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THE EFFECTS OF CREATIVITY TRAINING IN PROBLEM SOLVING ON THE ACHIEVEMENT OF THE PROSPECTIVE MATHEMATICS TEACHERS

ABSTRACT

Creativity training in problem solving on the achievement of mathematic teachers is a significant research issue. This study aims to examine the achievement of prospective mathematics teachers who have different creative thinking styles. 16 prospective mathematics teachers participated in the study. One group pre-test and post-test experimental group design were used in the study. The program aimed to teach how to develop creativity in mathematics education and included creativity techniques used actively in mathematics education. After the program, KAI Inventory and also TLT were applied as a post-test. According to the result of study, there is a significant correlation between the KAI Inventory and Thinking Link Test scores. It was found that the creativity-training program has dissimilar affects on those who have different creativity styles.

Keywords: Creativity, Creative Teaching, Mathematics Education

MATEMATİK ÖĞRETMENİ ADAYLARININ FARKLI YARATICILIK STİLLERİNİN YARATICILIK EĞİTİMİNDEKİ BAŞARILARI ÜZERİNE ETKİSİ

ÖZET

Matematik öğretmen adaylarının başarısı konusunda problem çözmede yaratıcılık önemli bir araştırma konusudur. Bu çalışmanın amacı problem çözmede yaratıcılık eğitimi alan matematik öğretmeni adaylarının farklı yaratıcılık stillerinin bu eğitimdeki başarıları üzerine etkisini incelemektir. Çalışmaya 16 öğretmen adayı katılmıştır. Tek grup ön test-son test deseni kullanılmıştır. Araştırmada uygulanan eğitimin amacı, problem çözmede yaratıcılığın nasıl geliştirileceğini öğretmen adaylarına öğretmekti ve program yaratıcılık tekniklerinin problem çözmede kullanımını içermekteydi. Araştırmada son test olarak KAI ve DBT uygulanmıştır. Araştırma sonucunda, ön testten son teste öğretmen adaylarının yaratıcılık stilleri puanları değişmezken, son testler olan KAI'den alınan yaratıcılık stilleri puanlarıyla DBT'den alınan başarı puanları arasında anlamlı bir ilişki bulunmuştur. Bu sonuç farklı yaratıcılık stilleri olan öğretmen adaylarını yaratıcılık eğitiminin farklı etkilediğini göstermektedir.

Anahtar Kelimeler: Yaratıcılık, Yaratıcı Eğitim, Matematik Eğitimi

1. INRODUCTION (GİRİŞ)

In education, instead of classical conception of learning, today, knowing about learning and critical and creative thinking skills have significant roles. Mathematics education has to keep pace with present education philosophy. According to Ersoy (2002), in terms of scientific and mathematical thinking, a classroom should be provided with appropriate environment and atmosphere for problem solving and other creative activities. Consequently, problem solving and creative activities in mathematics teaching are two considerable dimensions.

Teachers are responsible for education in classroom. Thus, mathematics teachers are supposed to provide appropriate classroom atmosphere for creativity in mathematics education. In order to apply a creative mathematics education in the classroom, not only appropriate mathematics curricula but also teachers who should know and can apply creativity in the mathematics education are needed (Kandemir, 2006). In the improvement of creativity, first of all, a teacher must be self confident, exceed superficial knowledge, work for the improvement of divergent thinking in students, pay attention to students' original, innovative and unusual ideas and encourage them to become real individuals (Ediger, 2000; Gürol and Tezci, 2001). In sum, a mathematics teacher must be an individual who knows how to improve creativity in mathematics education and have an innovative personality to have creative characteristics.

1.1. Adaptation-Innovation Theory and Its Measure of KAI Inventory (Uyumcu-Yenilikçi Teori ve KAI Envanteriyle Ölçümü)

Creativity is described as individual's dominant approach. Then, it should be adapted for problem solving in relation to personal characteristics, the formation of some styles of creativity related to individual's personal characteristics Higgins, 1996). In related literature, personal creativity is measured in different ways. The measurement approaches can be grouped into three; cognitive ability, personality, developmental (life) experiences (Puccio, 1994). It can also be defined as individual differences in approach towards creative problem solving. These individual differences can be also significant, as in problem solving, in making decisions and approaches towards change.

