. For example, humans determine their goals on a task, evaluate their progress, and revise their strategies if necessary. Therefore, what distinguishes human species from all other animals is metacognitive nature of human cognition (Lories et al., 1998).

The term metacognition has encouraged researchers to investigate its role on several areas of children’s learning (Paris & Winograd, 1990). Metacognition is a critical component of effective learning and refers to higher order thinking. One of the important objectives of schooling is to teach children become more conscious of their mental processes and control their thinking processes involved in learning. There has been a wealth of educational research conducted on this topic to explore the role of metacognition in variety areas of children’s’ learning.

The concept of metacognition is mostly associated with John Flavell, who was regarded as an influential figure in the field (Livingston 2003). After Flavell, there has been an increasing attention among the researchers to the study of
metacognition. The nature and development of metacognition has emerged an interesting area of investigation with the work of Flavell at the end of 1970s (Deseote & Veenman, 2006).

Metacognition indicates humans’ consciousness of their own knowledge and their ability to understand, control, and regulate their own mental processes (Flavell, 1976). There is much discussion about the definition of metacognition in the literature. This debate might be because of the existence of several terms used interchangeably in the literature such as self-regulation and meta-memory (Kayashima, Inaba, & Mizoguchi, 2004). For Flavell (1976):

Metacognition refers to one’s knowledge concerning one’s own cognitive processes and products or anything related to them...Metacognition refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects or data on which they bear, usually in the service of some concrete goal or objective. (p. 232)

According to Schraw and Dennison (1994), metacognition implies the ability of individuals to reflect upon, understand, and control their learning. Gradually, metacognition has been broadened to include not only cognitive but also psychological processes (Papaleontiou-Louca, 2008). Some of the researchers added affective components to the definitions of metacognition. Papaleontiou-Louca suggested a more extensive definition of metacognition:

Shortly, the definition of metacognition has been broadened and includes, not only “thoughts about thoughts” as it was before considered, but the following notions as well: knowledge of one’s knowledge, processes, and cognitive and affective states; and the ability to consciously and deliberately monitor and regulate one’s knowledge, processes, and cognitive and affective states. (Papaleontiou-Louca, 2008, p. 5)

There are some problems associated with the definitions of metacognition (Livingston, 2003). One of the important issues is separating cognitive and metacognitive strategies. While metacognitive activities are often thought to be
conscious, many other cognitive activities necessarily are not (Lories et al., 1998). For Flavell (1979), metacognitive knowledge and cognitive knowledge might not be distinct. Similar to Flavell, Livingston (2003) says that metacognition and cognition have a close relation and they base on each other. However, they distinguished from each other in terms of how information is used. For example, if cognition involves perceiving, understanding, remembering, then metacognition involves thinking about one’s own perceiving, understanding, and remembering (Papaleontiou-Louca, 2008). Metacognitive activity generally comes before and follows cognitive activity. Moreover, cognitive strategies help an individual to structure his knowledge, on the other hand, metacognitive strategies allow a learner to control and enhance this knowledge (Gourgey, 1998). For example, people use cognitive strategies to correctly solve the problems in Math, however, knowing why a strategy is necessary and appropriate is in metacognitive nature. Cognitive strategies help individual attain a specific goal, whereas metacognitive strategies help individual to confirm whether the goal has been achieved (Livingston, 2003).

Livingston (2003) views metacognition as higher order thinking that includes active control over the mental processes. For Livingston, activities such as planning how to approach a learning task, regulating comprehension, and evaluating progress are all in metacognitive nature. Several definitions of metacognition involve knowledge and strategy components. Therefore, metacognition can be categorized into two separate classes: metacognitive knowledge and metacognitive skills or processes (Deseote & Veenman, 2006).

For Flavell (1979), metacognition includes metacognitive knowledge and metacognitive experiences. Metacognitive knowledge comprises factual knowledge about tasks or people. It includes information about the functioning of human mind in general and functioning of one’s own mind in particular. Identification of the task, checking and evaluating the progress and prediction about the outcome of the progress are examples of metacognitive knowledge. Flavell further claims that metacognitive knowledge consists of person variables, task variables and strategy variables. Person variables encompass the information about both one’s own cognitive processes and other people’s cognitive processes. Task variables imply knowledge about the nature of the task and the cognitive demands the task requires for the individual. Strategy variables include knowledge about effective use of
cognitive and metacognitive strategies for achieving goals. Metacognitive experiences differ from metacognitive knowledge. Metacognitive experiences are the strategies that people actually apply to regulate and control the cognition (Desoete & Veenman, 2006). Metacognitive experiences involve the feelings and evaluations related to cognitive processing. Flavell (1979) discussed some of the important properties of metacognitive experiences. Firstly, metacognitive experiences have an influence on cognitive goals, metacognitive knowledge and cognitive strategy use. They lead the individuals to select and revise goals or abandon the old goals if necessary. Additionally, they support the metacognitive knowledge base by contributing to it, removing from it, or reviewing it. Finally, metacognitive experiences activate strategies to achieve cognitive or metacognitive goals. Jacobs (2004) emphasized the principal metacognitive strategies, which are making a connection between old and new information, purposively choosing most suitable mental strategies and planning, controlling, and evaluating mental processes. Therefore, metacognitive experiences are the online metacognition as contrasted to metacognitive knowledge. Metacognitive experiences inform people about the task processing demands and one’s history about similar problems (Desoete & Veenman, 2006). Task analysis, planning, monitoring, checking, and reflection are some examples for the metacognitive skills (Veenman & Spaans, 2005).

Some of the researchers inquired about the relevance of metacognition to creative thinking (e.g. Armbruster, 1989; Feldhusen, 1995; Runco & Chand, 1995). Since the process of creation is a cognitive process, creativity is investigated from the perspective of metacognition. Armbruster, (1989) stated that the creative process includes knowledge and skill acquisition, the transformation of knowledge into new forms, and as a result giving a shareable product. Armbruster concluded that creative individuals might be more creative because of their metacognitive skills. Highly developed metacognitive skills are recognized as one of the essential characteristics of good problem-solvers (Darling-Hammond, Austin, Cheung, & Martin, 2003; Schoenfeld, 1992). Therefore, the metacognitive processes that are important contributors of problem solving performances can be regarded essential for creative acts, as well.

For Dawson (2008), many of the skills necessary for active learning, critical thinking, reflective judgment, problem solving, and decision-making are in
metacognitive nature. Metacognition is one of the basic components of effective learning. It guides students toward attaining their goals in problem solving activities and develops the success of goal directed actions (Davidson, Deuser, & Stenberg, 1994). It was also instrumental in challenging mathematics tasks (Deseote & Veenman, 2006).

Davidson and Stenberg (1998) underlined the importance of metacognition for the problems students encountered in mathematics courses. They think that while the problems require different problem solving skills, mental processes and domain specific knowledge, they share two common characteristics. First of all, students direct their thinking processes toward achieving a goal in solving problems. Secondly, they use their metacognitive processes to guide their goal directed thinking. Davidson and Stenberg described metacognitive knowledge and processes that enabled problem solver to deal strategically with the givens, goals and obstacles found in problem solving. Davidson and Stenberg think:

*Knowledge about problem solving, in general, and about their own mental processes, in particular, helps students become better problem solvers. More specially, metacognitive skills help the student (a) strategically encode the nature of the problem and form a mental model or representation of its elements, (b) select appropriate plans and strategies for reaching the goal, and (c) identify and conquer obstacles that impede progress.* (p. 48)

In a similar vein, Armbruster (1989) argue that during a creative endeavor, individuals are aware of their goal directed behaviors and this goal directed behavior guides them until they generate a creative solution or give a creative product. Moreover, Armbruster called the recognition of strong conscious desire for something as the first occurrence of metacognition. Hayes (1989) also concluded that creative people have very sound knowledge of their thinking processes and the task, in other verbs, they have strong metacognitive knowledge. Moreover, creative people choose the best representation of the problem and evaluate their own performance and make revisions if necessary. According to Hayes, different representations of the problems change the problem difficulty and lead some people to solve it, while others could not. It can be concluded that creative person has a very sound
knowledge of his thinking processes and the task. By the help of this knowledge, depending on the type of the problem, he builds the best representation for his own thought processes. Moreover, Hayes asserted that accurately evaluating the shortcomings of one’s own work and taking effective action to revise the shortcomings were significant cognitive factors that were necessary in creative performance. Metacognitive factors accompany the cognitive factors in the creative acts. In the creation process, individuals often evaluate their performance and make revisions if necessary. They catch their own mistakes and know when to make use of a skill. So, individuals control and monitor their progress during the creative performance.

In the literature, several mathematics researchers have investigated how students’ think in solving mathematics problems that related with the retention of concepts, facts and procedures in mathematics. Two cognitive psychologists Polya and Wallas developed a four stage problem solving model to identify the mental stages through which problem solving proceed. In the problem solving process, Polya (1973) offered the following four steps: (1) understanding the problem, (2) develop a strategic plan, (3) implementing the plan, and (4) looking backward. According to Garofalo and Lester (1985), Polya’s problem solving model assumes metacognitive processes implicitly. They claim that analyzing the mathematical performance only cognitively is inadequate because of the fact that it overlooks the essential role of metacognitive activities. Therefore, they modified Polya’s four stage model to include metacognitive components to comprise four categories which were orientation, organization, execution, and verification. By using metacognitive knowledge and strategies, students can develop appropriate plans during their problem solving process. In a similar vein, Davidson et al. (1994) identified four metacognitive processes that help problem solver to reach the solution. These were: (1) identification of the problem, (2) mental representation of the problem, (3) planning how to proceed, (4) evaluating the solution. Effective use of these metacognitive processes in problem solving generates creative solutions.

Carr, Alexander, and Folds-Bennett (1994) conducted a longitudinal study to investigate the role of second grade students’ metacognitive knowledge in their mathematics strategy use. The study continued over a 5-month period. Consequently, it was found that internal strategy use (e.g., counting in the head) rather than external
strategy use (e.g., counting on fingers) was related to metacognition. Another longitudinal study was carried out by Van der Stel, Veenman, Delen and Haenen (2010) with secondary school students in the first 2 years of their education (13-14 years and 14-15 years). The objectives of the study were to investigate whether metacognitive skills in math developed over age and whether there was a relation between metacognitive skills, intellectual ability, and learning performance in math. Results showed that especially the quantity and quality of planning and evaluation activities developed with age. Moreover, intelligence significantly predicted mathematics performance for the youngest group. The predictive power of metacognitive skills appeared to be much stronger in the older group, even above the intelligence. Other researchers also agree with the assertion that metacognition develops with age. According to Armbruster (1989), younger and poorer readers display less effective metacognitive skills than older and better readers. Similarly, in an examination of the relation between mathematics achievement and metacognition, Lucangeli and Cornoldi (1997) revealed a close connection between metacognitive processes and mathematical achievement. Moreover, the researchers asserted that the relation is closer for the tasks that were based on reasoning ability such as problem solving compared to the tasks that are less automatized.

Creativity is an issue that has been challenging many cognitive science researchers. In the literature, different models have been proposed to explain the creative process (e.g. Isaksen & Treffinger’s, Creative Problem-Solving Model, 1985; Rossman’s Creativity Model, 1931; Wallas’ Model, 1926). These models are not so different from each other. They share some common characteristics.

One of the earliest researchers, who proposed creativity model, was Wallas (1926). Wallas’ model, in part, was based on the insights of Poincare. Metacognitive processes can be seen at every stage of Wallas’ creativity model. Using Wallas’ creativity model, Armbruster (1989) emphasized the significance of metacognitive processes for creative acts. Wallas proposed that creative thinking follows four sequential steps: preparation, incubation, illumination and verification. In the preparation stage, individuals are consciously working on the problem for a period of time. They are collecting information, identifying the problem and generating possible ideas. They build flexible knowledge representation of the problem for themselves. After working hard on the problem and if the progress in the solution is
stopped, the problem is put aside without conscious attention. Armbruster thought that in the preparation stage metacognition function in two ways. Firstly, creative individuals check whether their knowledge rich and flexible enough for restructuring in the act of creation. They evaluate whether they acquired necessary information and skills to assist the creative performance. Secondly, after the evaluation of their metacognitive knowledge, creative individuals control or regulate the acquisition of knowledge and skills. After the preparation stage, incubation begins. In the incubation stage, the problem is internalized into the unconscious mind. It is a wait time after preparation. Nothing appears externally to be happening. The mind continues to consider the problem while the individual do other activities. According to Sriraman, Yafitian and Lee (2011), while working hard on the problem, individual gets mentally tired. Incubation helps individual recover from this mental fatigue. Moreover, giving up the problem solving process for a while and engaging in something else will relax the mind and break the fixation. Metacognition at the incubation stage is unconscious and some inherent processes of mind control mental work (Armbruster, 1989). Individuals rebuild their schemata in order to satisfy the requirements of the problem. Ambruster asserted that creative individuals’ superior metacognitive ability let them recognize the mental representations which serve to the goal of creative enterprise. The solution is consciously recognized in the illumination stage which includes the “Aha!” experience. The ideas suddenly fit together, and the solution becomes clear. Illumination stage is also a metacognitive event. In the verification stage, the creative properties of the solution are tested and some revisions and adaptations are made when necessary. Armbruster concluded that the dialogue between the scientist and product entails two types of metacognition. Firstly, individual verify the product against an internal standard. In other terms, individual check whether the goal of the creative act is fulfilled and whether the product is appropriate for the mental image formed in the illumination stage. Secondly, the product is verified by an audience. If the solution is incomplete, individuals evaluate shortcomings of the work and take effective actions to revise the shortcomings and improve their products (Armbruster, 1989). The use of Walla’s four stage model by creative mathematicians in solving problems is also supported by Sriraman (2004). Sriraman carried out a qualitative research with five creative mathematicians to examine thought processes involved in doing mathematics in
order to examine how mathematicians created mathematics. The researcher found that mathematicians’ cognitive processes used in the creation of mathematics followed Wallas’ four-stage model that has preparation, incubation, illumination, and verification stages.

Runco and Chand (1995) offered the Two-tier model to explain the basic components and interactions of creative thinking (Figure 2.1). Cognitive aspects of creativity as well as the interaction of cognitive processes to produce creative outcomes are emphasized in the model. Problem finding (problem identification and problem definition), ideation (fluency, flexibility and originality) and judgmental processes (valuation and critical evaluation), which are the primary components of the model, interact with one another and with knowledge and motivation that constituted the second tier. Second tier elements depend on the primary components and rather than controlling role they contribute to the model. The second tier contains the knowledge and motivation components. Knowledge is divided into declarative knowledge, which enhances creative thinking by providing factual information, and procedural knowledge, which gives instructions for strategic thinking and helps how to find original and creative ideas and solution. To distinguish procedural knowledge from ability and skill Runco and Chand viewed it as in metacognitive nature. Runco (2007) argues that procedural knowledge provides tactics or strategies for creative thinking. It informs the individual about how to find creative ideas or solutions. Metacognition implies individuals’ consciousness of their own knowledge and their ability to comprehend, monitor, and manage their own cognitive processes (Flavell, 1976). Therefore, Runco thinks that metacognition is the basis for any tactical or strategic creative act.
To sum up, several researchers emphasized the cognitive aspect of creative act. Armbruster (1989) thinks that metacognitive activities, which control and regulate the activities of cognition, are at the top of psychological processes that are involved in cognition. Individuals’ metacognitive knowledge about the task and their own thinking processes assist them to control and regulate their skills and strategies in the creation process. In the literature, there is a scarce of research that investigates the relation of students’ metacognition to their creative ability in mathematics. The researcher conducted this study to fulfill this gap.
CHAPTER III

RESEARCH METHODOLOGY

This chapter involves the methodology of the study comprising research design, description of dependent and independent variables, sample, the instruments used, data collection procedure and data analysis.

