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Effect of Activities Prepared by Different Teaching Techniques on Scientific Creativity Levels of Prospective Pre-school Teachers

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Abstract: The purpose of this research is to evaluate the effectiveness of the activities, which are prepared by teaching techniques that support scientific creativity, on the scientific creativity levels of prospective pre-school teachers. In the research, combined design is used, which is one of the mixed research approaches. The study group of the research included a total of 46 prospective pre-school teachers who have studied in the Education Faculty of Kafkas University in 2016-2017 academic year. The applications were carried out in the "science education" which is one of the third-grade 5th-semester courses of the pre-primary education program. The application process was completed in 4 hours a week for a total of 40 hours. In the analysis of the quantitative data collected by Scientific Creativity Test, percentage calculation and t-test were used. Explanatory and inferential codes were used in the analysis of qualitative data obtained from the in-class observations. As a result of the research, it was seen that the course activities in which different techniques were used positively influenced the scientific creativity levels of the prospective teachers. Prospective teachers' level of skills involved in creative trait, creative process, and creative product sub-dimensions also developed. It has been suggested in the direction of these results that different techniques should be used together to develop scientific creativity.

Keywords: *Scientific creativity, pre-school prospective teachers, science education, instructional techniques supporting scientific creativity.*

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Introduction

Individual creativity skills are closely related to the future of a society. Individuals with creative thinking skills can bring different perspectives to events, innovate and become easier to adapt to innovations. For this reason, the training of the individuals who can produce new ideas started to come to the forefront in science education (Ozdemir & Dikici, 2017). The concept of creativity can manifest itself in different areas under a general roof. In this context, it is necessary to understand the scientific creativity, which is an important area of individual scientific competence (Hu et al., 2013; Liang, 2002; Ozdemir, 2013). Scientific creativity, which is referred as creativity in science education, is expressed as a personal ability that is prone people to design different and useful products that are necessary to produce scientific ideas, theories, methods or findings (Aktamis & Ergin, 2006; Grosul, 2010). Scientific creativity can also be explained by the ability of individuals to develop their perceptions of the world when original ideas are considered to have a role in altering and improving the ideas of the natural world (Antink Meyer & Lederman, 2015).

Research has shown that the role of creativity in science education has become more important in recent years (Barrow, 2010; Schmidt, 2010). However, it is also noteworthy that the work in this area did not reach the desired level (Liang, 2002; Summak & Aydin, 2011). When the relevant literature is examined, it could be seen that the effects of the teaching processes (Aktamis & Ergin, 2007; Aksoy, 2005; Cheng, 2004; Demir; 2014; Demir Kacan, 2015; Hu and et al., 2013; Laius & Rannikmae, 2005; Lin, Hu, Adey & Shen, 2003; Ngaewkoodrau & Suwwannoi, 2009; Kadayifci, 2008) designed for different purposes or for the development of creative thinking (Karatas Ozturk, 2007; Kadayifci, 2008; Koray, 2005; Kurtulus, 2012; Rabanos & Torres, 2012) for science lessons on the development of scientific creativity were investigated.

As can be seen from the research, scientific creativity skills that exist in students can be improved with a structured science teaching. Students with advanced scientific creativity skills can make a useful product by making their science

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education become functional. For this reason, it is stated to be necessary to support the development of scientific creativity of children from early ages (Koray, 2003). Beginning in the pre-school period to support scientific creativity skills is paralleled by the need to "develop the imagination and creative thinking skills of the students" in the basic principles of pre-school education (MEB, 2013).

The scientific creativity of pre-school teachers needs to be developed in order for students to have these desired skills. Teachers, who are aware of the importance of creativity and strive to develop it, can raise individuals who can think creatively. It is stated that the efforts of the teachers to take into account the scientific creativity of their students and to improve the quality of the science education can also contribute to the training of qualified thinking individuals (Orcan, 2013). The support and development of young children's imagination skills will contribute to the development of their scientific creativity (Lee & Kemple, 2014). However, research has shown that teachers are aware of their role in the development of scientific creativity of students, but feel that they are inadequate in confidence because they consider their knowledge insufficient in this area (see eg. Kampylis, Berki & Saariluoma, 2009). Some teachers stated that they did not give students enough chance to improve their creativity in their lessons (Inel Ekici, 2016).

The use of different methods and techniques in lessons can make learning processes more interesting, exciting and effective (Demir & Sahin, 2014). On the other hand, some techniques can both encourage or weaken students' creative thinking (Dikici & Soh, 2015). It is stated that brain blooming teaching techniques (Mirzaie, Hamidi & Anaraki, 2009), creative drama applications (Sedef, 2012), science games and toys (Demir Kacan, 2015) have positive effects on the development of scientific creativity. It has been seen that these studies in the literature often focuses on a single technique, and there is very limited research involving multiple learning techniques (Candar, 2009; Kiras & Bezir Akcay, 2016). It is understood that Candar (2009) used the Torrance Thinking Test as a measurement tool and examined the students' overall creativity. At the same time, it could be seen that this study was designed on the relationship between the relevant teaching techniques and motivation, achievement, and attitude. Kiras and Bezir Akcay (2016) designed these researchers to examine the influence of related teaching techniques on scientific creativity. However, both researchers preferred primary school students as a study group. In light of the literature, it seems that the studies aimed to develop scientific creativity by using multiple techniques together, carried out with prospective pre-school teachers and dealing with qualitative and quantitative data together are inadequate. In this context, it is thought that these research data on prospective pre-school teachers will shed light on these shortcomings in the literature.