Kirton, who put forward that differences in approach result from cognitive styles, developed the theory of Adaptation-Innovation (A-I) in 1970's; It is also called as the theory of cognitive styles. An individual prefers changing (Kubes, 1990). In A-I theory, conceptually, cognitive style is independent from cognitive capacity, cognitive technique, coping attitude, achievement, culture and individual characteristics (Kubes, 1998; Clapp, 1993; Kirton, 1989). A-I theory includes different approaches on individuals preference in problem solving, making decisions, change and claims that these characteristics do not change in the course of time (Sim and Wright, 2002). Adaptive-Innovative cognitive style appears as an individual characteristic. The characteristic is just a cognitive style for creativity, but not capacity of creativity (Foxall and Hackett, 1992; Kirton, 1994).

The measurement tool of A-I cognitive style theory is Kirton Adaptation-Innovation Inventory (KAI) (Kirton, 1987; 1994). KAI was developed to measure differences in cognitive styles, which includes creative process, problem solving, and decision making (Kubes, 1994). It puts the individuals into two groups, Adaptor and Innovator (Kirton, 1994). According to points they get in KAI, the individual

are classified from "highly innovative" to "highly adaptive" with unchanging gaps. "Highly Innovative" individuals tend to redefine the structure and conditions in which they are and also the problems. They regard all the issues and deal with new opportunities to be reassessed. They bring radical solutions to problems. "Highly adaptive" individuals, based on their post experiences, try to unite and improve the existing structural systems and paradigms without spoiling its harmony (Tullet and Davies, 1997; Kubes, 1998; Bobic et.al, 1999). It is mainly that there are different styles of approach between innovators and adaptors because the innovators see themselves as "doing things differently" and adaptors see themselves as "doing things better" (Kirton, 1984).

There are 32 items in KAI measurement. Each item is scored from 1 to 5. Theoretical measurement interval is between 32 and 160. The average score is 96 (Sim and Wright, 2002; Tullet and Kirton, 1999). As a result of the administrations by the researchers, the scores were generally found to change generally between 46 and 145 (Kirton, 1987). Kirton (1976), by using the factor analysis, showed that A-I dimension up of 3 sub-traits which reflect the individual's comprehensive elements in terms of psychology. These three sub-traits are sufficiency of originality, efficiency, and rule/group conformity.

- **Sufficiency of Originality:** This factor is related to number and efficiency area of innovative ideas produced. Adaptors usually produce less idea and their ideas are seen more reliable and practical. Innovators, contrary to the former group, produce new ideas. Their ideas are considered to be away from the desired situations and to be risky. There are 13 items in this sub-trait. The scores range from 13 to 65. The average in the population is 41 (Sim and Wright, 2002; Kubes, 1998; Bobic et.al, 1999).
- **Efficiency (E):** This factor is related to the attention to which an individual pays during problem solving and whether he uses the present systems in problem solving. Efficient sub-factor reflects adaptors' certainty, choosing reliable ways and working more efficiently for more plausible information. Innovators make their choice for paying less attention to details and avoiding perfectness. Efficiency has seven items, and scores change from seven to 35 (Sim and Wright, 2002; Kubes, 1998).
- **Rule/Group Conformity:** It is the degree to work in social norms and to refuse the critical elements formed by social norms. Adaptors choose to approach using the ways disciplined in accordance with the norms. They are rational and have methodological attitudes which are more widely admitted in problem solving. Innovators, on the other hand, have the tendency to give less importance to rules and even leave them (Higgins, 1996; Bobic, et. al., 1999; Kubes, 1998).

The investigations on the validity studies were conducted in different cultures and countries supports the three-factorial structure developed by Kirton (Bogazzi and Foxall, 1995; Clapp, 1993; Kubes, 1998; Bobic, et.al, 1999; Tullett and Kirton, 1995).