3.1 Research Design

Correlational research design was used in the present study. It allows the researcher to investigate the existence, the degree and the direction of the relationship between the variables (Frankel & Wallen, 1990). The current study attempted to explore the relationship among the study variables that were mathematical creativity, personality traits (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism), motivation (intrinsic and extrinsic goal orientation), academic risk-taking and metacognition (knowledge of cognition and regulation of cognition).

3.2 Variables

There were eleven variables involved in this study. Variables were categorized as dependent variable and independent variables. There were one dependent variable and ten independent variables.
3.2.1 Dependent Variable

The dependent variable was students’ Creative Ability in Mathematics Test score (CAMT) that was measured by Creative Ability in Mathematics Test. Creative ability in mathematics was a continuous variable and measured on interval scale.

3.2.2 Independent Variables

There were ten independent variables that were related to personality traits (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism), motivation (intrinsic and extrinsic goal orientation), academic risk-taking and metacognition (knowledge of cognition and regulation of cognition). The predictor variables were continuous and measured on interval scale.

3.3 Participants of the Study

The target population of this study is all the ninth grade science high school students in Ankara and Istanbul and all English preparatory private high school students in Izmit. The sample consisted of 217 high school students from two different school types. 181 ninth grade and 36 English preparatory students participated to the study. The study was carried out in two science high schools in Istanbul and Ankara and a private high school in Izmit. The sample consisted of 119 boys and 98 girls. Prior to the study, permission was taken from the Turkish Ministry of National Education.

Science high schools are government schools that select their students on the basis of High School Entrance Examination (OKS) conducted by Turkish Ministry of National Education. Students have to answer 100 multiple choice questions in four sections: Turkish Literature, Mathematics, Science, and Social Sciences. According to the total scores on this test, students are emplaced to the science high schools regarding their preferences. The students of the private school are selected by the school itself in a three stage exam procedure including written exam, individual assessments and observation camp. Many times it is extremely difficult to select a random sample. Because of the ease of the administration of the instruments for the researcher in the selected schools, the study was conducted in science high schools.
and a private high school. Also, it was considered that the selected sample could supply a variety of answers to open-ended questions which required divergent thinking and from which students would not receive any grade. Moreover, students of these schools generally cared mathematics much more than the other types of school students. Therefore, convenience sampling, a non-probability sampling technique, was used to choose study sample from the target population. Generalizations of the findings of the study can be done on subjects having the same characteristics mentioned here. Nevertheless, since sample size was not large enough generalizations of the findings of the study were limited.

3.4 Procedure

3.4.1 Data Collection

The present study started with literature review about creativity and its relation with components of the research question. Then, the data collection instruments were selected within the literature. The pilot study of Creative Ability in Mathematics Test was conducted to ensure that the items were clearly presented, answerable, and appropriately worded for Turkish students. It was administered to 55 preparatory, ninth and tenth grade students at a private school in Istanbul. Before the real testing situation of the study, the necessary permissions were obtained from the National Ministry of Education. The study was carried out during the fall semester of 2011-2012 academic year at two science high schools in Istanbul and Ankara and a private high school in Izmit. The questionnaires were administered to students during two class hours of each school by the researcher. Before the administration, the researcher gave students instructions for completing the questionnaires.

In addition, it was assumed during the study that
- there was no interaction between the subjects to influence the results of the study.
- the subjects filled the questionnaires accurately and sincerely.
- the subjects understood and interpreted the items truly.
- no outside event occurred during the study.
• the administrations of the scales were completed under standard conditions.

3.5 Data Collection Instruments

In the study, the following measuring instruments were used:
1. Creative Ability in Mathematics Test
2. Short Form of Five Factor Personality Inventory
3. Intrinsic and extrinsic goal orientation subscales of Motivated Strategies for Learning Questionnaire
4. Academic Risk-Taking Scale
5. Turkish Version of Jr. Metacognitive Awareness Inventory

3.5.1 Creative Ability in Mathematics Test

Complex nature of creativity makes the measurement of this construct challenging. In the literature, there are a few instruments that measure mathematical creative ability of students and most of them are developed for middle school students. According to Starko (2010), the purpose of assessing creativity in schools is not to designate students “creative” or “not creative”. Rather, the tests are used to recognize creativity and to establish conditions that facilitate the creative behavior among students.

In the present study, mathematical creativity was measured using the Creative Ability in Mathematics Test (see Appendix A) developed by Balka (1974). CAMT was developed for middle school students who had potential creative ability in mathematics. In CAMT, students are presented with scenarios in which they are required to give as many relations, questions, or answers as possible. However, after taking the views of mathematics educators and secondary school teachers, the researcher of the present study decided to use CAMT to measure mathematical creative ability of high school students because of the non-availability of a mathematical creative ability instrument developed for the high school students.

Balka (1974) developed CAMT by considering the input of 244 mathematicians, mathematics education professors, and secondary school
mathematics teachers. Creative Ability in Mathematics Test was sent to 100 mathematicians, 100 university mathematics teachers, and 100 secondary school mathematics teachers. 81.3% of content experts responded to the questionnaire. The use of content experts and the high response rates to Balka’s questionnaire indicated a high degree of confidence in the content-validity of the instrument. The CAMT was applied to a sample of 500 middle school students in 6th, 7th and 8th grades (Balka, 1974). Balka reported the internal consistency coefficient of the CAMT as .72 and the standard error of measurement as 7.24.

In the adaptation process of the CAMT into Turkish, first, the items of original scale were translated into Turkish by the researcher of the current study and then two translators checked the equivalence of the words and the statements in the pilot form with the original scale. In CAMT, there were two convergent and four divergent items. Mann (2005) stated that since the scorer give “1” for a right answer and “0” for a wrong answer to the convergent items on CAMT, the creativeness of student’s approaches in the solution process was not assessed. Therefore, it is questionable to use items that have one correct answer to measure students’ creative ability. According to Lee, Hwang and Seo (2003), creative thinking ability in the field of mathematics can be measured by open ended or open response problems and questions that require more than one answer. Moreover, Guilford (1957) emphasized the divergent production abilities (such as fluency, flexibility, originality, and elaboration) essential to creativity. Furthermore, Venable (1994) confirmed that the most widely known tests of creativity measure divergent thinking. Therefore, the present study aims to examine and analyze how high school students respond to open ended problems which can be used as essential tools to measure mathematical creativity. In order to investigate how creatively they solve problems, they were presented with problems that have several answers and can be solved with original and unique ideas. Hence, only the divergent items of CAMT were decided to be taken to the analysis in the current study.

The adaptation study of the scale into Turkish was carried out with 55 high school students attending preparatory, 9th and 10th grades in a private school. In the pilot study of CAMT, a random selection of 19 CAMT papers were selected and scored by the researcher and a mathematics teacher using the scoring procedure developed by Balka (1974) (see Appendix B). Differences in scoring were compared
and discussed. Agreement between the scorers was achieved. The inter-rater reliability of fluency, flexibility and originality scores of each question ranged from .80 to .90. The remainder of the tests was scored by the researcher. The internal reliability coefficient of the Turkish-version of scale was calculated as .86 in the pilot study.

In the main study, a random selection of 20 CAMT papers was given to a mathematics teacher. Differences in scoring were compared and discussed. Agreement between the scorers was achieved. The inter-rater reliability of fluency, flexibility and originality scores ranged from .80 to .98 for each question. The internal reliability coefficient of CAMT was .84. Torrance (1974) believed that emotional, physical, motivational, and mental health factors have an influence on creative thinking and may decrease test-retest reliability.

### 3.5.1.1 Scoring Procedure for Creative Ability in Mathematics Test

The measurement of creative thinking ability of children has concentrated on the factors of fluency, flexibility and originality (Balka, 1974; Strum, 1971). According to Balka (1974), the fluency score on CAMT was given on the basis of correct responses a student generated. 1 point was given for each relevant answer. Flexibility score was evaluated in considering different categories of responses. Similar to the fluency score, each category of answers was assigned to 1 point. Moreover, originality score in the present study was judged against the criteria developed by Balka. Participants’ originality scores were weighted with 0, 1, or 2 in considering specific predetermined criteria in the scoring rubric of CAMT (see Appendix B). Balka’s creativity test along with the scoring rubric was used with middle school students and pre-service elementary education teachers (e.g., Fetterly, 2010; Mann, 2005; Walia, 2012). Balka developed the scoring rubric of CAMT in considering the responses given by 500 students. The categories and originality weights were provided in this rubric (see Appendix B). Balka assigned a weight of 0, 1 or 2 for the originality scores based on the uncommonness of the responses. For the originality score, Balka gave a weight of 0 to common responses that constituted 5% or more of the sample population. The responses that were given by 5% or less of the
sample population were regarded as uncommon and a weight of 1 was assigned to those responses. If less than 1% of the population gave responses to a given situation, then those responses were weighted with a score of 2.

For example, the first question on CAMT requires students to list of (as many things as they can) what happens when the number of sides on a polygon is increased. Assume that a student gives the following answers: 1) the number of triangles formed by the diagonal increases; 2) the perimeter of the polygon increases; 3) polygon becomes circle. This student provides 3 relevant responses, therefore, for fluency score 3 points is given. When we look at the scoring rubric of CAMT (see Appendix B), the first answer belongs to the category “number of shapes, kinds of shapes, designs increases”. So, 1 point is given to this category. On the other hand, the second and the third answers belong to the categories which are “perimeter of figure probably increases” and “polygon acquires shape of circle”, respectively. The scorer has to give another 1 point for each category and, in the total, this student takes 3 points for the flexibility score. Furthermore, for the originality score, the expressed category of the first answer is assigned with a weight of “0” and the expressed category of the third answer is assigned with a weight of “1” on the basis of the weights provided in the scoring rubric. Moreover, the category of the second answer is weighted with a score of “2”. As a result, after totaling the originality scores of each answer, this student earns 3 points for the originality score. Combined scores of fluency, flexibility and originality scores are regarded as the mathematical creativity scores of students. Examples of students’ answers for each question are presented in Appendix C.

3.5.2 Short Form of Five Factor Personality Inventory

The Five Factor Personality Inventory (5FPI), which was developed by Somer, Korkmaz and Tatar (2002), is a tool for detailed assessment of normal personality. The 5FPI is a concise measure of the five major domains of personality and 15 sub-dimensions. The five major domains are extraversion-introversion, agreeableness-hostility, conscientiousness-undirectedness, neuroticism-unstability, and openness to experience-unintelligence. There are 220 items in the long version of the scale, but in the present study, short version of 5FPI developed by Tatar (2005)
was used (see Appendix D). There are 85 items in the short version of the inventory. The short version of 5FPI was administered to 2000 people (500 adult male, 500 adult female, 500 female students, and 500 male students) by Tatar. The development of the scale was based on item-factor analyses and internal consistency procedures. The results supported reliability and construct validity of sub-dimensions and Five-Factor Model.

One of the five major domains of personality is neuroticism. Neuroticism defined by stability and low anxiety at one end and it was defined by instability and high anxiety at the opposite end (Pervin, 1989). Individuals with low levels of neuroticism show emotional stability, on the other hand, individuals with high levels of neuroticism show negative emotions. Tatar (2005) calculated Cronbach’s alpha reliability coefficients .87 for neuroticism dimension. In the present study, it was .89.

The agreeableness measures how people get along with others. It is associated with altruism, nurturance, caring and emotional support versus competitiveness, hostility, indifference, self-centeredness, and jealousy (Howard & Howard, 1995). Tatar (2005) reported an internal consistency reliability coefficient of .82 for agreeableness dimension. It was .80 in the present study.

The third dimension is extraversion. Extroverts have an ability to get along better with others and they have a keen interest in external events, and also they like adventures into the unknown (Ewen, 1998). Internal consistency coefficient of extraversion dimension was .82 (Tatar, 2005). It was .85 in the present study.

Openness to experience is the fourth dimension of Five Factor Model. People with a high openness to experience have broad interests, curious, independent thinkers and like novel experiences. For the openness dimension, Tatar (2005) reported an internal consistency reliability coefficient of .79. In the present study, it was .68.

The last dimension is conscientiousness. Conscientious people are competent, orderly, responsible and thorough (Costa & McCrae, 1992). Tatar (2005) reported the internal consistency reliability coefficients of .85 for agreeableness dimension. It was .79 in the present study.
3.5.3 Motivated Strategies for Learning Questionnaire

In the present study, an adapted version of the relevant sections from the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich, Smith, Garcia and McKeachie (1991) was used. The MSLQ consists of two sections: a motivation section and use of learning strategies section. The first scale has three broad areas (1) value (intrinsic goal orientation, extrinsic goal orientation and task value), (2) expectancy (self-efficacy for learning and performance, and control of learning beliefs), and (3) affect (test anxiety) (Pintrich et al., 1991). There are 31 items in the motivation section. The questions are scored on a Likert scale ranging from 1 to 7. The items are scored from “not at all true of me” as 1, to "very true of me" as 7. The various sub-scales on the MSLQ can be used together or separately (Pintrich et al., 1991). Therefore, intrinsic goal orientation and extrinsic goal orientation sub-scales were selected in response to the purpose of the present study.

As the MSLQ was originally developed in English, it was translated into Turkish by Hendricks, Ekici, and Bulut (2000). For the pilot study of the scale, it was administered to students in Foreign Languages Education Department at Middle East Technical University. For the high school students, the Turkish version of the MSLQ was piloted by Ozturk (2003) to 414 ninth grade students. The reliability (Cronbach’s alpha) of the scale for intrinsic goal orientation and extrinsic goal orientation in mathematics were 0.63 and 0.56, respectively. In the current study, the Cronbach’s alpha reliability coefficient was .73 for intrinsic goal orientation subscale and .74 for extrinsic goal orientation subscale.

3.5.4 Junior Metacognitive Awareness Inventory

The Turkish version of Junior Metacognitive Awareness Inventory (Jr. MAI) was used in this study in order to measure students’ metacognition. Metacognition is generally based on two major components of metacognition: knowledge of cognition and regulation of cognition. The Jr. MAI was developed by Sperling, Howard, Miller, and Murphy (2002) and adapted into Turkish by Aydin and Ubuz (2010). Jr. MAI includes 18 five point Likert-scale items for use with students in grades six through nine. The Turkish version of Jr. MAI included 17 items on two subscales with a five choice response (never, seldom, sometimes, often, and always) (see Appendix F).
The Cronbach’s alpha reliability coefficients of the Turkish version of Jr. MAI subscales were .75 for knowledge of cognition subscale and .79 for regulation of cognition subscale (Ubuz & Aydin, 2010).

In the present study, the internal consistency coefficients of Jr. MAI were calculated as .76 for knowledge of cognition and .77 for regulation of cognition subscales.

### 3.5.5 Academic Risk-Taking Scale

In this study, Academic Risk-Taking Scale, which was developed by Clifford (1991) and adapted into Turkish by Korkmaz (2002), was used to measure academic risk-taking behavior of students (see Appendix E). The scale measures the learning states of students, their courage to handle with the difficulties and their willingness/unwillingness. There are 36 items in the questionnaire. The questions are scored on a Likert type scale with a five choice response (never, seldom, sometimes, often, and always). The test was translated to Turkish by Korkmaz (2002) and piloted to 247 university students. The internal consistency reliability coefficient of .89 was reported for this sample. Then, the test was also piloted to 67 students in 7th grade. The internal consistency reliability coefficient of the scale was .90 for the seventh graders. In the Turkish version of the test, the items can be investigated under four headings: the items that reflect the tendency of students carrying negative feelings after failure, the items that reflect the students’ tendency of preferring difficult operations, the items that reflect the students’ tendency to recover and be active after the failure and the items that reflect students’ tendency not to do homework.

In the present study, the internal consistency coefficient of Academic Risk-Taking Scale was calculated as .70.