Purpose of the research

The aim of this study is to evaluate the effects of the lessons prepared by different teaching techniques on the scientific creativity levels of pre-school prospective teachers. Based on this general aim, the following questions were asked:

1. How are the scientific creativity levels of prospective pre-school teachers?
2. How was the scientific creativity of prospective teachers changed after the lessons conducted with activities prepared with different teaching techniques?
3. What were observed during the implementation process of the research?

The Importance of the Research

There are lots of researches on creativity and how creativity should be supported, which is an important issue for the progress of society (eg Rubenstein, McCoach & Siegle, 2013). The common output of the researches is the difficulty of developing the creative skills of the individual and that the process requires a long time (Barnes & Shirley, 2007, Kaptan & Kusakci, 2002, Sahin Pekmez, Aktamis & Can, 2010). In some studies, it is stated that the training of the teachers in their classes will support the development process of the creative skills of the students, and may even be accelerated and brought them to higher levels (Erdogan, Akkaya & Celebi Akkaya, 2009; Orcan & Kandil Ingec, 2015). It is stated that teachers can have a positive effect on the students at the point of being able to influence the students' creativity and to allow them to produce original ideas with the values given to their students, with the behaviors they exhibit and with the views of life (Lim & Smith, 2008; Soh, 2015). Considering that creativity is a process that needs to be supported from an early age, the prominence of the creative skills of pre-school teachers in the first stage of formal education emerges (Oliveira & Gallardo Echenique, 2015).

Summak and Aydin (2011) and Argun (2012) stated that; a teacher with the creative personality traits; can support children's learning and cause them to gain experience in exploring with the planned science activities. The creative teacher can prepare classroom environments that encourage the student to be active and free to think. These classroom environments can encourage students to relationally think among concepts, imagine, solve problems differently, to be able to make different estimates and to be able to put forth new thoughts by considering other people's ideas (Argun, 2012; Summak & Aydin, 2011). The creative individual is the person who is flexible, fluent, sensitive to situations outside him, and chooses the original instead of the usual methods (Argun, 2012). Newton and Newton (2009) have shown that the creativity of teachers is inadequate and they are not able to solve creativity in all dimensions. In this context, it is thought that the prospective teachers should also be examined in view of their education at the undergraduate level.

Prospective pre-school teachers take a course called 'Development of Creativity' which is based on the development of general creativity in education at the undergraduate level. It was explained in the previous section that the scientific creativity which was the scope of this research was different from general creativity. For this reason, the design of an effective science education course that contributes to the development of scientific creativity has been given priority. It is believed that a science education supporting scientific creativity can give prospective teachers a realistic perspective on knowledge (Shanahan & Nieswandt, 2009).

This research is important for the prospective teachers to realize that they have the potential of constantly creating in the scientific areas and to allow them to give their students this awareness. On the other hand, the use of many techniques that effective on both the sample group and creativity in a study increases the importance of research. The activities used in the research are also suitable for use by teachers in different fields.

Methodology

In this research, the importance of qualitative and quantitative data is emphasized equally because the development of prospective teachers in the level of scientific creativity is dealt with in detail. Combined design has been used as a concurrent mixed research pattern to fit the nature of work (Creswell, 2017). Since the study group participating in the research was assessed in detail in itself, a single group was studied.

Participants

The study was carried out in the "science education" course in the 5th semester of the third year constitutes with a total of 46 prospective teachers (35 girls, 11 boys) who are studying at the Pre-Primary Education of Basic Education Department of Kafkas University-Education Faculty in 2016-2017 academic year. A purposeful sampling approach was used in the selection of prospective teachers. It is preferred that this sampling technique be used in special situations with certain criteria and characteristics (Buyukozturk, Cakmak, Akgun, Karadeniz & Demirel, 2014). In this study, prospective pre-school teachers who will take science education course were determined as a research group.

Data collection tools

Scientific creativity test

The 'Scientific Creativity Test (SCT)' used in the research was developed by Hu and Adey (2002) and adapted to Turkish by Denis Celiker and Balim (2012). Originally, it is stated that the questions of this test developed for primary school students are also suitable for other student levels due to their contents (Hu & Adey, 2002).

The test includes seven open-ended questions that measure the sub-dimensions of the Process, Trait, and Product main dimensions of the Scientific Structure Creativity Model (SSCM). These questions were designed to measure "unusual uses", "problem finding", "product development", "scientific imagination", "problem solving", "science experiment" and "product design" skills.

Classroom observations and observation notes

The development of the prospective teachers related to their creativity skills was observed by the researcher during classroom teaching practices and recorded as observation notes.

During observation, researchers have difficulty in how to record details and in which way. For good analysis, all that observed should be recorded. Camera recordings were also used for classroom teaching practices in line with the permission of prospective teachers. At the end of each lesson, observations were edited based on the camera records. The materials that the prospective teachers developed in the lessons and the ideas about the process were taken into consideration during the analysis of the observation data. Prospective teachers visual materials can be used to support or confute the results gathered from the observations, or to provide alternative explanations to obtained results (Yildirim & Simsek, 2016).

Collection of data

The research was completed in a total of 40 hours, 4 hours per week. Lessons with pre and post tests were excluded from this time. In the pilot study, which was completed before the research period and lasted for 6 weeks, the actual implementation process was carried out by making necessary arrangements.