1.2. Using Concept Maps for Assessing Creativity Programme in Problem Solving (Problem Çözmede Yaratıcılık Programının Değerlendirilmesinde Kavram Haritası Kullanımı)

Concept maps are educational techniques which are used to indicate the relationship between concepts and properties. They are designed to show if the relationship between concepts on a certain issue is understood. In concept maps, a list of vocabulary defining

important situations is given. The concepts are listed hierarchically from the most specific to the most general. Lines are drawn between key concepts, and, on the lines, the relation between concepts and written …(Novak and Gowin, 1984).

In educational environment, the use of concept maps can provide some benefits. When a subject is taught for the first time, usage of concept maps will help the students understand and learn the subject comprehensively. A teacher may use them to determine the students' misconceptions and also to get feedback from the students for themselves (Novak and Gowin, 1984; Okebokola and Jegede, 1988; Mayer, 1989). As a result, new and original relationships can be set up in concept maps. They are the indicators of how well the map maker understood the subject (Novak and Gowin, 1984).

When the literature about the concept maps in education is searched, it is seen as a method which allows feedback from students, which make the assessment to students' comprehension level possible and which are used for supplementary goals. Conclusively, one or all of three goals were used. They were researched to see which provides a deeper comprehension than the conventional methods in a comparison study (Heinz-Fr and Novak, 1990). They were also used as the means to assess the comprehension of students (White and Gunstone, 1992). Getting feedback from the students was used with three of the goals in order to enhance student's comprehensive learning and to assess student's comprehension (Roberts, 1999). Lastly, they are assessed in qualitative terms (Novak & Gowin, 1984; Mason, 1992; Roberts, 1999). In related literature, there is no concept map scoring in education or mathematics education. In this study, a different and alternative scoring method was developed to assess different relationships between concepts and creativity.

2. RESEARCH SIGNIFICANCE (ARAŞTIRMANIN ÖNEMİ)

The purpose of this study is to determine whether the achievement of the future mathematics teachers who had creativity training in problem solving and different creativity styles in establishing significant relationships between mathematics education and creativity changes in terms of their creativity styles. This study is a part of a program which includes the training on the improvement of creative thinking in problem solving with creativity techniques. In addition, whether the individual's creativity styles change according to the creativity-training program in terms of gender was also analyzed.

3. METHOD (YÖNTEM)

In this study, pre-experimental design was used in the One Group Pretest and Posttest as the research design (Cohen and Manion, 1994, p.165).KAI inventory and Thinking Link Test developed by the researchers were used. KAI inventory was applied as pretest and posttest. Thinking Link Test developed by the researcher was applied as posttest.

3.1. Participants (Çalışma Grubu)

16 Prospective mathematics teachers participated voluntarily in creativity-training program. The subjects were prospective mathematics teachers who are at 9th term of their undergraduate education and will graduate after the 10th term.

3.2. Creativity Training Program in Problem Solving and Procedures (Problem Çözmede Yaratıcılık Eğitimi Programı ve İşlemler)

The study was carried out in the fall term of 2005-2006. Creativity Training Program was carried out in the pedagogical Content knowledge of Mathematics course, which is 4 credits, as the objectives of the study suggest. The goal of the course is to enable the learning of how to make mathematics education better with the help of efficient methods and techniques, the objectives of the program and the course coincide. The program was completed in 11 weeks. Before starting the program, KAI inventory was given to the prospective teachers. Before the creativity training in problem solving, the subjects were given information about creativity and 22 different techniques were introduced. The techniques of creativity used were "Brainstorming"(Starko, 2004), "The Creative Pause", "Challenge", "Focus", "Alternatives", "The Six Thinking Hats" (De Bono, 1993), " Movement" "Creative Exchange Technique", "Nominal Group", "Idea writing", "Delphi" (Moore, 1994), "Upside Turning", " Matrix" (Michalko, 1991), "Simulation" (Dacey, 1989), "Directing Toward the Goal",", "5W 1H" (Van Gundy, 1988), "Redesigning", "Gathering" Classification", "Question Production", " Guessing and investigating the reasons", "Imagination" (Rıza, 2001). Problem solving activities including creative thinking and divergent thinking exercises were done by the researchers. Pairs were formed voluntarily among the 16 prospective teachers. They were asked to choose two or three of the 22 creativity techniques and to prepare activities including the use of them in the problem solving process. The activities prepared by the prospective mathematics teachers using all the 22 creativity techniques were carried out one by one. The objective of preparing activities is to enable them to learn by doing and experiencing in the process and by creating a synergy to make them obtain more beneficial outcomes. During the activities of the prospective mathematics teachers, the researchers also continued to apply similar activities. The researchers acted as facilitators in the prospective mathematics teachers' activities (Sternberg, 1996; Wilson, 1993). With the role of the facilitator, the researchers prevented deviation from the content; they enabled continuity of the activities by asking questions widening the topic in the points where the future teachers are stuck. At the end, KAI inventory was given again. Besides, Thinking Link Test, developed by the researchers, was also applied as posttest.