### 3.6 Analysis of Data

Multiple regression, which is one of the statistical methods used in quantitative research studies, was used in the present study. Multiple regression is a statistical procedure to examine the relationship between two or more variables. According to Fox (1997), regression analysis helps researchers to analyze the
relationship between a quantitative dependent variable Y, and one or more quantitative independent variables X. The usefulness of each independent variable in predicting mathematical creativity, and the degree to which explains the variance of the predicted variable is essential for the current study. Data analyses of this study were conducted in the following statistical techniques:

- The collected data from the subjects were transferred to computer environment with Statistical Package for Social Sciences 16.5 for Windows (SPSS 16.5).
- The reliability coefficients were reported as evidence for the internal consistency of the scales.
- Descriptive statistics were used by the following reasons:
  o To detect the outliers, to check the data and whether data recording error was made.
  o To get the mean, standard deviations, percentages and frequencies of the responses of each item.
  o To check normal distribution of variables.
- Standard regression analysis was used to assess how well creative ability in mathematics can be explained in terms of personality traits (openness, conscientiousness, extraversion, agreeableness, and neuroticism), motivation (intrinsic and extrinsic goal orientation), academic risk-taking and metacognition (knowledge of cognition and regulation of cognition) in the high school students.
- The significant level was set to .05 (t = 1.96) since it was the most used value in educational studies.
CHAPTER IV

RESULTS

Previous chapters were devoted to the theoretical background of the study, the review of creativity literature and the methodology of the current study. This chapter contains the results of the analysis that were performed to provide statistical evidence for the study claims. There are five sections in this chapter. The first section presents the research problems of the present study. The second section presents preliminary analyses of the data and the descriptive statistics of major variables including means and standard deviations of the criterion and predictor variables. In the third section, correlation matrix of the study variables is presented. In the fourth section, assumption checking of the study variables is explained. Finally, the fifth section includes the results of standard multiple linear regression analysis derived from the present study.

4.1 Research Problem

This study aims to address the following problem: “How well creative ability in mathematics can be explained in terms of personality traits (openness, conscientiousness, extraversion, agreeableness, and neuroticism), motivation (intrinsic and extrinsic goal orientation), academic risk-taking, and metacognition (knowledge of cognition and regulation of cognition)”.

Four sub-questions are formulated to examine the relationships:

a) Which personality traits (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism) are related to the mathematical creative ability of the high school students?
b) What is the relationship between academic risk-taking and mathematical creative ability of the high school students?

c) What is the relationship between motivational orientation (intrinsic and extrinsic goal orientation) and mathematical creative ability of the high school students?

d) What is the relationship between metacognition (knowledge of cognition and regulation of cognition) and mathematical creative ability of the high school students?

In order to examine the research problem, the following hypotheses were stated. The hypotheses were stated in the null form and tested at a significance level of .05.

1) The personality traits (openness to experience, conscientiousness, extraversion, agreeableness, neuroticism) do not explain a significant amount of variance in students’ mathematical creative ability.

2) The motivational variables (intrinsic and extrinsic goal orientation) do not explain a significant amount of variance in students’ mathematical creative ability.

3) Academic risk-taking does not explain a significant amount of variance in students’ mathematical creative ability.

4) The metacognitive variables (knowledge of cognition and regulation of cognition) do not explain a significant amount of variance in students’ mathematical creative ability.

4.2 Preliminary Analysis of the Data and Descriptive Statistics

Before the main statistical analyses, the data were checked in terms of possible mistakes made by the researcher while entering the data. The minimum and maximum values and frequencies of each major variable were examined for scores that were not within the range of possible values. A missing value analysis was performed with 217 cases. According to Tabachnick and Fidell (2007), if less than 5% of data is missing, then the problems related to missing data are less serious. Researchers can use any method to deal with missing values. Additionally, Cohen and Cohen (1983) stated that less than 5% or even 10% missing data on a variable
was not large. Since the percentage of missing values did not exceed 5% in this study, the missing values were not a major threat for the analyses. Therefore, pairwise deletion of cases was used for handling missing data.

Descriptive statistics were conducted to describe predictor variables namely five factor personality traits (openness, conscientiousness, extraversion, agreeableness, and neuroticism), motivation (intrinsic and extrinsic goal orientation), academic risk-taking, metacognition (knowledge of cognition and regulation of cognition) and the criterion variable (creative ability in mathematics). Table 4.1 shows the means and standard deviations of the dependent and independent variables as a function of whole subjects by using raw scores. The scores of inventories and subscale scores for the whole subjects were divided by the number of items on the scales. For OPENS, CONSC, EXTR, AGRBL, NRTCSM, ART, KNFCOG, and REGCOG, the scores represent their position on the original 5-point Likert type scale. For IGO and EGO, the scores represent their position on the original 7-point Likert type scale.

Table 4.1 Descriptive Statistics of the Scales in the Study

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Variance</th>
<th>Min.</th>
<th>Max.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAMT</td>
<td>15.30</td>
<td>4.24</td>
<td>18.00</td>
<td>6.25</td>
<td>30.75</td>
<td>24.50</td>
</tr>
<tr>
<td>OPENS</td>
<td>4.16</td>
<td>.46</td>
<td>.21</td>
<td>2.64</td>
<td>5.00</td>
<td>2.36</td>
</tr>
<tr>
<td>CONSC</td>
<td>3.46</td>
<td>.61</td>
<td>.37</td>
<td>2.12</td>
<td>4.76</td>
<td>2.65</td>
</tr>
<tr>
<td>EXTR</td>
<td>3.62</td>
<td>.71</td>
<td>.50</td>
<td>1.50</td>
<td>5.00</td>
<td>3.50</td>
</tr>
<tr>
<td>AGRBL</td>
<td>3.77</td>
<td>.58</td>
<td>.34</td>
<td>1.94</td>
<td>5.00</td>
<td>3.06</td>
</tr>
<tr>
<td>NRTCSM</td>
<td>2.57</td>
<td>.81</td>
<td>.65</td>
<td>1.00</td>
<td>4.80</td>
<td>3.80</td>
</tr>
<tr>
<td>ART</td>
<td>2.97</td>
<td>.36</td>
<td>.13</td>
<td>2.03</td>
<td>4.08</td>
<td>2.06</td>
</tr>
<tr>
<td>IGO</td>
<td>5.15</td>
<td>1.10</td>
<td>1.20</td>
<td>1.50</td>
<td>7.00</td>
<td>5.50</td>
</tr>
<tr>
<td>EGO</td>
<td>5.51</td>
<td>1.16</td>
<td>1.34</td>
<td>1.75</td>
<td>7.00</td>
<td>5.25</td>
</tr>
<tr>
<td>KNFCOG</td>
<td>4.27</td>
<td>.46</td>
<td>.21</td>
<td>2.13</td>
<td>5.00</td>
<td>2.88</td>
</tr>
<tr>
<td>REGCOG</td>
<td>3.58</td>
<td>.61</td>
<td>.38</td>
<td>1.90</td>
<td>5.00</td>
<td>3.11</td>
</tr>
</tbody>
</table>

Note: CAMT: Creative Ability in Mathematics; OPENS: Openness to Experience; CONSC: Consciousness; EXTR: Extraversion; AGRBL: Agreeableness; NRTCSM: Neuroticism; ART: Academic Risk-Taking; IGO: Intrinsic Goal Orientation; EGO: Extrinsic Goal Orientation; KNFCOG: Knowledge of Cognition; REGCOG: Regulation of Cognition
For Creative Ability in Mathematics Test, minimum score was 6.25 and maximum score was 30.75 and the mean was calculated as 15.30 (SD = 4.24). Since there is no upper limit of creativity score, it is hard to make any comment about the creativity scores. However, this test produced data with more variance compared to the other scales in the study. The means for the OPENS, CONSC, EXTR, AGRBL and NRTCSM scales were 4.16, 3.46, 3.62, 3.77, and 2.57 and with standard deviations of .46, .61, .71, .58, and .81, respectively. When the scale is thought as a continuum, the mean score of the openness is close to the highest end of the scale. Also, when we look at the neuroticism score, it could be reasonable to conclude that the sample consisted of more emotionally stable individuals. The means and standard deviations were 2.97 and .36 for academic risk-taking, 4.27 and .46 for knowledge of cognition and 3.58 and .61 for regulation of cognition. Table 4.1 shows that the mean scores of the motivation subscales ranged from 5.15 to 5.51. Therefore, it can be said that students’ extrinsic goal orientation (M = 5.51) is slightly greater than their intrinsic goal orientation (M = 5.15).

### 4.3 Bivariate Correlation Matrices of the Major Study Variables

Pearson correlation coefficient was computed to examine the relationships among the variables used in the study. The correlations among the scores of independent and dependent variables for the total sample are presented in Table 4.2.

As it can be seen from the Table 4.2, Pearson Product Moment correlation coefficients yielded a significant correlation between dependent variable (creative ability in mathematics) and five of the independent variables that were openness to experience, consciousness, intrinsic goal orientation, knowledge of cognition and regulation of cognition.
Table 4.2 Pearson Product Moment Correlations among the Measures of the Study

<table>
<thead>
<tr>
<th>Variable</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.CAMT</td>
<td>.36**</td>
<td>.21**</td>
<td>.10</td>
<td>.04</td>
<td>-.11</td>
<td>.12</td>
<td>.39**</td>
<td>.04</td>
<td>.32**</td>
<td>.31**</td>
</tr>
<tr>
<td>2.OPENS</td>
<td>.42**</td>
<td>.35**</td>
<td>.33**</td>
<td>-.29**</td>
<td>.12</td>
<td>.43**</td>
<td>-.03</td>
<td>.37**</td>
<td>.42**</td>
<td></td>
</tr>
<tr>
<td>3.CONSC</td>
<td>.08</td>
<td>.29**</td>
<td>-.35**</td>
<td>.24**</td>
<td>.36**</td>
<td>.07</td>
<td>.40**</td>
<td>.43**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.EXTR</td>
<td>.08</td>
<td>-.31**</td>
<td>-.11</td>
<td>.24**</td>
<td>-.09</td>
<td>.26**</td>
<td>.25**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.AGRBL</td>
<td>-.39**</td>
<td>-.02</td>
<td>.20**</td>
<td>-.10</td>
<td>.28**</td>
<td>.16*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.NRTCSM</td>
<td>.28**</td>
<td>-.33**</td>
<td>.28**</td>
<td>-.36**</td>
<td>-.24**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.ART</td>
<td>.31**</td>
<td>.39**</td>
<td>.23**</td>
<td>.31**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.IGO</td>
<td>-.08</td>
<td>.51**</td>
<td>.51**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.EGO</td>
<td>.06</td>
<td>.07</td>
<td>.58**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.KNFCOG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.REGCOG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *p < .05, **p < .01, two-tailed. CAMT: Creative Ability in Mathematics; OPENS: Openness; CONSC: Consciousness; EXTR: Extraversion; AGRBL: Agreeableness; NRTCSM: Neuroticism; ART: Academic Risk-Taking; IGO: Intrinsic Goal Orientation; EGO: Extrinsic Goal Orientation; KNFCOG: Knowledge of Cognition; REGCOG: Regulation of Cognition

To begin with, creative ability in mathematics was significantly and positively correlated with openness to experience \((r = .36, p < .01)\) and consciousness \((r = .21, p < .01)\). Additionally, intrinsic goal orientation has the highest correlation with creativity \((r = .39, p < .01)\). Moreover, knowledge of cognition \((r = .32, p < .01)\), and regulation of cognition scores \((r = .31, p < .01)\) indicated a significant correlation with mathematical creativity scores. Even though it was not significant, there was a small positive correlation of creative ability in mathematics with extraversion \((r = .10, p > .01)\) and academic risk-taking \((r = .12, p > .01)\) and a small negative correlation of creative ability in mathematics scores with neuroticism \((r = -.11, p > .01)\). No correlation was found between agreeableness and CAMT scores.

4.4 Testing Assumptions for Multiple Regression

Before the analyses, each of the variables was examined to determine whether the variables were normally distributed. Skewness and kurtosis values were
examined and issues for normality were checked. All of the measures were observed within acceptable limits.

Before conducting the main analysis, the assumptions underlying multiple regression analyses were checked. The main assumptions are: (1) variable types (variables should be quantitative or categorical with two levels); (2) nonzero variance of all variables; (3) no perfect multicollinearity; (4) homoscedasticity; (5) normally distributed errors; (6) linearity; (7) independence of errors; and (8) independent observations (Field, 2009).

Firstly, all of the predictor variables (personality traits, motivation, academic risk-taking, and metacognition) and the criterion variable (creative ability in mathematics) were quantitative variables. Also, all predictors and the criterion variables had some variance in value. All of these are evidence of no violation with regard to the assumptions of variable types and non-zero variance of variables.

When variables are too highly correlated that is .90 or greater, multicollinearity and singularity create statistical problems (Tabachnick & Fidell, 2007). Table 4.2 shows that predictor variables do not have high correlations among themselves. Therefore, it was derived that multicollinearity and singularity were not problem for the present study. Moreover, multicollinearity can be assessed by examining tolerance and the variance inflation factor (VIF). The criteria to detect the multicollinearity are that VIF should not be greater than 10 (Myers, 1990), and tolerance statistic should not be smaller than .10 (Menard, 1995). The value of VIF ranged from 1.33 to 1.73 and the tolerance statistics ranged from .58 to .75, indicating no multicollinearity for the current data.

To test the assumptions of normality, linearity, and homoscedasticity, the residuals scatter plots must be examined (Tabachnick & Fidell, 2007). In multiple regression analysis, the normality assumption means that all errors in prediction are normally distributed around each dependent variable score (Tabachnick & Fidell, 2007). Linearity assumption assumes a linear relationship between each predictor variable and each criterion variable (Field, 2009). In order to check the normality and linearity assumptions, histogram and normal plot were performed and inspected.
Figure 4.1 Histogram for the Standardized Residuals

Figure 4.2 Normal Probability Plot of Regression Standardized Residuals

The histogram (see Figure 4.1) shows that CAMT is normally distributed. Additionally, the points are arranged on the line like a cigarette in the normal probability plot (Figure 4.2). There was no evidence of the violation of the assumptions of normality and linearity, so the assumptions were met.
The assumption of homoscedasticity means that standard deviations of residuals are the same for all predicted dependent variable scores (Tabachnick & Fidell, 2007). To check the assumption of homoscedasticity, the scatter plot of regression standardized residuals against regression standardized predicted values should be inspected (Field, 2009). The scatterplots indicated that the residuals appeared to be randomly scattered around zero that provides evidence of homoscedasticity (see Figures 4.3).

![Figure 4.3 The Scatter Plot of Regression Standardized Residuals against Regression Standardized Predicted Values](image)

The Durbin-Watson test was observed to test the assumption of independent errors. Independence of error terms means that errors of predictions are not correlated and independent of one other. The Durbin-Watson value should range from 0 to 4. The statistical value indicates the following situation: a value of 2 indicates that residuals do not correlate each other, a value greater than 2 means a negative correlation and a value less than 2 means a positive correlation (Field, 2009). The Durbin-Watson coefficient should not be above 2.5 and below 1.5 in order not to contradict the assumption. In the present study, the Durbin-Watson value was 1.96 which indicated the independence of the error term. Therefore, the assumption of independent errors was not violated.
An outlier could substantially change the results of regression analysis. The outlier detection included the extreme value in dependent variables and independent variables. Mahalanobis distance is the distance from the case to the centroid of all cases for the predictor variables (Stevens, 1992). An outlier is regarded as an observation with a large Mahalanobis distance. Tabachnick and Fidell (2007) suggested using the Chi-Square critical values table with degrees of freedom equal to number of predictor variables at Alpha level = .001, as a way of determining whether a variable is a multivariate outlier. Researchers should examine all Mahalanobis distance values in order to see if the values are above the predetermined critical value. In the present study, Mahalanobis distance should be less than $X^2(10) = 29.59$, $p < .001$. One case was identified as an outlier but as it can be seen in Table 4.3, its Mahalanobis Distance and Cook’s distance were in the acceptable ranges, so this case was not removed from the data set.