The activities used in the lessons were organized in accordance with the Scientific Structure Creativity Model (SSCM), with the emphasis on "creative product (technical product, science knowledge, scientific phenomenon and science problems), creative process (thinking and imagination) and creative trait (fluency, flexibility, and originality) dimensions. In lessons where imagination and divergent thinking were front-line, activities that incorporate techniques such as concept caricature, conceptual network, brain blooming, case study, mind map, quality ranking, cartoon filling, creative drama, role-playing, dull image, six action shoes, story completion, acrostic, station technique, creative problem solving and scamper, which is supposed to support the development of scientific creativity, were used according to the feature of the subject. The first two weeks of the program were held in the form of the presentations of teaching techniques supporting preliminary information and scientific creativity.

During the implementation process, a free and democratic classroom atmosphere was created, away from the press, without any comparison, where each opinion was valued and prospective teachers were made to feel this situation.

Adequate time was given to prospective teachers in the process of producing a new product or idea, and the topics they were excited were supported. Throughout the entire implementation process, questions such as "What do you think?" "What else could it be?", "What would it be?" were used. Some of the activities were carried out individually, while others were conducted as group work. During the teaching process, the prospective teachers were encouraged to design something, make something new by themselves, and facilitated their access to knowledge.

Analyzing of data
Analysis of data obtained from scientific creativity test

While the answers given by the prospective teachers to the questions in the scientific creativity test were scored, all their ideas were examined and the answers with the same idea but in different expressions were grouped in the same category (Kurtulus, 2012). The scoring of the questions was detailed in Table 1.

Table 1. The Details of Scoring of the Test Questions

Questions	Scoring
Question 1, 2, 3, 4	1 point for each response (fluency score) +1 points for each of the different implementations (flexibility score) 2 points for each response revealed by less than people of 5%; 1 point for between 5% to 10% (originality score)
Question 5	3 points for each response revealed by less than people of 5%, 2 points for 5% to 10%, 1 point for more than 10% (integration of fluency and originality).
Question 6	For each method introduced, a maximum of 9 points (3 for instruments, 3 for principals, 3 points for process sequence). If a response contains two complete methods, a total of 18 points. In addition, 4 points for methods with less than 5% of all answers, 2 points between 5% and 10%
Question 7	3 points for each function of the designed machines. In addition, based on the overall impression, an originality score of 1 to 5

As can be seen in Table 1, the Scientific Creativity Test questions were scored according to the fluency, flexibility and originality dimensions. The analysis of the answers was done by three researchers and scored in terms of common opinion. The score for the expression "what would you do if you were able to make an ordinary bike more interesting, more useful, and more beautiful" in Question 3 of the test was given as an example in Table 2.

Table 2. Scoring for Question 3

Category	Answers	n	%	The score of originality
Usage way	Running by its own	8	17.4	0
	Running by hand	2	4.3	2
	Running with brain waves	1	2.2	2
	Running by remote control	1	2.2	2
	Running by voice command	4	8.7	1

As shown in Table 2, it is seen that the originality score is 2 points for each response given by less than 5%, 1 point for between 5% and 10%. Additionally, 1 point was given for each response as a fluency score, and 1 point was given for each different application as a flexibility score. In addition, when the scoring system is examined, it appears that there is not a maximum score that can be taken from this test. In short, the points to be taken from the scientific creativity test vary completely depending on the creativity of the prospective teachers. A dependent t-test was performed for the scores obtained from the pre/post test of the prospective teachers.

Analysis of observation data

Explanatory and inferential codes generated during the analysis directly from the data were used in order to explain the collected data and reach the associations (Miles & Huberman, 1984, Yildirim & Simsek, 2016). Since the first and most important part of the analysis was the coding of the data, the data were read in detail and the important locations within the scope of the objective were identified and codes were created. This code list created a conceptual structure when the data were processed. In addition, personal documents were used in the direction of pre-determined codes, supporting observational data, and allowing for incorrect and alternative explanations.

Ensuring validity and reliability

Ensuring validity-confidence related to scientific creativity test

The reliability of the original test was 0,893 (Hu & Adey, 2002), the internal consistency coefficient of the Turkish version test was 0.86, and the test re-test correlation was 0,91 (Denis Celiker & Balim, 2012).
In this study, a change was made in the seventh question of the test, in order to be fit to the nature of the study. In the original test, while students were asked to draw "apple picking machine", prospective teachers were asked to draw “a machine that would make the teaching profession easier". The test was then applied to 71 undergraduate students and the factor loadings of the questions were calculated. For factor load values, 0.45 and above are accepted as a good measure (Buyukozturk, 2008). The reliability of the test was found to be 0.61. For the tests with a low number of questions, the acceptable value for reliability was determined to be 0.60 and above (Sipahi, Yurtkoru & Cinko, 2006).

Ensuring validity-reliability related to qualitative data

Consistency in terms of internal reliability to ensure the reliability of qualitative data; and in terms of external reliability, conformability methods were preferred (Yildirim & Simsek, 2016). The reliability formula developed by Miles and Huberman (1984) was used for the reliability of the analysis of the observational data (Reliability: agreement/agreement + disagreement). Accordingly, the investigator analyzes the data and extracts the codes. A second academician specialist in science education who had knowledge about the subject but not in the research environment was given 10% of the research data and was asked to generate codes in accordance with their own evaluations. Relevance ratios between the researchers' ideas were determined and reliability analysis was conducted. It was understood that the encoding used in the analysis of the data was reliable because there was a relevance of over 80% between the codes (Johnson & Christensen, 2004). The findings of the research, however, were accepted in the hand.

Findings

Findings from scientific creativity test

The Scientific Creativity Test was applied twice as a pre-test and post-test to see the changes of the prospective teachers. The scientific creativity average scores of these applications were totally presented in Table 3.