3.3. Data Collection Tools (Veri Toplama Araçları)

Data collection instruments were KAI Inventory and Thinking Link Test, developed by the researchers and used in the study Kirton Adaptation Innovation Inventory, developed by Kirton (1976). They were applied as pre- and posttest. Additionally, as posttest, Thinking Link Test, developed by the researchers, was used.

3.3.1. KAI Inventory (Kirton Uyumcu-Yenilikçi Envanteri)

Before the administration of the KAI inventory, a validity and reliability investigation was carried out in Turkish version. KAI was firstly examined for its English-Turkish translation with the help of four linguists. To determine understandability and accuracy, it was first administered to a group of individuals. After the pilot study, to obtain reliability and validity, a second application was carried out in a group of 354 individuals that includes university students, teachers, education directors and freelancers. The data obtained were analyzed in SPSS 12.0. Firstly, with analysis of principal component analysis varimax method, the items were classified into three

categories. Items classified in three categories, were the same as Kirton's (1976) original study and similar results were obtained.

The KMO value of the test was .828, Barlett's test was 3379,271 and total variants are %36,533. However, the announced variants were expected to be higher values in measurements having more them one factor. For this purpose, explanation under four factors was chosen. In that case, all the items expect rule/group conformity subscale were gathered under the same Sub-factor, five items in rule/group conformity was put under the 4^{th} category. The variant of the four factor measurement was found %42,179 and KMO value was .828. The Cronbach Alpha values of the originality, efficiency and rule/group conformity sub-measurements were found as .83, .82, .80, respectively. Furthermore, in every sub-dimension, in the comparison of upper group and sub-group, differentiation level of each item was found to be (p= .000) meaningful, (p.<.05) that was differentiate.

3.3.2. Thinking Link Test (TLT) (Düşünce Bağı Testi)

Thinking Link Test (TLT) is a test formed by gathering 80 key concepts related to education and mathematics education. Besides, the key concepts used in related literature, codes prepared by Kandemir (2006) were also used by the researchers. In his study, Kandemir (2006) drew a framework by taking creativity thinking in problem solving in mathematics education through divergent and an entire point of view. The outcomes obtained formed the structure of the study. Five field specialists and field education specialists expressed their opinions. The test was developed before the application to the individuals taking creativity training and pilot study was conducted. Firstly, the test was applied to the future teachers who haven't been given creativity program yet. The test was finalized after the necessary corrections according to the outcomes and opinions of the specialists. In the second step, the test was applied to do primary school and 34 secondary school prospective teachers. The comprehensibility and process of the test was tested. It was decided to apply the test in 70 minutes by taking the individuals' mind mapping formation period into consideration.

The aim of the TLT is to make the individuals form new and different concept map(s) between problem solving, creativity and mathematics education by using the concepts formed meaningfully by themselves during test and after training.

3.4. Data Analysis (Veri Analizi)

3.4.1. Data Analysis of KAI (KAI'nin Veri Analizi)

The pretest and posttest scores obtained from KAI were analyzed with relation test. As there is not a significant difference between the scores obtained from KAI in pretest-posttest, (p< .05) the test scores of each factor obtained from KAI and the mapping scores obtained from TLT was observed for relation. The regression analysis was carried out to determine the type and extend of relationship between the scores obtained from sub-dimensions of KAI and average scores obtained from TLT.