**Table 4.3 Residuals Statistics**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahal. Distance</td>
<td>.15</td>
<td>25.31</td>
<td>3.98</td>
<td>3.39</td>
</tr>
<tr>
<td>Cook’s Distance</td>
<td>.00</td>
<td>.19</td>
<td>.01</td>
<td>.01</td>
</tr>
</tbody>
</table>

Since the participants answered the items in each questionnaire independently of one another during the data collection process, independent observations assumption was assumed for the present study. Overall, these findings provide evidence for no violation of the basic assumptions of multiple regression analysis. Nevertheless, since the sampling method of the study was not random sampling, cautions should be taken when making generalizations from the current sample to the entire population.

Tabachnick and Fidell (2007) stated that the desired sample size for multiple regression was $50 + 8m$ where $m$ represented the number of independent variables. In the current study, there were 10 independent variables. The sample size was 217, so the sample size criterion was met for the current study.
According to Pallant (2007), the independent variables should show at least some relationship (above 0.3 preferably) with the dependent variable to run the regression analysis. Therefore, four of the variables that were intrinsic goal orientation, openness to experience, knowledge of cognition and regulation of cognition were taken to the multiple regression equation.

### 4.5 Results of Standard Multiple Regression Analysis

In order to evaluate the predictive power of personality traits, motivation, academic risk-taking and metacognition, standard multiple regression analysis was conducted. The predictors were openness to experiences, intrinsic goal orientation, knowledge of cognition and regulation of cognition scores, while the criterion was CAMT scores. Since the independent variables should show at least some relationship with the dependent variable (above 0.3 preferably) (Pallant, 2007) four of the variables, which were intrinsic goal orientation, openness, knowledge of cognition and regulation of cognition, were taken to the multiple regression analysis. All of the four variables entered the regression analysis at one step. As mentioned above, the main assumptions underlying multiple regression analysis was checked as an initial step and results indicated no violation of the assumptions.

#### 4.5.1 Results Concerning the Predictors of Creative Ability in Mathematics

In the regression analysis, creative ability in mathematics was treated as dependent variable. The results indicated that multiple regression model was significant. In other words, linear combination of predictor variables was significantly related to the creative ability in mathematics scores, $F(4, 212) = 14.21$, $p < .001$. 

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Table 4.4 Standard Multiple Regression Analysis Results for Openness, Intrinsic Goal Orientation, Knowledge of Cognition and Regulation of Cognition as Predictors of Creative Ability in Mathematics

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>Std. Error</th>
<th>β</th>
<th>t</th>
<th>Sig. (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>-.204</td>
<td>2.96</td>
<td>-.69</td>
<td>.49</td>
<td></td>
</tr>
<tr>
<td>OPENS</td>
<td>1.88</td>
<td>.65</td>
<td>.20</td>
<td>2.88</td>
<td>.00*</td>
</tr>
<tr>
<td>IGO</td>
<td>.92</td>
<td>.30</td>
<td>.24</td>
<td>3.09</td>
<td>.00*</td>
</tr>
<tr>
<td>KNFCOG</td>
<td>.79</td>
<td>.74</td>
<td>.09</td>
<td>1.07</td>
<td>.29</td>
</tr>
<tr>
<td>REGCOG</td>
<td>.40</td>
<td>.56</td>
<td>.06</td>
<td>.72</td>
<td>.48</td>
</tr>
</tbody>
</table>

Note. R = .46, R² = .21, ΔR² = .20, * represented statistical significance at Alpha = .05 for each independent variable.

As Table 4.4 indicates, the combination of four predictor variables together (openness to experience, intrinsic goal orientation, knowledge of cognition and regulation of cognition) explained a significant amount of variance in students’ creative ability in mathematics test scores:

\[ R^2 = .21, \text{ adjusted } R^2 = .20, F(4, 212) = 14.21, p = 0.000 \]

The results indicated that approximately 21% of the variance of the CAMT scores can be accounted for by the combination of independent variables together.

The individual effect of each predictor variable can be seen in Table 4.5. According to this table, openness to experience and intrinsic goal orientation explain a significant amount of variance in mathematical creative ability scores.

Table 4.5 Summary of Partial and Part Correlations

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Partial</th>
<th>Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPENS</td>
<td>.19</td>
<td>.18</td>
</tr>
<tr>
<td>IGO</td>
<td>.21</td>
<td>.19</td>
</tr>
<tr>
<td>KNFCOG</td>
<td>.07</td>
<td>.07</td>
</tr>
<tr>
<td>REGCOG</td>
<td>.05</td>
<td>.04</td>
</tr>
</tbody>
</table>
The standardized regression coefficient (Beta) indicates the correlation between the independent and the dependent variable. The unstandardized regression coefficient (B) is the slope of the best fitted regression line for the scatterplot. The unstandardized regression coefficients would suggest a regression equation to predict the raw scores of the dependent variable from the combination of independent variables. Using Table 4.4, a standard multiple regression equation can be written in order to estimate students’ mathematical creative ability from four significant predictors. The equation is:

\[ Y = 1.88X_1 + .92X_2 + .79X_3 + .40X_4 - 2.04 \]

Y represents the predicted mathematical creative ability score and \(X_1, X_2, X_3,\) and \(X_4\) represent openness to experience, intrinsic goal orientation, knowledge of cognition and regulation of cognition, respectively. Intrinsic goal orientation was the strongest significant predictor of students’ mathematical creative ability, accounting for 3.6 % of the variance in CAMT scores. Moreover, openness to experience explained 3.2 % of variance in CAMT scores. Since intrinsic goal orientation and openness to experience were highly correlated there was a lot of shared variance that was statistically removed when they included in the model. Although knowledge of cognition and regulation of cognition were found to be significantly related to CAMT, they were failed to predict creative ability in mathematics scores.
CHAPTER V

DISCUSSIONS, CONCLUSIONS, IMPLICATIONS, LIMITATIONS AND RECOMMENDATIONS

In this chapter, discussion and conclusion of the results, educational implications drawn from the findings and recommendations for future research are presented. In the first section, discussions about the predictors of creative ability in mathematics are presented. Second section is devoted to the conclusions and implications of the results. The third section includes limitations and recommendations for further research.

5.1. Discussion of the Results

The purpose of the present study was to investigate the extent to which personality traits (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism), motivation (intrinsic and extrinsic goal orientation), academic risk-taking and metacognition (knowledge of cognition and regulation of cognition) explain the mathematical creativity of the high school students. The review of the related literature shows that up to now very few studies have been conducted on mathematical creativity in the school level. The present study was conducted for the purposes of finding simpler ways to identify creative potential of students and, based on the findings of the study, facilitating creative behavior among students. In order to examine the relationships, standard multiple linear regression analysis was carried out. The discussion of the results is presented separately for personality traits, academic risk-taking, motivation and metacognition.
5.1.1 Discussion of Findings Regarding the Personality Traits

Pearson correlation coefficient was computed in order to examine the relationships between mathematical creative ability and personality traits. The results of bivariate correlation analysis showed that only openness to experience and consciousness were significantly correlated with mathematical creative ability. To begin with, creative ability in mathematics was significantly and positively correlated with openness and consciousness. Even though they were not significant, there was a small positive correlation of creative ability in mathematics with extraversion, and a small negative correlation of creative ability in mathematics with neuroticism. Yet, agreeableness was not correlated with mathematical creative ability scores. Moreover, only the personality trait “openness” was taken to the multiple regression analysis because its correlational coefficient was bigger than .30. The multiple regression analysis revealed that openness to experience accounted for approximately 3.2% of the total variance of mathematical creative ability of the participants. Furthermore, the results pointed out that openness to experience was the second significant predictor of mathematical creative ability. Participants, who scored higher in CAMT scale, were seen to have higher scores on openness to experience scale.

Several studies have been carried out on personality and creativity in the literature. Some of the common characteristics were found for highly creative people, but not necessarily all of them (Hennessey & Amabile, 2010). The findings of the present study were consistent with the previous research conducted on creativity and personality characteristics. Several studies depicted the significant positive relation of openness to experience to creative performance in line with the findings of the present research (e.g. Chamorro-Premuzic & Furnham, 2005; Feist, 1998; Kelly, 2006; Sung & Choi, 2009; Wolfradt & Pretz, 2001). The first meta-analysis on creativity and personality derived by Feist (1998) also confirmed that open to new experiences was one of the personality characteristics common in both artists and scientists. Feist and Barron (2003) concluded that the traits of self-confidence, openness, tolerance, and psychological mindedness seemed to have a close relation with the creative behavior. In addition, Sung and Choi (2009) showed that openness had significant positive influence on creative performance. Moreover, Sung and Choi reported that openness to experience and creativity showed strong positive
relationship when the individual had high extrinsic motivation. In an investigation of the relationship between creativity and personality among college students, Wolfradt and Pretz (2001) measured creativity by written stories, list of personal hobbies, and scores on the Creative Personality Scale (CPS). The results of the study suggested that openness to experience was positively related to all three creativity measures. Based on the results of these studies, it can be logical to assume that openness to experience seems to be a common personality trait of creative individuals (McCrae, 1987).

McCrae offered three possible reasons for the relationship between openness to experience and creativity. For McCrae “First, open people may be more fascinated with the open-ended, creative, problem-solving tasks and they may simply score higher on such tasks. Second, open people may have developed cognitive skills associated with creative, divergent thinking, namely flexibility and fluidity of thought. Third, open people have an interest in seeking sensation and more varied experiences, and this experiential base may serve as the foundation for flexibility and fluency of thinking” (as cited in Feist, 1998, p. 303). Open individuals are generally curious and have a tendency to approach novel ideas and situations. Instead of habitual way of living, they expose themselves to different ideas, new ways of solving questions, try unfamiliar experiences and go through untried paths. As McCrae stated, they have flexible cognitive style. This flexible cognitive style leads them to generate original and a variety of mathematical ideas, thoughts and problem strategies. They like changes and overcome their fear of stepping outside of their comfort zone. In CAMT, instead of routine mathematical tasks, students are presented with unusual and new mathematical scenarios in which students are required to give as many relations, questions, or answers as possible. This property of test may have attracted the interest of open students to produce a number of new ideas or responses that are critical for creative thinking. For example, in the second question, students are presented with a new mathematical scenario in which they are required to think all the things which could happen as a result of doing geometry on a ball. Students in this sample often studied Euclidean geometry in their mathematics courses. The spherical geometry was new to all of them. Most of the geometric concepts such as angle measures, straight lines or area measure changes in spherical geometry. Open individuals’ intellectual curiosity, imagination and interest in new
sphere geometry situation might have challenged them to pursue original and a variety of responses compared to students who preferred familiar mathematical tasks. Furthermore, in the third question, students were supposed to ask as many questions as possible to find the names of two hidden geometric figures that were related in some manner. The game-like situation of this question in CAMT may be enjoyable and adventurous to open individuals. They ask more questions to uncover and explore actively the hidden geometric figures. Therefore, the present study suggested that individuals, who were imaginative, curious, independent thinkers, open to new ideas, experiences, and unusual perspectives, engaged in creative acts in mathematics more than other personality types.

Although many studies have showed openness to new experiences as one of the common characteristics of creative individuals, the relation of other personality characteristics to creativity has showed some variance and even seemed to conflict. The results of the present study showed that creative ability in mathematics was significantly and positively correlated with consciousness, but since the correlation coefficient was smaller than .30, it was not taken to the regression analysis. The current study suggested that conscious people, who were described as careful, cautious, self-controlled, orderly, and reliable, showed high creative ability in mathematics. Whereas some studies in the literature reported positive correlation between consciousness and creativity, others have reported no relation or even depicted negative relation between these two constructs. Feist’s (1998) meta-analysis showed that scientists were more prone to be conscientious compared to artists. In addition, Batey and Furnham (2006) indicated a negative relation of consciousness with artistic creativity, but they reported positive relation with scientific and everyday creativity. Based on the findings of these two studies, it could be rationale to conclude that the relation between consciousness and creativity depends on the context. The results of the present study was supported in part by McCrae (1987) in an examination of the relation between creativity that was measured by divergent thinking tests and the Creative Personality Scale (CPS), and multiple measures of five factors. Although only CPS scores were positively correlated with conscientiousness, no relation was found between the divergent thinking test and conscientiousness. Moreover, Wolfradt and Pretz (2001) revealed that creative story-writing was predicted by low scores on conscientiousness. As it
can be seen, the results of the studies are scattered in relation of creativity to consciousness. Possible reasons for the relationship between conscientiousness and mathematical creativity in the present study might be some of the personality characteristics that are special to conscientious students such as preservance, self-discipline, responsibility, and hard working. The questions on CAMT required students to submit a variety of and original responses. Participant students voluntarily participated to the study. They knew that even if they would do worse on the test, the results would not affect their course grade. However, conscientious students’ sense of responsibility might have influenced them to take the task seriously. Moreover, their preservance and self-discipline might have encouraged conscientious students to supply responses to unfamiliar items on CAMT during the testing period. Furthermore, their hard working and achievement oriented behavior might have led them to perform better on a paper and pencil creativity test.

The current study reported no significant correlation of creative ability in mathematics with extraversion, neuroticism, and agreeableness. In the literature, whereas some of researchers found a relation between these personality characteristics and creativity, other researchers reported no relation. Firstly, Wolfradt and Pretz (2001) indicated a positive relation between creativity and extraversion among college students from psychology, art and design, science and various other fields. On the other hand, the meta-analysis by Batey and Furnham (2006) showed that extraversion was positively related to everyday creativity and negatively related to artistic and intellectual creativity. Moreover, in an examination of the relation between creativity, which was measured by divergent thinking tests and CPS, and multiple measures of five factors, McCrae (1987) found no consistent relation between divergent thinking abilities and extraversion, however, a positive relation was reported between CPS scores and extraversion. Furthermore, Kaufman (2009) claimed that extraversion appears to be fairly related to creativity, but there might not be a relation, as well. The variance among the results of these studies could be because of the difference in personality characteristics of individuals from different domains and the variety of the instruments that were used to measure personality and creativity. In the present study, mathematical creativity was measured by a paper and pencil test. That is why, it might not have been the kind of creativity task that attracted extroverts’ attention. Extroverts are sociable, talkative and have a keen
interest in external events. However, the nature of CAMT does not allow students to work with other students or require verbal performance in the creation process. Moreover, during the performance on CAMT, there is no engagement into the external events physically which was a common characteristic of extroverts. Mental engagement into questions is important in the creation process on CAMT. All the mentioned reasons might have influenced the relation between creativity and extraversion.

Secondly, in the literature, the relation between agreeableness and creativity is not so clear. According to Kaufman (2009) and Batey and Furnham (2006), there is a small relationship between agreeableness and creativity. Sung and Choi (2009) concluded that agreeableness positively predicted creative performance only when the person had low extrinsic motivation. On the other hand, a negative relationship between agreeableness and creative achievements was revealed by King et al. (1996). Moreover, Wolfradt and Pretz (2001) reported no relation between CPS scores and agreeableness. The present study contributed to the literature by finding no relation between mathematical creative ability in mathematics and agreeableness. Finally, Feist (1998) concluded that personality trait neuroticism seems to contribute artistic creativity, but decrease from scientific performance. Batey and Furnham (2006) claimed that the role of neuroticism on creativity was dependent on the domain of area. Majority of the participants in the present study consisted of science school students. These students are generally emotionally stable, calm, and less likely to feel anxiety, depression or tense. Therefore, it was not surprising to find no relation between neuroticism and mathematical creativity in line with the findings in scientific creativity.

It can be argued that the characteristics of the sample might influence the results of the present study. The sample was consisted of the high school students. As they get older, their personalities are subjected to change. In addition, in the literature, studies have used different assessment tools to measure personality and creativity. Moreover, studies also conducted with participants from different fields. The variance among the results might be because of these differences in the characteristics of participants and variety of assessment tools that were used. Therefore, further research is required to clarify whether and under what circumstances different personality types assist the creative acts.
5.1.2 Discussion of Findings Regarding Motivation

The results of bivariate correlation analyses showed that intrinsic goal orientation was significantly and positively correlated with mathematical creative ability. On the other hand, no correlation was found between extrinsic goal orientation and creative ability in mathematics. Therefore, only the variable intrinsic goal orientation was taken to the multiple regression equation. Within the regression model used in the present study, intrinsic goal orientation was the strongest predictor of student performance on the CAMT. The multiple regression analysis revealed that intrinsic goal orientation was accounted for approximately 3.6% of the total variance of mathematical creative ability of the participants.