Table 3. Average Scores for SC Pre / Post Test Questions

		Average Scores							
		SCT questions							
Test	N	Unusual Uses	Finding the Problem	Product development	Scientific Imagination	Problem solving	Scientific experiment	Product designing	Total
Pre-test	46	5.98	9.17	7.37	7.02	6.07	12.91	12.09	60.61
Post-test	46	8.89	14.49	10.15	12.04	8.00	21.87	15.07	90.46

When Table 3 is examined, it is seen that the scientific creativity of the prospective teachers participating in the research is different if the average scores of the pre and post-tests on the question base are examined. Dependent t-test analysis results of this difference were given in Table 4.

Table 4. Dependent t-test Analysis of Prospective Teacher' Total Pre and Post-Test Scores with Lower Dimensions of the Scientific Creativity Test

	SCT	N	$\overline{X}$	S	sd	t	p
Fluency	Pre-test	46	32.79	9.78	45	7.57	.000*
	Post-test	46	42.90	9.52			
Flexibility	Pre-test	46	12.15	4.30	45	11.86	.000*
	Post-test	46	19.57	5.36			
Originality	Pre-test	46	15.66	6.75	45	9.84	.000*
	Post-test	46	27.97	8.70			
Total	Pre-test	46	60.61	18.21	45	12.27	.000*
	Post-test	46	90.46	20.60			

*p<.05

It is seen that there is a significant difference between pre and post-test total scores for fluency (t(45)=7.57, p<.05), flexibility (t(45)=11.86, p<.05) and originality (t(45)=9.84, p<.05), which is from the scientific creativity test subscales of prospective teachers. However, there is also a significant difference between the total scores of the scientific creativity pre and post-test (t(45)=12.27, p<.05). According to the general average scores, it is seen that the prospective teachers who participated in the research have higher scores on the scientific creativity post-test ($\overline{X}$= 90.61) than pre-test scores ($\overline{X}$= 60.61).

Findings obtained classroom observations

Prospective teachers' classroom observations are presented to be supported by materials prepared in the classroom. In this context, examples of the applications of the synectic and mind map in which they presented concrete product were presented. In the synectic technique, prospective teachers were asked: "what is scientific creativity?" The answers of the prospective teachers listened and direct analogy, personal analogy, and convergence of opposites were directed in the order of the questions in the application steps. After these steps, the concept was redefined, and once again the same question was addressed. Some of the answers given by prospective teachers in the first and last stages of the study were given below.

First stage

PT5: *"Scientific creativity is about putting new ideas in the name of science".*

Last stage

PT5: *"It is the ability to look at with a different eye to a problem, an event or an object".*

When both answers of the prospective teachers are examined together, it is noticed that they both refer to originality. In the second definition, however, we can encounter creativity not only in generating an idea but also in problems, events or objects.

First stage

PT 16: "*Scientific creativity is to behave out of the ordinary in science education".*

Last stage

PT16: "*It is to pass free thought to practical life and to make additions to what exists".*

The first stage response of the prospective teachers was seen as follows; only originality was emphasized; in the last stage, the product and the process are handled together and the product development was also mentioned.

First stage

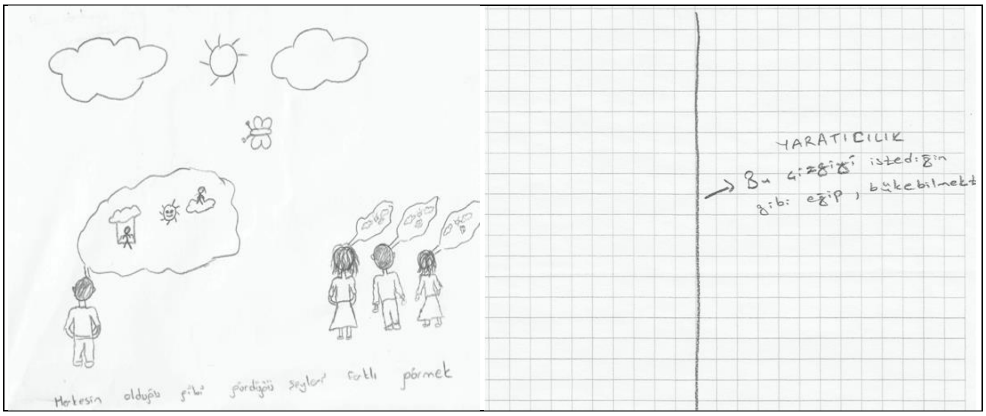
PT21: "*It is to put forth a new product with distinctive aspects".*

Last stage

PT21: "*It is all the ways for you to recognize yourself and follow the passage from the vanishing to the present".*

The prospective teacher made a product-oriented definition in the first stage and touched on the originality. At the last stage, he emphasized that there might be more than one way in the development of creativity while maintaining the place of product and originality.

It was observed that prospective pre-school teachers consider other dimensions besides originality for the concept of creativity and could give more comprehensive answers. In the process of introducing a specific work of synectic practice, the prospective teachers were required to make a unique drawing. It was observed that the prospective teachers had difficulties and unwillingness in drawing applications. Some examples from the drawings belonging to the prospective teachers were given below.



A *B*

Figure 1. Drawing examples of prospective teachers

While different people look at the cloud, the sun and the butterfly in the Figure A and see them as they are, another person sees, in the cloud, a rocking one in the swing or a smiling sun. *In Figure B, the concept of scientific creativity is explained as to be able to bent and flex a line as desired.* In this drawing, it is emphasized that even things which sometimes seem to be fixed or stereotyped may take different forms, which is totally dependent on human potency. The capability of thinking flexibly and originally for prospective teacher in this drawing is foreground.