3.4.2. Data Analysis of Thinking Link Test (Düşünce Bağı Testinin Veri Analizi)

There are studies on the scoring of concept maps in related literature. In this study, adapting concepts related to mathematics education and creativity together was necessary with the help of concept maps for the first time. An original scoring instruction was prepared for this purpose, during this process, the suggestions of

five field and field education specialists were taken. Scoring instruction was given in Table 1.

The analytical scoring instruction prepared for scoring TLT consisted of three sub-dimensions. These were the usage of key concepts, relating the key concepts with each other and explanation of related concepts. Each sub-dimension varied from 0 to 6 points. The highest point obtained was 18.

Table 1. Proposed scoring scheme for concept maps
(Tablo 1. Kavram haritalarının puanlanmasında kullanılan puanlama şeması)

Categories	Detailed Descriptions	Points
The Usage of Key Concepts	It's blank or using concept randomly	0
	Using less than half of the total key concepts.	1
	Using key concepts between 41 and 55.	2
	Using key concepts between 56 and 70.	3
	Using more than 71 key concepts.	4
	Using by adding key concepts.	5
		6
Relating	Meaningless or incorrect relation.	0
	Nearly half of relations established are invalid or lacking.	1
	Misclassification of 2 upper, 2-4 sub concepts due to relationships established between key concepts in creativity, mathematics education and education.	2
	Misclassification of 1 upper, 1-2 sub concepts due to relationships established between key concepts in creativity, mathematics education and education.	3
	Establishing only one way relations.	4
	As well as one way, also making diagonal relations.	5
	Relating to key concepts under creativity, mathematics education as a whole.	6
Explaining the Relations	Making no explanation.	0
	Making less than half of the relationships established or making false explanation.	1
	More than half of explanation is correct.	2
	The most of the explanations are correct but lacking.	3
	The explanations are generally correct.	4
	The explanations showing coherence.	5
		6

The concept maps formed in TLT were analyzed in accordance with three sub-dimensions. In correct use of the key concepts, the level of using as many concepts as possible was paid attention to, with regard to sub-dimension, the level of relating as many and divergent has taken into consideration. In the explanation of relations, the accuracy of explaining the relationships formed was examined.

The individuals were divided into four groups in terms of achievement depending on the scores obtained from the test. First group consisted of unsuccessful relaters while the second included poor relaters. In addition, the third one consisted of moderate relaters while the fourth included good relaters. The score ranges were given in Table 2.

Table 2. The score ranges of TLT and styles of relating according to the scores
(Tablo 2. Düşünce bağı testinden alınan puanların dağılımı ve alınan puanlara göre ilişki kurma stilleri)

Score Ranges	Individuals' styles of relating
0-4.0	Unsuccessful Relaters
4.1-8.9	Poor Relaters
9.0-14.9	Moderate Relaters
15.1-18.0	Good Relaters

The concept maps of 16 prospective mathematics teachers were scored by four scorers. Three of those were subject and field specialists. The other was another field specialist. The scores given by the four scores to each teacher were given in Table 3.

The inter-rater reliability of scoring instruction between scores was computed both for the whole test and for the sub-dimensions separately with Cronbach Alpha Reliability Coefficient. The test was scored by four different people, including the researchers. In the analysis of total scores of the test, .923 was found as Alpha Reliability Coefficient. In the total scores, the lowest correlation between the scores is .511 and the highest was .943. The correlation between the scores in the sub-dimensions and Cronbach Alpha Values were shown in Table 3.

Table 3. Inter-rater reliability correlations
(Tablo 3. Puanlayıcı güvenilirliği katsayıları)

1. Sub-Dimension		Scorer 1	Scorer 2	Scorer 3	Alpha
Usage of Key Concepts (UKC)	Scorer 2	.725			.899
	Scorer 3	.454	.751		
	Scorer 4	.603	.880	.883	
2. Sub-Dimension		Scorer 1	Scorer 2	Scorer 3	Alpha
Relating Between Concepts (RC)	Scorer 2	.419			.888
	Scorer 3	.652	.655		
	Scorer 4	.690	.718	.845	
3. Sub-Dimension		Scorer 1	Scorer 2	Scorer 3	Alpha
Explaining Relationships Between Concepts (ERC)	Scorer 2	.809			.805
	Scorer 3	.620	.695		
	Scorer 4	.457	.481	.422	

The lowest correlation in the sub-dimensions of the instruction was between the first second scorer in the second sub-dimension (r=.419). The highest was between 3rd and 4th scorer in the 1st sub-dimension (r=.883). To add, The level of inter-rater reliability was obtained by scoring three (low, average, high quality) sample materials. The scorers made their scorings cooperatively and the scores obtained for three different quality materials were shown in Table 4.