The findings of the current study were in congruence with the findings in the literature. Hennessey (2004) claimed a direct relationship between motivational orientation of a student and tendency of her being creative on a task. Intrinsic motivation encourages better problem solving skills and deep conceptual understanding (Hennessey, 2007). Intrinsically motivated individuals have high interest, curiosity, and persistence which lead them to work hard on complex tasks and focus on original ideas. Intrinsic motivation facilitates creativity by fostering positive affect, mental flexibility, risk-taking, and persistence (Shalley, Zhou, & Oldham, 2004). When people are motivated by the interest, enjoyment, satisfaction, and challenge of the work itself, they engage in more creative acts (Hennessey & Amabile, 2010). In addition, Lepper (1988) claim that intrinsically motivated individuals present some desirable behaviors such as focusing on a task for a long time, persistence in the face of failure, selection of more difficult tasks, greater creativity and risk-taking. According to Amabile (1996), individuals must have task motivation to produce a creative work or to generate a creative solution or an idea. Love of inventing and desire to improve, which can be regarded as intrinsic motivators, are among the top two motives which cause the creative individuals to invent (Rossman, 1931). In an experimental creative writing task, Moneta and Siu (2002) studied the influence of trait intrinsic motivation on creativity. The findings suggested that intrinsic motivation correlated positively with creativity of the written stories. Intrinsic Motivation Principle of Creativity suggests that intrinsic motivation facilitates creativity, but extrinsic motivation generally decrease it (Hennessey &
Amabile, 1987). However, the research regarding extrinsic motivation and creativity is complex. There has been no agreement on the effects of extrinsic motivators on creativity. The result of the current study on the relation between creative ability in mathematics and extrinsic goal orientation is similar to the results of the study performed by Moneta and Siu (2002). Moneta and Siu reported no correlation between extrinsic motivation and creativity on a creative writing task with college students. In addition, Amabile (1985) examined the effects of motivational orientation on creative writing. The results showed that students given the extrinsic reasons for writing were significantly less creative than other two groups who received intrinsic reasons for writing and did not receive any list for reasons of writing. However, Oral et al. (2007) conducted a research to see whether creativity research findings of Western cultures would hold true for Turkish participants. They observed higher levels of creativity for men other than for women when extrinsic motivation was higher. After conducting several investigations on the relation between extrinsic motivation and creativity, Amabile revised Intrinsic Motivation Principle of Creativity. Amabile stated that informational extrinsic motivation rather than controlling motivation could facilitate creativity if initial levels of intrinsic motivation were high. Therefore, it can be concluded that the role of extrinsic motivation on creativity depends on how it is used.

To sum up, there has been no agreement on the effects of extrinsic motivation on creative performance. Experimental studies can be carried out to identify under what conditions different types of extrinsic motivators affect the creative ability.

5.1.3 Discussion of Findings Regarding Academic Risk-Taking

The results of bivariate correlation analysis showed that there was not a significant relation between academic risk-taking and creative ability in mathematics. Although Strum (1971) also reported no significant relationship between creativity and academic risk-taking among fifth grade students, the finding of the current study related to risk-taking was contrary to the findings in the literature. Several researchers have emphasized the essential role of risk-taking for creative acts (e.g. Budge & Clarke, 2012; Stenberg, 1999).
Creativity requires eagerness to take chances, searching the unknown, using unfamiliar approaches, and going through the untried paths. In an investigation of interrelationships among selected measures of creativity, intelligence and risk-taking in a sample of fifth grade children, Pankove and Kogan (1968) revealed a significant positive relationship between creativity and risk-taking, but only in the case of boys. A similar conclusion was reported by Kurtzman (1967) who found creative students more adventurous than the less creative ones. Moreover, according to Haefele (1962), individuals engage in risk-taking behavior in every creative act. Additionally, most of the definitions of creativity emphasize risk-taking characteristics of creative people. Anderson and Cropley (1966) claimed that risk-taking was among one of the important nonintellectual component of creative potential.

The contradiction of the result of the present study with the literature might be because of cultural differences and educational system of Turkey. First of all, Turkish culture is socially-collectivist and conservative compared to Western cultures. Individuals are expected to respect and obey social norms throughout their life. The identities of individuals are shaped by traditions. There are some mechanisms that transmit and preserve the Turkish traditions and customs. These mechanisms create a sense of shared identity among Turkish people. Schooling is among one of the mechanisms that emphasize uniformity among Turkish students. Therefore, deviations from social norms and rules are not accepted in Turkish schools. So, there is reluctance among students to try new experiences, to go untried paths, to search unknown and to question authority.

Secondly, in Turkish education system teachers are trying to minimize failure and error making by which they think they would maximize academic success in schools. Therefore, students are not allowed to take risks, experiment and try unfamiliar approaches. Most students are afraid of asking questions in the classroom, engaging in class discussions, sharing opinion with their teachers’ and friends’ and answering the questions in which students are uncertain about the answer. The fear of making mistakes, appearing less competent than others, and fear of failure lead students not to take risks in the classroom. In addition, mistakes are not regarded as an important part of learning and inquiry process by teachers. Teachers do not discriminate between an intelligent mistake and a stupid mistake. An intelligent
mistake can give teacher clues about thinking processes of students. Sometimes students learn more from their mistakes than their successes. Despite the great efforts to improve Turkish educational system, conservative approaches to teaching and learning have dominated many schools. All these factors might have an influence on Turkish students not to take academic risks.

5.1.4 Discussion of Findings Regarding Metacognition

The interpretation of the relative importance of knowledge of cognition and regulation of cognition is a bit complicated. Confirming previous findings, both of the variables showed moderate correlations with creative ability in mathematics scores obtained from the instrument used in the present study. However, they were not significant predictors of creative ability in mathematics scores in multiple regression equation. Creativity requires both metacognitive knowledge and metacognitive skills to produce novel ideas, to solve complicated problems or to make innovations. Creative individuals are more aware of their thinking processes and they control and regulate these processes consciously. They know which strategy to use in the creation process. Moreover, they effectively evaluate their knowledge level and the effectiveness of their strategy use which are necessary for the creative acts. Furthermore, highly developed metacognitive skills are recognized as one of the key traits good problem-solvers possess (Darling-Hammond, Austin, Cheung, & Martin, 2003; Schoenfeld, 1992). Individuals’ metacognitive knowledge about the task and their own thinking processes assist them to control and regulate their skills and strategies in the creation process. In this respect, the importance of metacognition for problem solving activity in mathematics courses was emphasized by Davidson and Stenberg (1998). They think:

Knowledge about problem solving, in general, and about their own mental processes, in particular, helps students become better problem solvers. More specially, metacognitive skills help the student (a) strategically encode the nature of the problem and form a mental model or representation of its elements, (b) select appropriate plans and strategies for reaching the goal, and (c) identify and conquer obstacles that impede progress. (Davidson & Stenberg, 1998, p. 48).
Firstly, students direct their thinking processes toward achieving a goal in solving problems and then, they use their metacognitive processes to guide their goal directed thinking. Previous study derived by Biryukov (2004) also confirmed the importance of metacognition in mathematical problem solving on the example of combinatorics problems. Armbruster (1989) stated that creative process includes knowledge and skill acquisition, the transformation of knowledge into new forms, and as a result, giving a shareable product. Each stage involves the cognitive process. Metacognitive factors accompany the cognitive factors in the creation process. Effective use of these metacognitive processes in problem solving generates creative solutions. In the literature, the importance of metacognition for creativity could also be seen in the models that were proposed to explain the creative process. For example, Wallas’ Creativity Model (1926), Isaksen and Treffinger’s Creative Problem-Solving Model (1985) and the Two-tier model offered by Runco and Chand (1995) include metacognitive knowledge and skills that are used by creative individuals. As a result, this study contributed to the literature by supporting the relation between creativity and metacognitive knowledge and skills.

5.2 Conclusions

In this section, the conclusions of the current study would be presented. The present study was conducted for the purposes of finding simpler ways to identify creative potential of students and, based on the findings of the study, facilitating creative behavior among students. In order to examine the relationships, standard multiple linear regression analysis was carried out.

1. Openness and consciousness were significantly and positively correlated with mathematical creative ability. Additionally, openness was the second significant predictor of creative ability. That is, individuals, who were imaginative, sensitive to aesthetics, curious, independent thinkers, and open to new ideas, experiences, and have unusual viewpoints, engaged in creative acts in mathematics more than the other personality types. Moreover, conscientious students, who were described as careful, cautious, self-controlled, orderly, and reliable, showed also high creative ability in mathematics.
2. The present study has reported no significant correlation of creative ability in mathematics with extraversion, neuroticism, and agreeableness.

3. Intrinsic goal orientation was significantly and positively correlated with mathematical creative ability. On the other hand, no correlation was found between extrinsic goal orientation and creativity. Moreover, intrinsic goal orientation was the strongest predictor of student performance on the CAMT. This means that when students are motivated by the interest, enjoyment, satisfaction, and challenge of the work, they engage in more creative acts.

4. The current study reported no significant relation between academic risk-taking and creative ability in mathematics. This means that students, who take high academic risks, are not necessarily creative, as well.

5. Knowledge of cognition and regulation of cognition showed moderate correlations with creative ability in mathematics. However, they were not significant predictors of mathematical creativity scores in multiple regression equation. Students with a high level of metacognitive knowledge and skills showed high level of creativity.

5.3 Implications of the Findings

The results of the present study might contribute to the literature in identifying and facilitating the creative potential in students. Having a clear understanding of the nature of creativity help educators to make improvements in programs to better recognize and facilitate creativity among all students. Therefore, based on the findings of the current study, focusing on the constructs that have a relation with creativity help teachers to develop and facilitate creative behavior among all students.

One of the important findings of this study was to provide evidence to support the relation between creative ability in mathematics and intrinsic goal orientation. On the light of this result, following recommendations were made for mathematics teachers. Mathematics teachers play an essential role in getting students interested and involved in math. To develop and facilitate creativity in mathematics courses, teachers should encourage students’ intrinsic motivation. Intrinsic
motivation in mathematics courses can be promoted by several practices. First of all, teachers should make mathematics learning meaningful and useful for students (Middleton & Spanias, 1999). This can be done by connecting mathematical concepts with real life applications and in turn, showing the beauty of mathematics. Authentic problems can be used as a tool to make this connection and attract students’ interest in mathematics. Additionally, appropriately challenging open-ended problems that require divergent thinking, like the ones in CAMT, can be used to actively engage students in their mathematics learning process. Moreover, using small groups in mathematics courses can motivate students by allowing them to discuss mathematical problems with their friends, look at situations from different perspectives, learn to think flexibly, and ask questions about unclear points. Furthermore, teachers should allow students some degree of choice for their mathematics projects, homework, or the form of presentations. By this way, students will feel ownership in their mathematics learning. Finally, the value and joy of mathematics learning should be emphasized rather than competitions, grades and rewards. These practices in the classroom will encourage students’ intrinsic motivation and in turn, they will increase mathematical creativity.

Another important finding of this study was the relation between mathematical creativity and personality characteristics “openness to experience and consciousness”. If teachers want to promote creativity among their students, they should create a learning environment that gives students opportunity to follow untried paths and experience a wide variety of new ideas, unconventional perspectives, independent and flexible thinking. Open individuals have a tendency to experience new things and enjoy adventure. So, mathematics teachers can use unfamiliar and new mathematical scenarios in the problems, like the second question in CAMT, in order to increase open students’ curiosity. This curiosity will challenge students to pursue novel and original mathematical ideas and engage in new experiences. Additionally, mathematical investigations can be used in these open ended mathematical scenarios to allow students actively explore the mathematical situations. In an investigation, like a professional mathematician, open students pose questions to understand the complex situation, make hypothesis and try to prove them, develop different strategies to arrive at the solution, make predictions and generalizations. By this way, students develop independent mathematical
thinking which is an important characteristic of open individuals. Openness to experience might also be increased by improving cognitive skills (Jackson, Hill, Payne, Roberts, & Stine-Morrow, 2012). According to Jackson et al. (2012), appropriately challenging materials that include tests for recognizing patterns in numbers such as Sudoku puzzles can increase individuals’ openness. Finally, active exploration in mathematics classrooms gives students a sense of responsibility and self-control over their learning processes that are important characteristics of conscious individuals.

From the early ages, parents’ role modeling has an essential influence in shaping children’s’ personalities. Therefore, in order to facilitate creativity, it is the responsibility of parents to be good role models of the personality trait “openness to experience”. Instead of traditional family activities, parents should engage in new, adventurous and entertaining experiences with their children such as going to camp, playing with numbers, or using geometric shapes to make unusual paintings.

The results of the current study have also important implications for textbook authors on mathematics. First of all, authors should make mathematical concepts meaningful to students. They should present the beauty and aesthetic of mathematics by showing real life applications. Additionally, they should write open ended mathematical problems or scenarios that attract students’ attention and allow them to explore and investigate new experiences and ideas. Moreover, they should also present entertaining mathematical activities that require students to pose questions related to a mathematical scenario in order to actively engage students to their learning.

Finally, although the present study suggested the relation between creativity and metacognitive knowledge and metacognitive regulations they failed to predict mathematical creativity of students. Creativity requires both metacognitive knowledge and metacognitive skills to generate novel ideas, to solve complex problems or to make innovations. Students’ metacognitive knowledge about the task and their own thinking processes assist them to control and regulate their skills and strategies in the creation process. Increasing metacognitive competence in students increases the realization of creative thoughts and actions. Therefore, teachers can facilitate creativeness by strengthening students’ awareness of their metacognitive knowledge and metacognitive regulations. There are several methods to increase
students’ metacognition. Schraw (1998) offered four strategies for facilitating the establishment and development of metacognitive awareness of students. These methods are encouraging general awareness, promoting self-knowledge and regulatory skills, and enhancing learning environments that fosters the construction and use of metacognition. To begin with, teachers should model metacognitive skills in the classroom. They should ask students open-ended questions and teach them the techniques of solving questions in order to help the construction of metacognitive knowledge and skills. They should urge students to reflect on their own mental processes. They should ask questions to clarify what students think while solving a question and what kind of strategies they offer to use. By this way, students become more self-aware about their thinking and they purposefully control and regulate their creative acts.

5.4 Limitations

The present study has certain limitations that need to be taken into account when considering the study and its contributions. First of all, creativity is too complex to be assessed by a numerical score on a paper and pencil test. Torrance (1974) believed that emotional, physical, motivational, and mental health factors influence creative thinking of students. Therefore, creativity tests that are based on just paper and pencil may fail to capture the mathematical creative ability of students. Therefore, in this respect, CAMT has some limitations in measuring mathematical creativity. Additionally, CAMT was originally developed for the measurement of mathematical creative ability of middle school students. However, in the present study, it was used with high school students because of the non-availability of a mathematical creativity instrument developed for the high school students. Guilford (1957) emphasized the divergent production abilities (such as fluency, flexibility, originality, and elaboration) important to creativity, so only the divergent items of CAMT were decided to be taken to the analysis. For that reason, CAMT used in the current study did not attempt to serve all the criteria Balka (1974) developed as a measure of mathematical creative ability. Moreover, as it can be seen from the examples of student responses in Appendix C, scoring of the CAMT was open to scorer interpretation because of the several possible responses. Since the
CAMT had open ended questions, some students had difficulty in verbally expressing their ideas and thoughts. Some of the written responses were unclear and ambiguous to the scorer, so it increased the subjective effects on scoring. For example, item II required students to list all the things which could happen as a result of drawing geometric figures on a globe or on a large ball. Some of the students wrote “there would be some students who could not see the figures”. Do they intend to emphasize small size of the globe or the ball? Or they mean the entire figures could not be seen because they would overlap, connect and touch if drawn large on the globe. Therefore, the actual intent of students was not clear without asking follow-up questions to clarify their responses. Another limitation of CAMT was that scoring rubric had some shortcomings and caused restrictions on the scorer. First of all, especially for the flexibility score, a rater might have difficulty in categorizing the expressed answers. For example, in the scoring rubric of the first question, there was no mention of the exterior angle of the polygon. In the second question, a few students divided the ball in half and did geometry on that surface. Additionally, in the fourth question, some students expressed different categories other than the given categories in the scoring rubric of this question. Moreover, for the fourth question again, there were students who added extra information involving the numbers and then posed questions in considering the mathematical situation. Therefore, because of these shortcomings in the scoring rubric of CAMT, two raters might differ in their scoring of the same student.