Figure 2. Drawing of PT36 about the scientific creativity concept

It is understood that when he says 'a new creature' he emphasizes the originality of creativity and when he says ‘without thinking of the truth' he emphasizes imagination. When the drawing is examined, a new creature consisting of an elephant head, body of a cow and tail of a horse are seen. In the drawing, with the help of his imagination beyond reality, a living creature, which is much different and unique than the other creatures of which he has acquired properties, has formed.

In the mind mapping technique, the prospective teachers were requested to prepare a mind map about 'water' theme (14.10.2016). At the end of the process, mind maps were collected and all were projected and discussed on the board. In the last lesson of the applications, the prospective teachers were requested to prepare a new mind map without subject limitation (19.12.2016). The first and last mind map prepared by PT25 were shown in Figure 3

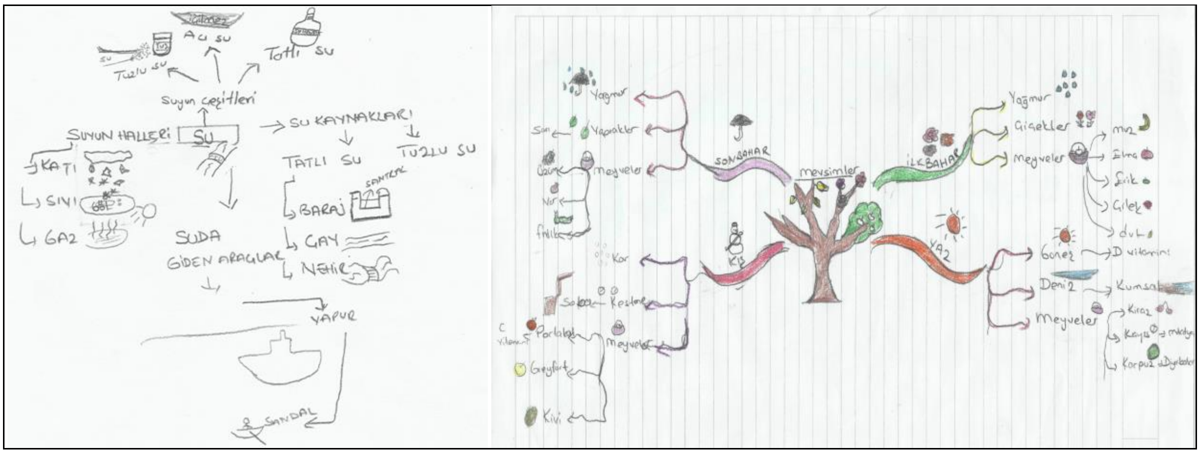


Figure 3. Mind maps of PT25

When Figure 3 was examined, it could be seen that PT25 preferred more straight lines in the first prepared mind map, and colored pencils were used in the last prepared mind map, thus allowing circular lines to be easily remembered. It was noticed that while PT25 preferred to express his thoughts in a certain boundary on the first mind map, he thought to be more comprehensive in the final mind map.

The first and last prepared mind maps of PT12 were given in Figure 4.

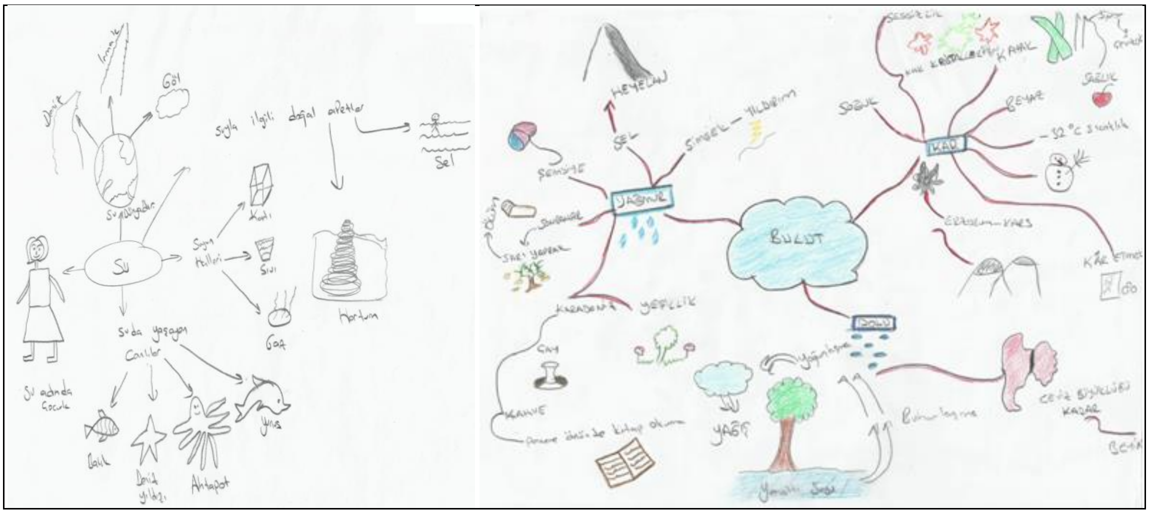
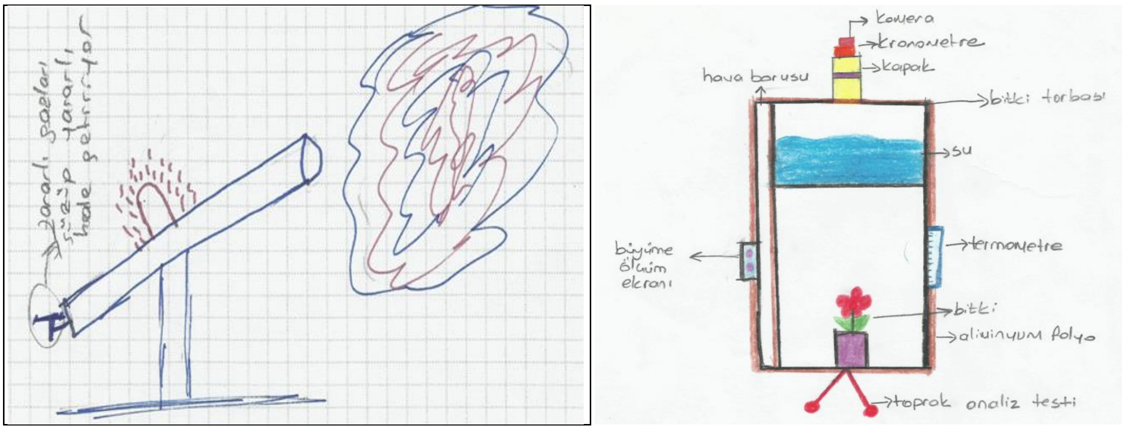