Table 4. The scores obtained for the 3 different materials
(Tablo 4. KAI'nin alt boyutlarina göre 3 farkli materyale puanlayicilarin verdiği puanlar)

	Low Quality Material				Average Quality Material				Good Quality Material			
	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
UKC	1	1	1	1	3	4	3	3	6	6	6	5
RC	2	1	2	1	3	3	3	4	6	6	5	6
ERC	1	1	1	2	4	3	3	4	6	6	6	5

S= Scorer

The values given in Table 4 show that the material had a differentiating quality. In the table, the correlational values in the 3rd sub-dimension was lower than the other sub-dimension, the level of inter-rater reliability in Table 3 was quite high.

4. FINDINGS (BULGULAR)

While the points of participants of the study from the KAI were similar in pre- and posttest, their scores were between 104 and 124. Their scores were presented in Figure 2. The highest score in KAI was 145 and the mean was 96. Theoretically, the scores may change from 32 to 160 (Sim and Wright, 2002; Tullet and Kirton, 1999). The point determined whether the individual was a harmonious or innovative or not was 72. The individuals who had higher and lower than 72 in KAI were named as innovative and harmonious respectively (Tullet and Kirton, 1995). The scores the prospective mathematics teachers had were higher from the mean. This showed that they were moderate innovative individuals. Also, Table 5, the pre- posttest and mean scores of prospective mathematics teachers were classified in accordance with their genders.

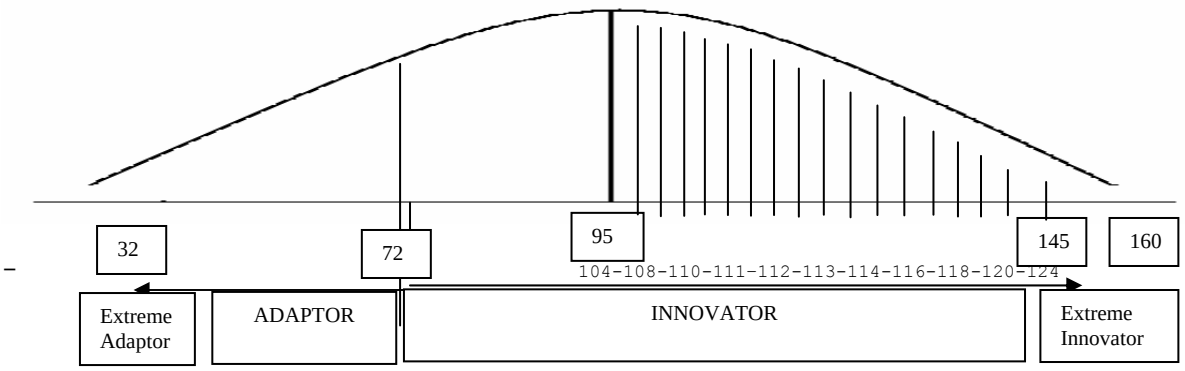

Figure 1. The score distribution of prospective mathematics teachers
(Şekil 1. Öğretmen adaylarının KAI envanterinden aldıkları puanların dağılımı)

Table 5. The score range pretest-posttest scores and means of prospective mathematics teachers according to gender
(Tablo 5. Öğretmen adaylarinin kai envanterinden aldiklari ön test-son test puanlari ve cinsiyete göre puanlarin dağilimi)

Gender	Pretest Scores		Posttest scores	
	Female(n=8)	Male (n=8)	Female(n=8)	Male(n=8)
Scores	108	104	108	104
	111	104	111	104
	112	108	112	108
	113	110	113	110
	115	110	115	110
	115	120	115	120
	117	124	117	124
	118	124	118	124
Mean ($\overline{X}$)	113.6	113	113.6	113

Examining Table 5, it was observed that the scores the female and male prospective mathematics teachers had from KAI didn't change and the scores of male and female prospective mathematics teachers were very similar. The similar scores showed that they had similar innovative characteristics. The mean score from KAI is $\overline{X}$=113,6. This finding showed that the sample group consisted of moderate innovative individuals.