Furthermore, the use of a small sample was a limitation of this study for the generalizability of the findings. However, care was taken in design, methodology, analyses and procedures to maximize generalizability of the findings.

5.5 Recommendations for Future Research

This study focused on the analysis of the relationship of creative ability in mathematics to personality, motivation, academic risk-taking and metacognition in the high school students. As stated above, findings believed to suggest valuable implications for mathematics teachers and educators. On the light of the findings of the present study, recommendations for further research were identified.
First of all, in order to be able to talk about Turkey overall, subjects from different school types and grade levels can be selected for further research studies. Additionally, current instruments are inadequate in the measurement of mathematical creativity for the high school students. That is why, a study can be conducted to develop a valid and reliable instrument that measures mathematical creativity of the high school students. Moreover, mathematics education research has developed significantly since the construction of CAMT (Mann, 2005). Therefore, the set of criteria developed by Balka (1974) as a measure of mathematical creative ability may be determined again. Additionally, new questions as well as new scoring procedures of CAMT may be developed. In considering the shortcomings and restrictions of scoring rubric of CAMT mentioned in the limitations part of the present study, the new scoring rubric must be developed with a larger sample size before using this instrument in another study.

Since creativity is a multi-faceted construct and too complex to be assessed by a numerical score in a quantitative study, its investigation should include different methodologies and research designs. It would be better for future research to include qualitative research designs and also mixed designs, combination of quantitative and qualitative research, to obtain a holistic picture of mathematical creativity. Firstly, for a deep investigation about the cognitive aspects of students’ mathematical creativity, qualitative research methods can be utilized with a small sample. For example, during an open-ended problem solving process, the use of observations, interviews, thinking out loud procedures, and verbally reflecting on thought processes will yield deep insights into the creative thinking processes of students. This method will generate better explanations of the structure of students’ mental models in a creative problem solving process. Moreover, for the mixed studies, explanatory designs can be used. In an explanatory design, a quantitative study can be conducted at the first phase to reach a number of students, and then, a qualitative study can be conducted to understand the meaning of quantitative design results. For example, after the quantitative study, a few students with low and high creativity scores can be selected and follow-up interviews can be conducted to clarify the actual intent of the students in answering open-ended questions.

There is a controversy on the role of extrinsic motivation on creativity. Instead of correlational studies, experimental studies might be carried out to identify
how different types of extrinsic motivators affect the creative activity. Moreover, every student has creative potential. A research might be conducted to develop a creativity program to change attitudes, encourage divergent thinking skills, and enhance problem solving performance of students in mathematics courses.

Although academic risk-taking did not seem to be related to mathematical creative ability in the present study, there may be a relation between these two constructs. Further investigations should be conducted with different age groups in different research settings.
REFERENCES


Juter, K., & Sriraman, B. (2011). Does high achieving mathematics = gifted and/or creative in mathematics? In B. Sriraman & K. H. Lee (Eds.), The elements of creativity and giftedness in mathematics (pp. 45-66). Rotterdam: Sense publishers.


APPENDIX A

CREATIVE ABILITY IN MATHEMATICS TEST

Ad-Soyad: ………………………………………………………………………………………………………
Okul: ……………………………………………………………………………………………………………
Sınıf: ……………… Doğum Tarihi: …………………
Cinsiyet: ……………

Açıklamalar

Test ile ilgili herhangi bir sorunuz varsa lütfen şimdi sorunuz.

LÜTFEN İZİN VERİLENE KADAR KİTAPÇİĞİ AÇMAYINIZ.
SORU I

Açıklamalar

Aşağıda her bir köşesinden tüm olası köşegenleri çizilmiş (kesik çizgiler) çeşitli çokgen şekilleri verilmiştir. Çokgenlerin kenar sayılarının artırılması sonucu ortaya çıkabilecek her türlü durumu yazmaya çalışınız. Örneğin: Köşegen sayısı artar. Köşegen sayısı ile oluşturululan üçgen sayısı artar.

1. ……………………………………………………………………………………………
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12. ……………………………………………………………………………………………
Soru II

Açıklamalar

Sınıfnızdaki tahtanın kırıldığını ve hiç kimsenin kâğıdının olmadığı varsayın; dolayısıyla siz ya da öğretmeniniz doğru, üçgen, kare, çöken vb. hiçbir düzlem geometri şeklini çizemiyorsunuz. Sınıfta kalan ve üzerine çizebileceğiniz tek nesne bir top ya da coğrafya dersinden kalan bir küre. Geometrik çizimlerinizi bu top üzerinde yaptığınızda olabilecek her şeyi listeleyniz. Örneğin, eğer küre üzerinde düz bir doğru çizmeye başlarsanız sonunda başladığınız noktaya ulaşsınız. (Küre üzerindeki haritaları göz ardı ediniz.)

1. ............................................................................................................................
2. ............................................................................................................................
3. ............................................................................................................................
4. ............................................................................................................................
5. ............................................................................................................................
6. ............................................................................................................................
7. ............................................................................................................................
8. ............................................................................................................................
9. ............................................................................................................................
10. .........................................................................................................................
11. .........................................................................................................................
12. .........................................................................................................................
13. .........................................................................................................................
SORU III

Açıklamalar

Farz edin ki iki geometrik şekil sizden saklanıyor ve bunların ne olduğuna karar vermeniz isteniyor. Bu iki şekil birbiri ile bir şekilde ilişkili olduğu size söyleniyor. Bu iki şeklin ne olduğuna karar verebilmek için aklınıza gelen tüm soruları listeleyniz. Örneğin, bu şekiller top, kutu ya da piramit gibi katı cisimler mi? Kare, dördürtgen, ya da paralelkenar gibi düzlemsel şekiller mi? (Daha fazla yere ihtiyacınız olursa bu sayfanın arkasını kullanabilirsiniz.)

1) ........................................................................................................

2) ........................................................................................................

3) ........................................................................................................

4) ........................................................................................................

5) ........................................................................................................

6) ........................................................................................................

7) ........................................................................................................

8) ........................................................................................................

9) ........................................................................................................

10) .................................................................................................

11) .................................................................................................

12) .................................................................................................

13) .................................................................................................
SORU IV

Açıklamalar

Aşağıda verilen durum birçok sayısal bilgi içermektedir. Sizden beklenen, bu matematiksel durumu ilgilendiren, olabildiğince çok sayıda soru üretmektedir. Örneğin; aşağıdaki durum için şöyle bir soru üretilebilir: Eğer şirket her tür uçaktan bir tane alırsa; bu, şirkete ne kadara mal olur? Daha fazla yere ihtiyaçınız olursa bu sayfanın arkasını kullanabilirsiniz.

Yazdığınız soruları çözmenize gerek yoktur.

Bir havayolu şirketi üç tür yolcu uçağı satın almayı düşünmektedir: 747, 707 ve DC-10. Bir 747’nin maliyeti 15 milyon TL; bir DC-10’un maliyeti 10 milyon TL ve bir 707’nin maliyeti ise 6 milyon TL’dir. Şirket uçakların alımı için toplamda 250 milyon TL harcama yapabilecektir. Harcamalardan sonra şirketin her bir 747’den 800 000 TL; her bir DC-10 dan 500 000 TL ve her bir 707 den 350 000 TL kâr etmesi beklenmektedir. Şirketin kadrosunda bulunan eğitimli pilot sayısının ancak 25 yeni uçağa yeteceği tahmin edilmektedir. Şirketin uçak bakım ünitesi de toplamda ancak 45 tane 707’ye yetecek kapasitededir. Bakım ünitesinin kapasitesi her bir DC-10 için bir 707’nin \(\frac{1}{3}\)’üne ve her bir 747 için 707’nin \(\frac{2}{3}\)’üne eşittir.

1) …………………………………………………………………………………………………………
2) …………………………………………………………………………………………………………
3) …………………………………………………………………………………………………………
4) …………………………………………………………………………………………………………
5) …………………………………………………………………………………………………………
6) …………………………………………………………………………………………………………
7) …………………………………………………………………………………………………………
8) …………………………………………………………………………………………………………
APPENDIX B

SCORING PROCEDURE OF CREATIVE ABILITY IN MATHEMATICS TEST

SORU I

Açıklamalar

Aşağıda her bir köşesinden tüm olası köşegenleri çizilmiş (kesik çizgiler) çeşitli çokgen şekilleri verilmiştir. Çokgenlerin kenar saylarının artırılması sonucu ortaya çıkabilecek her türlü durumu yazmaya çalışın. Örneğin: Köşegen sayısı artar. Köşegen sayısı ile oluşanucan üçgen sayısı artar.

Puanlama prosedürü

Akılcılık puanı: Uygun her bir cevap için 1 puan.

Esneklik puanı: Belirtilen her bir kategori için 1 puan.

Orijinallık puanı: Belirtilen her bir kategori için 0, 1 ya da 2 puan. Aşağıda verilen Tablo 1’e göre kategorilerin ağırlığı belirlenecektir.
Tablo 1
Kategoriler ve orijinallık puanını hesaplamak için kategorilere verilen ağırlık puanları (Balka, 1974, p. 201)

<table>
<thead>
<tr>
<th>Belirtilen Kategori</th>
<th>Ağırlık</th>
</tr>
</thead>
<tbody>
<tr>
<td>Şekil sayısı, çeşidi, tasarımını artar</td>
<td>0</td>
</tr>
<tr>
<td>Doğru, doğru parçası ve katlanma sayısı artar</td>
<td>0</td>
</tr>
<tr>
<td>Köşe sayısı artar</td>
<td>0</td>
</tr>
<tr>
<td>Kesişme noktalarının sayısı</td>
<td>0</td>
</tr>
<tr>
<td>Büyüklük ve içerisinde oluşan şekillerin alanı değişir</td>
<td>0</td>
</tr>
<tr>
<td>Çokgen köşegen doğruları ile daha sıkışık ve siyah görünümü sahip olur</td>
<td>0</td>
</tr>
<tr>
<td>Köşegenlerle oluşturululan açı sayısı artar</td>
<td>0</td>
</tr>
<tr>
<td>Çokgenlerinin kenarları ile oluşturululan açı sayısı artar</td>
<td>0</td>
</tr>
<tr>
<td>Kenarların uzunluğu, doğru parçaları ve doğrular değişir</td>
<td>0</td>
</tr>
<tr>
<td>Çokgen boyunca uzaklık (çap) değişir</td>
<td>1</td>
</tr>
<tr>
<td>Çokgenin adı değişir</td>
<td>1</td>
</tr>
<tr>
<td>Şeklin alanı, büyüklüğü muhtemelen değişir, artar</td>
<td>1</td>
</tr>
<tr>
<td>Üçgenlerin çeşidi değişir</td>
<td>1</td>
</tr>
<tr>
<td>Yarı-düzlem, düzlem sayısı artar</td>
<td>1</td>
</tr>
<tr>
<td>Her bir köşeden geçen köşegen sayısı artar</td>
<td>1</td>
</tr>
<tr>
<td>Çokgen yuvarlaşmaya başlar</td>
<td>1</td>
</tr>
<tr>
<td>Paralel köşegenler doğrular ortaya çıkar.</td>
<td>1</td>
</tr>
<tr>
<td>Şeklin çevresi büyük ihtimalle artar</td>
<td>2</td>
</tr>
<tr>
<td>Çokgenlerin iç açılarının büyüklüğü artar</td>
<td>2</td>
</tr>
<tr>
<td>Simetri artar</td>
<td>2</td>
</tr>
<tr>
<td>Oluşan açıların çeşidi, türü artar</td>
<td>2</td>
</tr>
<tr>
<td>Şekle çizilen yükseklik artar, üçgen ya da şekil sayısını 2 katına çıkarır</td>
<td>2</td>
</tr>
<tr>
<td>Merkez noktası oluşur</td>
<td>2</td>
</tr>
<tr>
<td>Toplam derece ölçüsü artar</td>
<td>2</td>
</tr>
<tr>
<td>Doğruların çeşidi, yatay dikey artar</td>
<td>2</td>
</tr>
<tr>
<td>Köşegenlerce oluşturululan açıların büyüklüğü</td>
<td>2</td>
</tr>
<tr>
<td>3 boyutlu şekillerin sayısı artar</td>
<td>2</td>
</tr>
<tr>
<td>Kesişen düzlem sayısı</td>
<td>2</td>
</tr>
<tr>
<td>Doğruların denklemi</td>
<td>2</td>
</tr>
<tr>
<td>Yarıçap değişir</td>
<td>2</td>
</tr>
</tbody>
</table>
PUANLAMA PROSEDÜRÜ

SORU II

Yönergeler
Sınıfınzdaki tebeşir tahtasının kırdığını ve hiç kimsenin kağıdının olmadığını varsayalım; sonuçta, siz ve öğretmeniniz hiçbir düzlem geometrisi şekillerini örneğin doğru, üçgen, kare, çokgen ya da diğerlerini çizemedi. Sınıfta kalan üzerine çizebileceğiniz tek obje bir top ya da coğrafya dersinden kalan küre şeklindeki dünyadır. Geometrik çizimlerinizi bu top üzerinde yaptığınızda olabilecek her şeyi listeleiniz. Aklıңızın çılgın fikirler düşünmesine izin ver. Örneğin: Eğer top üzerinde düz bir doğru çizmeye başlarsak sonunda başladığımız noktaya ulaşırız. (Dünya küresi üzerindeki ülkelerin haritalarından endişe etmeyiniz."

Puanlama prosedürü

Akılcılık puanı: Uygun her bir cevap için 1 puan.

Esneklik puanı: Belirtilen her bir kategori için 1 puan.

Orijinallik puanı: Belirtilen her bir kategori için 0, 1 ya da 2 puan. Aşağıda verilen Tablo 2’ye göre kategorilerin ağırlığı belirlenecektir.

Tablo 2

Kategoriler ve orijinallik puanını hesaplamak için kategorilere verilen ağırlık puanları (Balka, 1974, p. 204)

<table>
<thead>
<tr>
<th>Belirtilen Kategori</th>
<th>Ağırlık</th>
</tr>
</thead>
<tbody>
<tr>
<td>Şekiller çokgenler yamulur, yuvarlanır, uzatılır, eğrilir</td>
<td>0</td>
</tr>
<tr>
<td>Düz çizgiler eğri olur</td>
<td>0</td>
</tr>
<tr>
<td>Şeklin tamamı çok büyükse eğer gözükmez</td>
<td>0</td>
</tr>
<tr>
<td>Şekil çok büyük çizilirse dokunur, birleşir, çıkarır</td>
<td>0</td>
</tr>
<tr>
<td>Uzaklık, uzunluk ölçüümü farklılaşır</td>
<td>0</td>
</tr>
<tr>
<td><strong>Hiçbir düzlem oluşmaz; düzlemsel şekil oluşmaz; düzlem düz olmaz</strong></td>
<td>0</td>
</tr>
<tr>
<td><strong>Doğru yönündeği değişim spralleşen, kesişen, bitmeyen doğrular oluşturur.</strong></td>
<td>0</td>
</tr>
<tr>
<td><strong>Açı ölçümü farklı olur</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Mükemmel çemberler çizilebilir.</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Şekillerin alanı değişir</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Yarıçap, çap, çevre bulunabilir</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Açı ışınları kesişir</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Şekiller 3 boyutlu gözükür</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>İki düz doğru iki noktada kesişir</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Eğer topları yeterince büyükse geometri değişmez</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Şekiller toplu kaplar</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Hacim doğrudur</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Pisagor teoremi değişir</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Yeni bir matematiksel sistem kurmaya gerek vardır</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Simetri ekseni</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>En geniş çember ekvator</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Düz açı kalı eğri olur</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Topu geçen hayali çizgi; 3 nokta üçgen belirtir</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Topun yüzey alanı değişmez</strong></td>
<td>2</td>
</tr>
</tbody>
</table>
PUANLAMA PROSEDÜRÜ

SORU III

Açıklamalar

Farz edin ki iki geometrik şekil sizden saklanıyor ve bunların ne olduğuna karar vermeniz isteniyor. Bu iki şeklin birbiri ile bir şekilde ilişkili olduğu size söyleniyor. Bu iki şeklin ne olduğuna karar verebilmek için akılınıza gelen tüm soruları listeleiniz. Örneğin, bu şekiller top, kutu ya da piramit gibi katı cisimler mi? Kare, dikdörtgen, ya da paralelkenar gibi düzlemsel şekiller mi? (Daha fazla yere ihtiyacınız olursa bu sayfannın arkasını kullanabilirsiniz.)