Figure 4. Mind maps of PT12

When Figure 4 is examined, it is shown that while the mind map of the PT12 contains sharp and straight lines, in the final mind map, it is seen that more circular lines are dominant. It was noticed that colors were in the foreground in the final mind map of PT12, so that the imagination power was used more actively. Unlike the first prepared mind map, it was thought that PT12 thought more detailed in the last mind map, stated the relations between concepts more detailed. Besides, PT12 imagined that the hail would fall from the cloud which is the main concept, that its full size could be as walnut, and likened walnut to the brain, thus it was determined that he provided an analogy.

On the development of product design skills, prospective teachers were asked to design a useful tool that could be used both in space and in the world (26.10.2016). Below are some examples of products designed by prospective teachers.



A B

Figure 5. Examples of the designed products

Examined A, it seems that prospective teachers designed a tool that sends signals when they detect harmful gases, absorbs them and turns them into useful ones. The prospective teachers performing the drawing mentioned that this vehicle could be used for car exhausts and factory chimney in the world. Prospective teachers referred to a single feature of the product. In Figure B, it appears to be designed a tool to observe plant growth in different soil types in the world and space. It was determined that in the prospective teachers' products they thought several features, such as recording the growth of the plant with the camera, measuring the temperature, determining the growth rate and time. A common data on the scientific creativity test of the prospective teachers and the development of scientific creativity from in-class observations were obtained, and these data were presented collectively in Table 5.

Table 5. Joint Output of Quantitative and Qualitative Data on Scientific Creativity

Dimensions of SSCM	Items of SSCM	Quantitative Data	Qualitative Data
		Questions of SCT	**Classroom Observation**
		Data Obtained from Prospective Teachers	**Data from Researcher**
Creative Process	Imagining	*Imagining	Imagining Divergent thinking Relational thinking
	Thinking	*Unusual usages	Analogical thinking Comprehensive thinking Different uses of objects
Creative Trait	Fluency	* Finding the problem	Offering lots of ideas Quick thinking
	Flexibility	*Solving problem	Being able to look from different angles Solving problem
	Originality	Designing product	Producing new idea
Creative product	Creative product	Product developing	Product developing Product designing
	Scientific knowledge		Gaining Scientific knowledge
	Scientific problem	*Scientific experiment	Making scientific research

* A significant difference was found between the pre and post-test scores of the prospective teachers participating in the research in SCT questions.

In the process of creative process of SSCM through imagination and thinking; prospective teachers' ability to 'imagine', 'different uses of objects', 'Divergent', 'relational', 'analogical' and 'comprehensive thinking' were frequently observed. For the fluency item of the creative trait phase of SSCM; they demonstrated their ability to 'make a lot of ideas' and 'quick thinking', for the 'flexibility' item they demonstrated to 'look at from different angles' and 'problem-solving' and for the originality item, they demonstrated to 'produce new ideas'. For the creative product phase of SSCM, 'Product development', 'product design', 'ability to do scientific research', 'ability to acquire scientific knowledge' were observed.

Discussion

In this research, science education course was conducted with activities prepared by teaching techniques that support scientific creativity and the development of scientific creativity of prospective pre-school teachers was evaluated. When the total scores of the scientific creativity test applied before and after the application were evaluated, it was seen that there was a meaningful difference and the scientific creativity of the prospective teachers was improved. Similar results have been obtained in the researches to determine the effects of learning techniques used in science teaching on scientific creativity of students (Cheng, 2004; Chiang & Tang, 1999; Karwowski & Soszynski, 2008; Mirzaie et al., 2009; Oztuna Kaplan & Ercan, 2011; Sedef, 2012; Suzen, 2007). In addition, supportive findings were obtained from the researcher's in-class observations about the development of the level of scientific creativity of prospective teachers. It is thought that the creativity of prospective teachers develops through the learning environment where the feeling of curiosity and discovery is actuated, each idea and thought is important and the learning environment where thought and imagination power are the forefronts. Kurtulus (2012) states that creativity is a time-consuming ability, and that time must be spent on activities that will improve creativity. In this research, it is thought that the courses conducted with the prepared activities with different techniques during a semester are effective for the prospective teachers to think differently, to introduce new ideas and to develop the high-level thinking skills. In addition, it was seen that the prospective teachers' classroom communication was influenced positively, they carried out the activities in cooperation and thus brought out new ideas. Frank and Buining (2007) found similar results in their research. They stated that individuals can bring innovative and original solutions in collaboration, with creative thinking to the problems they encounter in daily lives. In another research, peer relations were shown to have a positive effect on creativity (Karwowski, 2015). Alsahou (2015), on the other hand, stated that group work in which the exchange of ideas is active is important for the exchange of ideas to support the development of creativity. This study included group work due to the nature of some of the techniques involved in the activities during the applications. Through group work, it was observed that prospective teachers exchanged ideas more intensively with other friends who had little communication. It can be thought that this situation strengthens their communication among themselves so that more unique ideas emerged with the blending of mutual ideas.