Table 6. Four diffirent scores the participants get from the scorers and mean scores
(Tablo 6. Dört farklı puanlayıcının puanlamaları ve ortalamaları)

Participants	Gender	First Scorer	Second Scorer	Third Scorer	Fourth Scorer	Mean Score
1	Male	14	13	12	8	11.75
2	Male	13	13	10	11	11.75
3	Female	10	11	10	10	10.25
4	Male	7	7	8	9	7.75
5	Female	10	10	6	7	8.25
6	Male	8	8	8	6	7.5
7	Male	7	10	12	13	10.5
8	Male	8	7	7	9	7.75
9	Female	10	10	6	8	8.5
10	Female	7	8	6	6	6.75
11	Female	8	9	9	8	8.5
12	Female	13	13	15	12	13.25
13	Female	8	8	7	6	7.25
14	Female	12	12	10	9	10.75
15	Male	2	2	1	2	1.75
16	Male	6	8	6	10	7.5
Mean ($\overline{X}$) = 9.11						

According to Table 6, when the mean scores were considered, it was seen that the study group had an average level achievement. The participants were moderate level innovative. These moderate level innovative individuals also had an average level achievement in terms of general mean in relating to TLT. Whether there was a relationship between their mean scores in the Relating Concepts and KAI were observed and Pearson Correlation Coefficient, presented in Table 7, was computed.

Table 7. The relationship between achievement and KAI Scores
(Tablo 7. Başarı ve KAI puanları arasındaki ilişki)

	Achievement	KAI Score
Achievement	1	.678**
KAI Score	.678**	1

** p= 0.01

When Table 7 was examined, it was seen that there was a significant correlation between the achievement and KAI scores (p< .01). Namely, there is a positive correlation the variables (r= .678). As the achievements increased, the scores obtained from KAI also increased: Simple Correlation Analysis showed that there was a strong (positive?) correlation between variables. However, KAI inventory was a 3-factors measurement. In order to identify which the sub-dimension(s) caused the correlation, multiple regression analysis was done. The relationship between achievement scores and the sub-factors of KAI inventory, Originally, Efficiency, Rule Conformity was given the in following table.

Table 8. Multiple regression analysis results related achievement prediction
(Tablo 8. Başarıyı tahmin etmeyle ilişkin çoklu regresyon analizi sonuçlari)

Variable	B	Std. Error	β	t	p
Constant	3.898	8.802	-	1.443	.666
Rule Conformity	-.588	1.082	-.119	-.543	.597
Efficiency	-1.388	.933	-.278	-1.488	.163
Originality	3.212	1.210	.602	2.655	.021
R = .790	R^2 = .623				
$F_{(3,15)}$ = 6.624	p = .007				

In the Table 8, the prospective mathematics teachers' achievement scores with the variables, the Rule Conformity, Efficiency, and originality had a high-level and significant correlation (R=790, R^2=623, p=.007). The 3 sub-factors the 60% of the total variants are explained.

According to β regression constant, which was standardized, predictive variables' order of importance on TLT was Originality, Rule Conformity and Efficiency. Also, when the test about the significance of Regression Coefficient, it was seen that only Originality sub-dimension was a significant predictive while Rule Conformity and Efficiency do not have a significant effect.

According to the Regression Analysis Results, the regression equality on achievement prediction was (Mathematical Model) Achievement= 3.898+ 3.212 Originality- 0.588 Rule Conformity- 1.338 Efficiency.