Puanlama prosedürü

Akılcılık puanı: Uygun her bir cevap için 1 puan.

Esneklik puanı: Belirtilen her bir kategori için 1 puan.

Orijinallik puanı: Belirtilen her bir kategori için 0, 1 ya da 2 puan. Aşağıda verilen Tablo 3’e göre kategorilerin ağırlığı belirlenecektir.

Tablo 3

Kategoriler ve orijinallik puanını hesaplamak için kategorilere verilen ağırlık puanları (Balka, 1974, p. 207)

<table>
<thead>
<tr>
<th>Belirtilen Kategori</th>
<th>Ağırlık</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenarları var mı? Kaç kenarı var?</td>
<td>0</td>
</tr>
<tr>
<td>Yuvarlak mı, eğri mi, çembersel mi, merkezden yayılan biçimde mi?</td>
<td>0</td>
</tr>
<tr>
<td>Çokgenin çeşidi</td>
<td>0</td>
</tr>
<tr>
<td>Noktaları, köşeleri var mı? Kaç noktası köşesi var?</td>
<td>0</td>
</tr>
<tr>
<td>Benzer ya da eş kenarları var mı?</td>
<td>0</td>
</tr>
<tr>
<td>Kağıda çizilebilen düz, düzlemsel şekiller mi?</td>
<td>0</td>
</tr>
<tr>
<td>Derinliği var mı? Uzayda bulunan 3 boyutlu cisim mi?</td>
<td>0</td>
</tr>
<tr>
<td>Köşegenleri var mı? Kaç köşegeni var?</td>
<td>0</td>
</tr>
<tr>
<td>Soru</td>
<td>Sayı</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Eş, benzer, eșit, aynı büyüklükte mı?</td>
<td>0</td>
</tr>
<tr>
<td>Açıların çeşidi, derecesi?</td>
<td>0</td>
</tr>
<tr>
<td>Hacmi, alanı, çemberin çevresi, şeklin çevresi nedir?</td>
<td>1</td>
</tr>
<tr>
<td>Açık ya da kapalı şekil veya eğri mı?</td>
<td>1</td>
</tr>
<tr>
<td>Karşıt kenarlar paralel mı?</td>
<td>1</td>
</tr>
<tr>
<td>Açıların sayısı?</td>
<td>1</td>
</tr>
<tr>
<td>Yüzü, tabanı var mı? Ne çeşit yüzü var?</td>
<td>1</td>
</tr>
<tr>
<td>Düz kenarları var mı?</td>
<td>1</td>
</tr>
<tr>
<td>Düzlem ya da yüzey sayısı</td>
<td>1</td>
</tr>
<tr>
<td>Kaç ayrıtı var?</td>
<td>2</td>
</tr>
<tr>
<td>Bir düzlemsel (katı) şekil diğerinin içerisinde girer mi?</td>
<td>2</td>
</tr>
<tr>
<td>Simetrik mi?</td>
<td>2</td>
</tr>
<tr>
<td>Düzlemsel ya da eğri alanlardan mı oluşuyor?</td>
<td>2</td>
</tr>
<tr>
<td>Yüzeylerinin şekli?</td>
<td>2</td>
</tr>
<tr>
<td>Yarıçapı var mı?</td>
<td>2</td>
</tr>
<tr>
<td>Yayı var mı?</td>
<td>2</td>
</tr>
<tr>
<td>Alanını, hacmini, çevresini bulmak için formül?</td>
<td>2</td>
</tr>
<tr>
<td>Bir doğru üzerinde mi?</td>
<td>2</td>
</tr>
<tr>
<td>Matematiksel eşitlikler</td>
<td>2</td>
</tr>
<tr>
<td>Konkav mı , konveks mı?</td>
<td>2</td>
</tr>
</tbody>
</table>
PUANLAMA PROSEDÜRÜ

SORU IV

Açıklamalar

Aşağıda verilen durum birçok sayısal bilgi içermektedir. Sizden beklenen, bu matematiksel durumu ilgilendiren, olabildiğince çok sayıda soru üretmektedir. Örneğin; aşağıdaki durum için şöyle bir soru üretilebilir: Eğer şirket her tür uçaktan bir tane alırsa; bu, şirkete ne kadar mal olur? Daha fazla yere ihtiyacınız olursa bu sayfannonun arkaşını kullanabilirsiniz.

Yazdığınız soruları çözmenize gerek yoktur. (Daha fazla yere ihtiyacınız olursa bu sayfannonun arkaşını kullanabilirsiniz.)

Bir havayolu şirketi üç tür yolcu uçağı satın almayı düşünmektedir: 747, 707 ve DC-10. Bir 747’nin maliyeti 15 milyon TL; bir DC-10’un maliyeti 10 milyon TL ve bir 707’nin maliyeti ise 6 milyon TL’dir. Şirket uçakların alımı için toplamda 250 milyon TL harcama yapabilecektir. Harcamalardan sonra şirketin her bir 747’den 800 000 TL; her bir DC-10’dan 500 000 TL ve her bir 707’den 350 000 TL kâr etmesi beklenmektedir. Şirketin kadrosunda bulunan eğitimli pilot sayısının ancak 25 yeni uçağa yetecek tahmin edilmektedir. Şirketin uçak bakım ünitesi de toplamda ancak 45 tane 707’ye yetecek kapasitededir. Bakım ünitesinin kapasitesi her bir DC-10 için bir 707’in \( \frac{\frac{11}{3}}{1} \) ’üne ve her bir 747 için 707’nin \( \frac{\frac{2}{3}}{} \) ’üne eşittir.

Puanlama prosedürü

Akılcılık puani: Uygun her bir cevap için 1 puan.
Esneklik puani: Belirtilen her bir kategori için 1 puan.
Orijinallik puani: Belirtilen her bir kategori için 0, 1 ya da 2 puan. Aşağıda verilen Tablo 4’e göre kategorilerin ağırlığı belirlenecektir.
Tablo 4
Kategoriler ve orijinallik puanını hesaplamak için kategorilere verilen ağırlık puanları (Balka, 1974, p.210)

<table>
<thead>
<tr>
<th>Belirtilen Kategori</th>
<th>Ağırlık</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bir çeşit uçağı belirli sayıda satın alma masrafi</td>
<td>0</td>
</tr>
<tr>
<td>İki ya da üç çeşit uçağı belirli sayıda satın alma masrafi</td>
<td>0</td>
</tr>
<tr>
<td>250 milyon dolara ya da bir bölümüne satın alınabilecek uçak sayısı</td>
<td>0</td>
</tr>
<tr>
<td>Bakım ünitesinin alabileceği DC 10 ya da 747'lerin sayısı</td>
<td>0</td>
</tr>
<tr>
<td>Belirli sayyadaki iki ya da üç çeşit uçaktan elde edilecek kâr</td>
<td>0</td>
</tr>
<tr>
<td>Belirli sayyadaki bir çeşit uçaktan elde edilecek kâr</td>
<td>0</td>
</tr>
<tr>
<td>Belirli sayyada uçak aldktan sonra kalan para</td>
<td>0</td>
</tr>
<tr>
<td>Uçak maliyetlerindeki farklar</td>
<td>0</td>
</tr>
<tr>
<td>Bakım ünitesinin kaldırabileceği iki ya da üç çeşit uçaktan elde edilecek kâr</td>
<td>0</td>
</tr>
<tr>
<td>DC 10 ve 747 uçaklarının büyüklük, yüzde ve karşilaştırmaları</td>
<td>1</td>
</tr>
<tr>
<td>Uçak satın alınken en iyi seçim, en ekonomik satın alış nedir?</td>
<td>1</td>
</tr>
<tr>
<td>Kârlardaki fark</td>
<td>2</td>
</tr>
<tr>
<td>Bir uçağın kendi masrafini ödeyebilmesi için geçmesi gereken yıl sayısı</td>
<td>2</td>
</tr>
<tr>
<td>Diğerlerinin kâryla satın alınabilecek uçak sayısı</td>
<td>2</td>
</tr>
<tr>
<td>İki ya da daha çok tipte uçağın farklı sayılarda satın alınması. Yatırım mı yoksa kâr mı daha iyi bir seçimdir?</td>
<td>2</td>
</tr>
<tr>
<td>En fazla kâr miktari</td>
<td>2</td>
</tr>
<tr>
<td>Soru</td>
<td>Sayı</td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Şirket belirli sayıda uçak alırsa eğer, yeterince pilot olacak mı?</td>
<td>2</td>
</tr>
<tr>
<td>Bir tür uçaktan, belirli sayıda farklı türdeki uçakların maliyeti ile kaç tane alınır?</td>
<td>2</td>
</tr>
<tr>
<td>Uçaklar tarafından kullanılan garaj yüzdesi</td>
<td>2</td>
</tr>
<tr>
<td>Maliyetin kâra oranı</td>
<td>2</td>
</tr>
<tr>
<td>Belirli zaman aralığında elde edilen kâr</td>
<td>2</td>
</tr>
<tr>
<td>Belirli saydaki uçağın masrafları</td>
<td>2</td>
</tr>
<tr>
<td>Uçakların bakım üniteleri kullanma farkı ya da karşılaştırması</td>
<td>2</td>
</tr>
<tr>
<td>Şirket belirli sayıda bir çeşit uçağtan alırsa, diğer başka bir çeşitten de alabileceği mi?</td>
<td>2</td>
</tr>
<tr>
<td>Bir uçak satın alındığında ve birkaç yıl elde tutulduğuında kâr elde edilir mi?</td>
<td>2</td>
</tr>
<tr>
<td>Belirli saydaki diğer tip uçaklar bakım üniteleri kullanılarak, burayı kullanabilecek bir tip uçak sayısı</td>
<td>2</td>
</tr>
<tr>
<td>İhtiyaç duyulan, belirli bir kaç yılda eğitilmesi gereken, pilot sayısı</td>
<td>2</td>
</tr>
<tr>
<td>Eğer şirket belirli bir sayıda uçağ istiyorlsa, en iyi seçim nasıl olur?</td>
<td>2</td>
</tr>
<tr>
<td>Bakım ünitelerinin en fazla kullanımı</td>
<td>2</td>
</tr>
<tr>
<td>Kârın büyüklüğü oranı</td>
<td>2</td>
</tr>
<tr>
<td>Bakım ünitelerinin en fazla kullanımına göre uçakların maliyeti</td>
<td>2</td>
</tr>
<tr>
<td>Uçağın aylık maliyeti</td>
<td>2</td>
</tr>
</tbody>
</table>
APPENDIX C

EXAMPLES OF STUDENT RESPONSES TO CREATIVE ABILITY IN MATHEMATICS TEST
Soru II

Açıklamalar

Sınıfımızdaki tabtanın kırıldığını ve hiç kimse kăğıdın olmadığını varsayın, dolaysıyla siz ya da öğretmeniniz doğru, üçgen, kare, çokgen vb. hiçbir düzlem geometri şeklini çizemiyorsunuz. Sınıfta kalan ve üzerine çizebileceğinize tek nesne bir top ya da coğrafya dersinden kalan bir küre.

Geometrik çizimlerinizi bu top üzerinde yaptığınızda olabilecek her şeyi listeleiniz. Örneğin, eğer küre üzerinde düz bir doğru çizmeye başlasırsınız sonunda başladığınız noktaya ulaşarsınız. (Küre üzerindeki haritaları göz ardı ediniz.)

1. Birleşmiş, gerekşiz, şekiller, kozmik...
2. Sekiller, birbirine, gecebilir...
3. Düz, büyük, bir, şekil, uzaktan... iç, büyük, bir, şekil, elle, edilir...
4. Yüzey, alanı, formülü, değişir...
5. Şekil, uzunluğu, formülü, değişir...
6. Ders, verimsiz, illü...
7. ...
8. ...
Açıklamalar

Farz edin ki iki geometrik şekil ziden saksınýyor ve bunlar ne olduğuna karar vermeniz isteniyor. Bu iki şeklin birbiri ile bir şekilde ilişkili olduğu size söyleniyor. Bu iki şeklin ne olduğuna karar verebilmek için aklınza gelen tüm sorular listeleyniz. Örneğin, bu şekiller top, kutu ya da piramit gibi katı cisimler mi? Kare, dikkörtgen, ya da paralelkenar gibi düzlemsel şekiller mi? (Daha fazla yere ihtiyaç olursa bu sayfannın arkasını kullanabilirsiniz.)

1. Dörtgen mi, iki taraflı mı?
2. Sayısı kaç?
3. Konar sayısı kaç?
4. Üzerinde yönlendirilecek teoremler?
5. Harim formüle?
6. Yüzey alanı formülü?
7. Sekillerin ilișkisi durum?
8. Kat sayıları, merkez yer?
9. Yüzey sayısı?
10. Iç, dış geometrik cisim mi, dış boyay mı?
Açıklamalar

Aşağıda verilen durum birçok sayısal bilgi içermektedir. Sizden beklenen, bu matematiksel durumu ilgilendiren, elabildiğince çok sayıda soru üretmektir. Örneğin; aşağıdaki durum için şöyle bir soru üretilebilir: Eğer şirket her tür uçaktan bir tane alırsa; bu, şirkete ne kadar mal olur? Daha fazla yere ihtiyaç olursa bu sayının arkasını kullanabilirsiniz.

Yazdığınız soruları çözmenize gerek yoktur.

Bir havayolu şirketi üç tür yolcu uçağı satın almayı düşünmektedir: 747, 707 ve DC-10. Bir 747'nin maliyeti 15 milyon TL, bir DC-10'un maliyeti 10 milyon TL ve bir 707'nin maliyeti ise 6 milyon TL'dir. Şirket uçakların alımı için toplamda 250 milyon TL harcamaya yarabilecektir. Harcamaların sonrasya şirketin her bir 747'den 800 000 TL; her bir DC-10'dan 500 000 TL ve her bir 707'den 350 000 TL kâr etmesi beklenmektedir. Şirketin kadrosunda bulunan eğitimli pilot sayısının ancak 25 yeni uçağa yeteceği tahmin edilmektedir. Şirketin uçak bakım ünitesi de toplamda ancak 45 tane 707'y eve yetecek kapasitededir. Bakım ünitesinin kapasitesi her bir DC-10 için bir 707'nin 1 \frac{1}{3} teneve ve her bir 747 için 707'nin 1 \frac{2}{3} teneve eşittir.

1. Zaman... funktion... en az... uçağını kiralama... yapma... tara... kara... uçağa...
2. Evin... döş... edecek... uçağa... kara... tane... alabilir?
3. Fakat... uçağa... sermayan... kara... olacak... pilot... sayı... yetecek... alımı... mı?
4. Uçağın... bakım... ünitesi... kaç... DC-10'yu... kaç... DC-10'u... alabilir?
5. Uçak... alınıbiliyor... kadar... özel... sermaye... kaç... DC-10'u... alabilir?
6. Uçak... alınıbiliyor... kadar... alınıbiliyor... bakım... ünitesi... yetecek... olup...