It was determined that the prospective pre-school teachers described scientific creativity in the following way; it is that individuals can think differently, originally and flexibly by adding something from themselves; that individuals are aware of their own potentials and can develop a product with the help of mental processes and imagination, or design a new product. In classroom observations, it was understood that prospective teachers who described and drew scientific creativity emphasized a mental process. Oztuna Kaplan and Ercan (2011) stated that students thought that mental factors were effective when defining scientific creativity. In this research, it was determined that the prospective teachers were interested in the originality in scientific creativity. Demir (2015b) reached a similar conclusion and stated that prospective teachers often referred to originality when describing scientific creativity. Park (2011) explained that creative thinking was an important aspect of scientific creativity. Another consequence of this research was that prospective teachers related to finding solutions to the problems in the definition of scientific creativity. Demir (2014) stated that scientific creativity was the ability to produce original ideas using a multi-disciplinary and innovative approach in different fields for the solution of a problem.

In general, the lack of a clear definition of creativity appears to be reflected in the expression of prospective teachers. When the definitions are examined, it can be said that prospective teachers tend to have a superficial perception for scientific creativity. Research in the literature supporting this conclusion suggests that many teachers are having difficulty in expressing what scientific creativity is in reality (Andiliou & Murphy, 2010; Cheung, Tse & Tsang, 2003, Demir, 2015a, 2015b, 2015c). During the course of the application, rather than providing the definition of scientific creativity directly, ensuring that prospective teachers make sense it with their own experiences may have influenced the understanding of the basic features of scientific creativity positively. On the other hand, that pre-school prospective teachers have recently encountered scientific creativity (Liang, 2002; Ozdemir & Sak, 2013), which is different from the general creativity and expressed as science-related creativity, is considered as the basis of superficial perceptions of the concept.

When the development of prospective teachers in scientific creativity sub-dimensions is examined, the increase in fluency is remarkable. Candar (2009), in his research on the effect of creativity in science education on the development of creativity, determined that the subscales of the test indicated that the scores of fluency in the experimental and control group students differed significantly. Karwowski and Soszynski (2008) reached the conclusion that the role-playing technique significantly changed the fluency scores of the students. Obtained from observational findings, the prospective teachers' quick thinking and their ability to express a large number of ideas support this development in the dimension of fluency. The inclusion of teaching techniques such as synectic, scamper, qualification and station in the applications suggests that the prospective teachers have influences on fluency skill levels which is the sub-dimension of scientific creativity. Nevertheless, it can be said that constantly facing with different problem situations throughout the process caused prospective teachers to think fast and introduce new ideas in a limited time. Environments were constantly prepared, where allow prospective teachers to raise multiple ideas with questions such as "what else could it be?", "Do you have any different ideas?", "What would it be like?".

The development of prospective teachers' flexibility skills was also seen to increase. Studies reveal that education based on creative thinking (Koray, 2005) and active learning methods (Kiras & Bezir Akcay, 2016) have a significant effect on students' flexibility skills. In this study, it was determined that the prospective teachers had the ability of flexibility to produce solutions and to look at the problems from a different perspective. Celebi Oncu (2014) stated that the ability to think creatively and find creative solutions to the problems is effective in increasing the quality of life of individuals. It can be considered that the inclusion of techniques such as six action shoes, role-playing and creative drama influenced the prospective teachers' flexibility ability which is a sub-dimension of scientific creativity. In the courses where different techniques are involved, it can be said that the ability of prospective teachers to adapt to different approaches improved. It was seen that prospective teachers with adaptive ability could handle the events in different ways and bring new solutions to the problems they encountered.

Candar (2009) found that creative thinking-based instruction had a significant impact on the development of students' original skills; and according to Karwowski and Soszynski (2008), the techniques of role-playing; to Kiras and Bezir Akcay (2016) the methods of active learning had similar effects. In this research, it was seen that the prospective teachers developed their skills in the dimension of originality to put forth new ideas. Creative activities are effective in introducing a new product that is different from others (Aktamis & Ergin, 2006). It is thought to be effective that the different teaching techniques in this study are planned to produce a unique thought or a product. Prospective teachers participating in the research forced themselves to think while conducting the activities and they tried to put new things into the process. It can be said that in the direction of the observations, it is possible for the prospective teachers to develop these skills by being directed by the researcher to produce continuously. Davies et al. (2014) and Rubenstein et al. (2013) emphasized the importance of schools and teachers for the development of creativity. Teachers can positively influence the development of creative thinking skills for their students by designing learning environments for different teaching methods and techniques, by encouraging them to express their thoughts and by supporting high-level thinking skills (Inel Ekici, 2016). In this study, the researcher tried to create a learning environment in which was far from repressive and dulling behaviors and there was healthy communication. Listening and appreciation of the ideas of the prospective teachers may have motivated them even more. It is thought that the science courses in which they have the high level of motivation and knowledge are influenced positively by scientific creativity levels.