5. RESULTS AND DISCUSSION (SONUÇLAR VE TARTIŞMA)

At the end of the study, a significant correlation was found between KAI scores and the ability to establish relations among key concepts. The reason of the relation's significance is that the correlation between achievement scores and originality, a sub-dimension of KAI inventory is high. Originality sub-factor is related to the number of innovative ideas and efficiency area. Adaptors usually prefer to produce fewer ideas and their ideas tend to be more reliable and practical. Innovative individuals, on the other hand, produce a lot of ideas (Sim and Wright, 2002). Their ability to

establish lots and divergent ideas enables the innovative to increase their achievement scores, as well as to present their creativity styles. The future teachers gained the ability to think divergently through the creativity program and showed it in their achievement scores.

A creative mathematics teacher, first of all, should be an innovative individual. The development of students' creative thinking in math education based on the ability of mathematics teacher to do divergent thinking exercises (Ediger, 2000) and his open-mindedness (Barak and Goffer, 2002). As long as a mathematics teacher can come over mental, comprehensive, environmental and emotional barriers, which obstruct creativity (Adams, 1986; Evans,1991; Vidal, 2004), fixation in problem solving (Haylock, 1987), he can carry out activities supporting creative thinking in mathematics education. As a result, the innovative style of thinking will be used in the techniques and education he follows. In other words, he can take on a developer role in creative thinking by keeping his mind open to new ideas.

Another result of the study is that when the prospective mathematics teachers participate in a program containing creativity, they succeed by monitoring their innovative characteristics to the program. The fact that both male and female prospective mathematics teachers have similar achievement scores indicates that gender is not significant variable in an individual's keeping his/her mind open new ideas. A male or female teacher can continue his/her will to learn and apply new things as long as she/he is innovative.

It is very important for a prospective mathematics teacher to be innovative because education field is not static. Education always changes as new methods and techniques are developed and applied. The knowledge she/he gained at university can only be transferred by an innovative teacher in questioning and developing the techniques during course. A teacher who adapts the knowledge learnt at university without any changes and who is not open to innovations and changes will not be sufficient for the development of the students. In conclusion, this study indicated that there is no change in the individuals' innovative traits but it showed they can come over challenging and the situations they have encountered for the first time successfully by enabling them to use their original ideas producing ability which is their most important characteristic.

5.1. Implications of the Study (Çalışmadan Elde Edilen Sonuçlar)

There is a continuing change in the field of education. The application of new programs and education techniques, the differentiation of people's educational purposes are the results of these changes. The innovative characteristics of a teacher who has innovative characteristic can have an important role in forming his/her own role according to the changes made in field of education. An innovative mathematics teacher not only feels the need to change his role in application of mathematics programs but also needs to change and develop the existing mathematics programs permanently. One of the most important characteristics of mathematics teacher is that he can use his own innovative characteristics in math education with the change of mathematics programs.

This study showed that moderate innovative math teacher had average achievement scores in a situation they encounter for the first time. Therefore, overcoming the new situations or achieving them is direct proportion with the individuals' innovative characteristics. This results in, thus, we should give courses which can improve the future teachers' innovative characteristics in teacher education

programs. Also, we should form different mathematics education applications and new situations challenging them. In the result of the study, the high correlation between originality sub-dimension and the result of TLT show this relationship. The study supported innovative changes in the field of teacher training.

It showed how important innovative characteristics in teacher training, because the pedagogical content knowledge given at university loses ground in a long time span. To show developments, they must be educated with an innovative approach. It is helpful to take individuals' innovative characteristics and elements to improve those characteristic into consideration during preparing teacher education programs. In addition, secondary school mathematics programs must construct flexibility in order to help them their innovative characteristics.

5.2. Further Research (Gelecek Çalışmalar)

In this study, an education program was assessed and the individuals' innovative characteristics used creative traits when they confronted new situations were investigated. In further studies, how future mathematics teacher reflected their innovative characteristics onto the mathematics education should be examined. Specifically, the variables affecting their reflection of innovative characteristics can be researched. How an innovative mathematics teacher can be educated can also an area to investigate.

Further research on educating innovative future teachers in all courses is quite important in education. In this respect, it will be useful to carry out studies in all disciplines for this purpose. On the other hand, it will be relevant to question the relationship between the innovative traits of teachers giving courses and the students' approaches and their achievement.

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