133
APPENDIX D

SHORT FORM OF FIVE FACTOR PERSONALITY INVENTORY

Aşağıda insanların bazı özelliklerini tanımlayan cümleleri verilmiştir. Lütfen dikkatlice okuyarak her ifadeyi sizi tanımlamakta ne derece uygun olduğunu belirten seçeneklerden bir tanesini işaretleyiniz.

Eğer cümle sizi tanımlamakta;

<table>
<thead>
<tr>
<th>Tamamen Uygunsu</th>
<th>Biraz Uygunsu</th>
<th>Pek Uygun Değil</th>
<th>Hiç Uygun Değil</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;TU&quot; yu</td>
<td>&quot;TU&quot; yu</td>
<td>&quot;PUD&quot; yi</td>
<td>&quot;HUD&quot; yi</td>
</tr>
<tr>
<td>baş hertleri olan</td>
<td>baş hertleri olan</td>
<td>baş hertleri olan</td>
<td>baş hertleri olan</td>
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<tr>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

Bu cümlede hangi hertleri belirten seçenek ("TU", "BU", "PUD", "HUD") daire içine alınıyor. Eğer hiç bir seçenek size uyumuya veya kararsızsanız "?" ni daire içine alınınız. Lütfen karar vermeden önce zorlanmadığınızı sıraya sou işaretleyiniz (?) kullanmayınız.


<table>
<thead>
<tr>
<th>Tamamen Uygunsu TU</th>
<th>Biraz Uygunsu ?</th>
<th>Kararsız PUD</th>
<th>Pek Uygun Değil HUD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tamamen Uygun</td>
<td>Biraz Uygun</td>
<td>Kararsız</td>
<td>Pek Uygun Değil</td>
</tr>
<tr>
<td>---------------</td>
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<td>---------</td>
<td>----------------</td>
</tr>
<tr>
<td>TU</td>
<td>BU</td>
<td>?</td>
<td>PUD</td>
</tr>
<tr>
<td>27. Yalnız oğmakan hoşlanır.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>28. Başıklarına tepeden bakılarım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>29. Geçmiş hatalarını düşünerek zaman harcarım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>30. Disiplin bir insanım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>31. Rekabetten çok işbirliğine önem veririm.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>32. Hayatın kırıklıklarını acımasız başklarından çıkarır.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>33. Macera ararsınız.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>34. Yapacağım işlerin listesini çıkarım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>35. Fırıncı buldamın mu geçerşiz yaparım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>36. Az konurum.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>37. Duyusal davranışa insanlar ahlakım.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>38. Duyunmeye iyi fülmü severim.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>39. Kalabalığa hoşlanmam.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>40. Başkalarını memnun etmek isterim.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>41. Her zaman görlüştüğüm gibi değilim.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>42. Hazır olup her birinin mende.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>43. Özürleri kolayca kabul ederim.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>44. Arkadaşlarını güldürürüm.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>45. Başkalarına çok fazla önem veririm.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>46. Hic beş inglés yarım adım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>47. Olumlu yaşamı tek bir adımı bırakam.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>48. Kendini bir şeyle vereyim.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>49. Kendini ahlamaya çalışır.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>50. İnsanları kolayca bağlılayabilirim.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>51. İşlerı planlayarak yaparım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>52. Yakalamayacağım bilsem dahi vergi kayıram.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>53. İsmini hiç duymam.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>54. Şıkta ayı şeyleri yapmaktan hoşlanmam.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>55. Kolayca huzuruz olarak.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>56. Düzensizlikten rahatsız olmam.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>57. Kin tuturm.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>58. Karıflara sıkı sıkıya bağlıyım.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>59. Olayları analizi emeye çalışırım.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>60. Ruh hali çok sık sık sık.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>61. Ilginç fikirleri oluşturmak istemirim.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>62. Aynı anda birçoq şeyi idame edebilirim.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>63. Kahkaha la gülerim.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>64. Eleştiriden kuzman daban kabul edebilirim.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>65. Düyularını yalnızca zifiririm.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>66. Sırrı dilsizyım.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>67. Vecet uygunu yürü elli kilitan atmama.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>68. Geze girmek için insanlara yararım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>69. Her zaman faaliyım.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>70. Amaçlarını ulaşmak için siki çalışanım.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>71. Her zaman söylüştü olarak.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>72. Yeni hiçbir şey söyleyem.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>73. Kolayca etkili alana kalarım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>74. Hareketi bitiririm.</td>
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<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>75. Genellikle eylemleri yineleme koymayan anlamam.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>76. Okumaktan hoşlanırım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>77. Kolayca kendimi başka atımı hisse ederim.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>78. Düyularını yoğun yapayım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>79. Tehlikeli şeyler yaparım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>80. İhsan yalan söylemek zorunda kalıram.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>81. Çevrelerin kabul kılınır.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>82. Sonradan pişman olacaklarını şeyler yaparım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
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<tr>
<td>83. Köşkçan bir insanım.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>84. Başıkları için örneklikta hoşlanmam.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
<tr>
<td>85. İnsanlara güvenirim.</td>
<td>TU</td>
<td>BU</td>
<td>?</td>
</tr>
</tbody>
</table>
APPENDIX E

ACADEMIC RISK-TAKING SCALE

Adı Soyadı: ...............................  Sınıfı: .........................
Cinsiyeti: ......................................

Açıklamalar

Bu ölçeekte yer alan ifadeleri okulunuzdaki derslerinizi düşünerek cevaplandırınız. Verilen 5’li ölçeği kullanarak cevabınızı en iyi yansıyan numaraya (X) işareti atınız.

(1) Benim için hiçbir zaman doğru değil,
(2) Benim için nadiren doğru,
(3) Benim için bazen doğru,
(4) Benim için genellikle doğru,
(5) Benim için her zaman doğru,

Yardımlarınız için teşekkürler.

<table>
<thead>
<tr>
<th>İfade No</th>
<th>İfadeler</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>1</td>
<td>Benim için zor olan okul ödevini yapmayı severim.</td>
<td></td>
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<tr>
<td>2</td>
<td>Okulda bir hata yaptığım zaman kendimi kötü hissederim.</td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td>Okulda sorular sormayı severim, çünkü sorular sorarak öğrenirim.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>4</td>
<td>Okuldaki çalışmalarında başarısız olursam, bunu kimsenin bilmesine izin vermem.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td>Daha fazla düşünme gerektiren problemlerle karşılaştığında, çabuk yapabileceğim problemleri tercih ederim.</td>
<td></td>
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</tr>
<tr>
<td>No.</td>
<td>Turkish Text</td>
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</tr>
<tr>
<td>6</td>
<td>Eğer okulda yeni bir çalışmada başarılı olamazsam hemen vazgeçerim.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Okul ödevlerinde aldığım düşük bir not beni çok mutsuz eder.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Bazı yanlışlar yapam bile güç ödevlerle uğraşmamı seviyorum.</td>
<td></td>
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<td>9</td>
<td>Okulda yeni bir şeye başladığım zaman düşündüğüm ilk şey başarısız olacağınımdır.</td>
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<td>10</td>
<td>Okuldaki bir problemle çalışmaktan kurtulmak için hemen hemen hiçbir şey yapmam.</td>
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<td>11</td>
<td>Okul çalışmalarında yanlış yaptığım zaman tekrar tekrar denemeye devam ederim.</td>
<td></td>
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<td>12</td>
<td>Okul çalışmalarımı yanlış yapmaktan endişe duyarım.</td>
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<td>13</td>
<td>Ne zaman okulda kötü bir not alırsam saklanma ihtiyacı duyarım.</td>
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<td>14</td>
<td>Gerçekten düşünerek yaptığım okul çalışmaları eğlencelidir.</td>
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<tr>
<td>15</td>
<td>Okul çalışmalarım için hedefler belirlemekten hoşlanmam, çünkü onlara ulaşamayabilirim ve o zaman da kendimi kötü hissederim.</td>
<td></td>
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<tr>
<td>16</td>
<td>Eğer okulda çok hata yaparsam, kendimi çok karamsar veya kızguns hissederim.</td>
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<td>17</td>
<td>Zor olan okul ödevleri kolay olanlardan daha eğlencelidir.</td>
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<tr>
<td>18</td>
<td>Sınıf arkadaşlarıyla çalışmaya sevmem, çünkü bir şeyleri bilememsem benim aptal olduğumu düşünebilirler.</td>
<td></td>
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<td>19</td>
<td>Zor bir derse çalışmaya, kolay bir derse çalışmaya tercih ederim.</td>
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<tr>
<td>20</td>
<td>Okulda başarısız olduğum zaman yemek yemek, oyun oynamaktan, konuşmaktan veya başka bir şey yapmaktan hoşlanmam.</td>
<td></td>
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<td>21</td>
<td>Ödevleri seçme şansı olduğunda zor olan ödevleri kolay olanlara tercih ederim.</td>
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<td>22</td>
<td>Eğer okul ödevim zor ise onu yapmadan geçmeyeye çalışırım</td>
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<td>23</td>
<td>Bir konuyu anlamazsam onu açıklaması için öğretmenime sorarım.</td>
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<td>24</td>
<td>Öğrenmeyle çalıştığım bir konuda hata yaparsam, cesaretim çok kırılır.</td>
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<td>25</td>
<td>Şaşma bir soru sormaktansa, herhangi bir konuda yanlış yapmayı ve tahminde bulunmayı tercih ederim.</td>
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<td>No.</td>
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<tr>
<td>26</td>
<td>Okulda yaptığım hatalardan daima bir şeyler öğrenirim.</td>
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<tr>
<td>27</td>
<td>Eğer okul çalışmalarımda düşük bir not alırsam, hatalarım üzerinde çalışır ve yanlış yaptığı problemi tekrar çözerim.</td>
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<td>28</td>
<td>Zor ve iddialı sorulara cevap vermek denemek eğlenceliidir.</td>
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<tr>
<td>29</td>
<td>Yapmak zorunda olmasam bile genellikle okul ödevlerinde yaptığım hatalara çalışır ve düzeltirim.</td>
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<td>30</td>
<td>Okul ödevleri benim için ne kadar kolay olursa, o kadar hoşlanırım.</td>
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<td>31</td>
<td>Hata yaptığım okul ödevlerini genellikle sevmem.</td>
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<td>32</td>
<td>Zor derslere çalışmaktan hoşlanan sınıf arkadaşlarıyla çalışmayı severim.</td>
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<tr>
<td>33</td>
<td>Okul ödevleri ile ilgili hedefler koymayı sevmem, ödevimi yapar ve unuturum.</td>
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<td>34</td>
<td>Öğretmenin sorusuna yanlış cevap verirsem kendimi kötü hissederim.</td>
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<tr>
<td>35</td>
<td>Kolay fakat sıkıcı bir ödevde mükemmel bir not alırsanız, zor bir ödevde hata yapmayı tercih ederim.</td>
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<tr>
<td>36</td>
<td>Eğer düşük bir puan alırsanız genellikle işi ciddiye almak için zihnimi toplar ve daha sıkı çalışırım.</td>
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</table>
APPENDIX F

JUNIOR METACOGNITIVE AWARENESS INVENTORY

Adı Soyadı:……………………………………… Sınıfı:……………………………
Cinsiyeti:……………………………………


Teşekkürler!

<table>
<thead>
<tr>
<th>İlk Okumada Anladığımı Bildirim</th>
<th>Hiçbir Zaman</th>
<th>Nadiren</th>
<th>Bazen</th>
<th>Sık Sık</th>
<th>Her Zaman</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bir şeyi anladığımı bildirim.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>2. Gerektiğinde, öğrenmek için kendimi motive edebilirim.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>3. Daha önce, benim için işe yararlı çalışma yollarını kullanmayı denerim.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>4. Öğretmenin benden ne öğrenmemi beklediğini bildirim.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>5. Konu hakkında daha önceden bilgim varsa daha iyi öğrenirim.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>6. Öğrenirken anlamama yardımcı olarak resimler veya şemalar çizerim.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>7. Çalışmamı bitirdiğimde kendime “Öğrenmek istediğim şeyi öğrendim mı?” diye sorarım.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>
8. Bir problemi çözmek için çeşitli çözüm yollarını denerim ve daha sonra en uygun olanını seçerim. | O | O | O | O | O | O |
9. Çalışmaya başlamadan önce neyi öğrenmem gerektiğini düşünürüm. | O | O | O | O | O | O |
10. Yeni bir şey öğrenirken kendime iyi gidip gitmediğime dair sorular sorarım. | O | O | O | O | O | O |
11. Önemli bilgiye gerçekten dikkat ederim. | O | O | O | O | O | O |
13. Zihinsel açıdan güçlü olduğum noktaları, zayıf olan noktalarımı telafi etmede kullanırım. | O | O | O | O | O | O |
14. Verilen işe bağlı olarak farklı öğrenme stratejileri kullanırım. | O | O | O | O | O | O |
15. Çalışmamı zamanında bitireceğimden emin olmak için ara sıra kontrol ederim. | O | O | O | O | O | O |
16. Bir işi bitirdikten sonra kendime “Daha kolay bir yol var mıydı?” diye sorarım. | O | O | O | O | O | O |
17. Bir işe başlamadan önce neyi tamamlamam gerektiğini karar veririm. | O | O | O | O | O | O |
Değerli Öğrenciler:

<table>
<thead>
<tr>
<th></th>
<th>Bana hiç uygun değil</th>
<th>Bana çok uygun</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Böyle bir derste, yeni bir şeyler öğrenebileyim diye beni gerçekten zorlayacak kısımları çalışmayı tercih ederim.</td>
<td>O O O O O O O</td>
</tr>
<tr>
<td>2.</td>
<td>Bu dersten iyi bir not almak şu an için beni en tatmin edecek şeydir.</td>
<td>O O O O O O O</td>
</tr>
<tr>
<td>3.</td>
<td>Şimdi benim için önemli olan genel not ortalamamı yükseltmek olduğundan esas kaygım bu dersten iyi bir not almakta.</td>
<td>O O O O O O O</td>
</tr>
<tr>
<td>4.</td>
<td>Eğer becerebilirsem, sınıftaki öğrencilerin çoğunun daha iyi notlar almak istiyorlar.</td>
<td>O O O O O O O</td>
</tr>
<tr>
<td>5.</td>
<td>Böyle bir derste, öğrenmeleri zor da olsalar, merakımı uyandıran konu ve okumaları tercih ederim.</td>
<td>O O O O O O O</td>
</tr>
<tr>
<td>7.</td>
<td>Bu derste fırsatım olduğunda, ödevlerimi, yüksek bir not garanti <strong>etmese</strong> bile bir şeyler öğrenebileceğimden seçerim.</td>
<td>O O O O O O O</td>
</tr>
<tr>
<td>8.</td>
<td>Bu derste çok iyi yapmak istiyorum, çünkü aileme, arkadaşlarına ve diğer kişilere becerebileceğimi göstermem önemlidir.</td>
<td>O O O O O O O</td>
</tr>
</tbody>
</table>
CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Baş, Selda
Nationality: Turkish (TC)
Date and Place of Birth: 22 September 1982
Marital Status: Single
e-mail: seldabas@gmail.com

EDUCATION

<table>
<thead>
<tr>
<th>Degree</th>
<th>Institution</th>
<th>Year of Graduation</th>
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<tbody>
<tr>
<td>BS</td>
<td>Bogazici University</td>
<td>2005</td>
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<td></td>
<td>Secondary School Mathematics Education</td>
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</tr>
<tr>
<td>High School</td>
<td>Sinop Anatolian Teacher Training</td>
<td>2000</td>
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<td>High School</td>
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WORK EXPERIENCE

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<th>Year</th>
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<tr>
<td>2009-2011</td>
<td>Darussafaka Educational Institutions, Istanbul</td>
<td>Mathematics Teacher</td>
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<tr>
<td>2006-2007</td>
<td>Dogus High School, Istanbul</td>
<td>Mathematics Teacher</td>
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FOREIGN LANGUAGES

English

HOBBIES

Tennis, Movies, Music