Another result obtained in the research is that the score of scientific creativity post-test fluency level is the highest and the score of flexibility level is the lowest. This result, obtained from the total scores, seems to be supported by other research results as well. Cetingoz (2002) determined that the highest value in the total points taken in the study conducted by pre-school prospective teachers belongs the level of fluency. Ersoy and Baser (2009) examined the students' creative thinking levels and found that the fluency scores of the students were maximum and the flexibility scores of them were minimum. In all of these studies, it is understood that prospective teachers, including this study, can present a large number of new ideas in the case of events or problems they encounter, but they can experience difficulty using these skills to handle events from different angles.

According to the research findings, it was found that the prospective teachers' views on the different uses of the objects as well as their comprehensive, relational, detailed, divergent and analogical thinking skills were improved. Oztuna Kaplan and Ercan (2011) reached the conclusion that applications prepared with synectic technique positively affected the level of students' analogical thinking. Seligmann (2007) mentioned the existence of analogical thinking among the sub-dimensions of creativity. Lin and others (2003) pointed out that the main objectives of science education are to produce new ideas that come with divergent thinking. Teaching techniques, such as a scamper, may have led prospective teachers to use the objects for different purposes or may have guided them to use instead of each other. Besides, it is thought that the synectic technique has positive effects on analogical thinking, conceptual network on relational thinking, quality order on divergence thinking, and six action shoes on comprehensive thinking. With these techniques, prospective teachers may be supported to run their minds, to get rid of their thought templates, to deal with the issues in a more comprehensive and detailed way and to relate them to each other. It can be said that these techniques are also effective on prospective teachers' imagination skills. Broinowski (2002) found that a pre-school education program, in which pre-school teachers and imaginative skills and creativity skills were supported, was strongly related to each other. Kind and Kind (2007) and Kurtulus (2012) emphasized the significance of imagination, the most important of mental skills, in order to produce new ideas in teaching practices that support creativity.

Another finding of the research is the development of prospective teachers' product development skills. The development of the ability to add new features or parts to existing products and use them for their own purposes or for new purposes, and the ability to think high through some techniques such as scampering, qualification sorting in the process can be explained by the fact that prospective teachers whose abilities has been developed no longer see any object only with its features.

Conclusions and Recommendations

In this research, planned activities in a certain period of time were achieved with the result that prospective teachers' scientific creativity ability could be developed. In the prospective teachers, the determination of the idea that creativity is an enhancement skill supports this end result. Prospective pre-school teachers who think in this way will make an effort for the development of the creative skills of them or their future students.

In addition, prospective teachers' ability to think in different ways also improved. Science education courses were conducted with a variety of techniques, such as six action shoes, story writing, creative drama, so that they could get out of the mental patterns of the prospective teachers. Efforts were made to change the perceptions of events or situations that allow them to think one way.

It was found that the science teaching courses run by various techniques keep the curiosity and exploration feelings of the prospective teachers alive and thus contribute to the development of creativity. Lessons carried out by teaching techniques that support scientific creativity enabled prospective teachers to positively influence classroom communication and interaction and enabled them to produce new ideas and share opinions with ease.

It was determined that the fluency, flexibility and authenticity skills of the prospective teachers' scientific creativity in creative trait sub-dimension also improved in the positive direction. It was determined that prospective teachers could present multiple ideas about the situation or problems encountered with teaching techniques such as cinematography, scamper, qualification sorting, and station. It was determined that the ability of students to adapt to different approaches by developing techniques such as six action shoes, role-playing and creative drama could find new solutions to the problems encountered by developing and dealing with events in different ways. It was seen that prospective teachers were developed in terms of the level of scientific creativity fluency, and their level of flexibility was improved the least. Prospective pre-school teachers were able to produce a large number of new ideas when compared with new events, but they were found to have problems in handling the events from different angles.

It was determined that the level of imaginative skill in the creative process sub-dimension of prospective teachers was positively developed. It was determined that the activities prepared by teaching techniques that support scientific creativity in science education course had positive effects on the unusual uses of prospective teachers in scientific creativity process sub-dimension and product development skill levels in creative product sub-dimension. It was thought that prospective teachers developed these skills because they could not perceive the objects or objects with the specified properties and add new features or functions to them for their own purposes or for a different purpose, and use them interchangeably.

In the light of these results, it is seen that giving the related techniques in lessons like science education which hosts abstract concepts is important for the development of the creativity levels of the students. The positive effects of the fluency ability of teaching techniques such as synectics, scamper, quality ranking and station to be used in science courses require an effort to diversify them in the next field, taking into account this consequence. Developing the flexibility skills of students in pre-school science education with applications such as six action shoes, role-playing and creative drama, which are preferred as teaching techniques, requires increasing the number of types of activity related to this field. For this reason, it is suggested to focus on these techniques more frequently in the training of teachers who will work in pre-school science education. In the training of pre-school prospective teachers, care should be given to ensure that these students should be self-confident, courageous individuals who can perform new and original practices, not merely individuals who fulfill ready-made practices in the training of pre-school prospective teachers, and programs should be prepared for this purpose.

Mental qualifications in pre-school science education should be maintained on an ongoing agenda and increasingly required to include work such as qualification, six action shoes, and story completion. For this, keeping processes active including imagination skills, to leave free time for prospective teachers, to allow for free thinking and to encourage imagination should be supported. On the other hand, it should be kept alive with the questions to produce an original thought.

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