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The use of creative problem solving scenarios in mathematics education: views of some prospective teachers

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Abstract

The purpose of this study is to examine what the prospective mathematics teachers who participated in creative problem solving training have learned during the process and to get their opinions at the end of the training. 51 prospective mathematics teachers who are in the 5th year in secondary mathematics education department. Purposed sampling was used in this study. As a data collection tool, semi-structured interviews and diaries were used. The data obtained was analyzed using content analysis. As a result of analysis of data “Creative Problem Solving in Mathematics Education” was found as the main theme. 10 sub-themes were found as sub-themes; “Perception of Creativity, Perception of Creative Problem Solving and development of it in the process, Attitude towards Creative Problem Solving Training, Contribution to Problem Solving, Contribution to Learning, Attitude towards Mathematics, Creative Class Environment, Closed ended questions versus creative problem solving, Divergent Thinking, and quality of scenarios.” Creative Problem Solving training achieved its objectives and it was concluded that it made a contribution to prospective mathematics teachers’ pedagogical development to develop students’ creative problem solving skills.

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1. Introduction

One of the most important objectives of mathematics education is to develop students’ problem solving skills. In mathematics education, the purpose is to develop students’ critical, creative and divergent thinking skills. However teachers do not know exactly how to develop creative thinking. It is mathematics teachers’ responsibility to develop problem solving skills. Students’ problem solving skills affect their success in mathematics; the students who do not have problem solving skills perform badly in mathematics. Application of new teaching techniques in mathematics education will contribute to students’ problem solving. It is necessary that mathematics teachers who will use and teach these teaching techniques have to the sufficient field knowledge.

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Furthermore, as a result of the perception of students as individuals who give back what is taught in educational philosophy (Whitson, 1994), although students have creativity potential while starting school, their creativity is totally removed with wrong measurement tools (Shaughnessy, 1991) produced by educational system which has mathematics philosophy. Students have fixations in problem solving (Haylock, 1987) and can not overcome them. However, the development of students' creative thinking plays an important role in their academics success (Onda, 1994). Therefore it affects their problem solving skills.

Creativity and creative thinking skills can be improved (Sternberg, 2003; Houtz, 2003). Scoot, Leritz and Mumford (2004), assume that success can be achieved when creative problem solving program is mostly used. Puccio and Murdock (2001), think creative thinking can be developed using creativity and creative problem solving techniques.

One of the most important processes which explain creative problem solving process is Osborn-Parnes creative problem solving process. Osborn-Parnes Creative solving process is classified as following phases:

1. Finding in object which is the phase of defining the area of the problem.
2. Finding the reality which is the phase of obtaining data.
3. Finding the problem which is the phase of defining the problem accurately.
4. Finding ideas which is the phase of generalizing the solutions in the problem,
5. Finding the solution which is the phase of assessing all the possible solutions and making selections among them;
6. Finding the acceptance which is the phase of application of selected ideas correctly.

In each phase of creative problem solving, both divergent and convergent thinking are used. Each phase consist of activities derived firstly from divergent thinking and then convergent thinking. In the divergent stage, the task is to produce as many ideas and solution as possible. No retractions should be applied to any designed ideas in that stage. The moment the desire the satisfactory number of ideas are reached, the convergent thinking should be launched. The purpose of the stated thinking way is to focus on solutions which are obtained from ideas produced with the help of divergent thinking by taking the problem as basis. The purpose of the activities can be thought as filtering all the ideas produced in the mind and filled in a funnel. Only practical and relatively good ideas among many ideas poured in the funnel can ass through the filter (Proctor, 1999).

Creative Problem Solving in Education

There are researches supporting the development of creative thinking through creative problem solving in the literature. Torrance (1972) examined 142 studies including of CPS between 1960 and 1972 and indicated that creative problem solving is effective with a percentage of go in creative thinking. Furthermore, Torrance (1987), examined 166 experimental studies of creative techniques in primary and secondary school level after 1972 and found creative problem solving to be best successful method in developing creativity.

Baer (1988), researched the long-term effects of creative problem solving training. Total 48 paired students in the 8. grade were divided into control and experiment groups. Students were asked to solve problems in 3 day and 2 nights to Osborn Parnes CPS model, control group was not given any tasks. They were only given a test before the training like experiment group. The post-tests are made up of in sub-training tests. These are; finding data, finding the problem; finding the ideas and finding the solution. These tests include both divergent and convergent ideas. The problem in the sub-test: mathematics, language, science, social sciences and students' life out of the school. In every test applied after 6 months, experiment group outscored the control group very significant which shows creative problem solving skills are not forgotten even after 6 months. Similarly the experiment group showed significant rises in the test after 6 months.

Cramond, Martin and Shaw (1990), researched the generalizability of creative problem solving in the real life. They dwelled on whether students generalized the training they were given into their life experiences. 78 gifted students from 6,7 and 8th grade participated in this research. They were randomly put into two of the control and experiment groups. Traditional creative problem solving was given to the first experiment group of 28 students. Creative problem solving training including transferring strategies was given the second group of 25. The control group of 25 student was given a training consisting of various memory programs and analytical skills. Each group independent of other groups participated 16 sessions which lasted 0 minutes for 8 weeks and was guided by a trainer. At the end of the training all students were given a problem solving homework and they were interviewed. Individual tests were used to assess application of creative problem solving strategies. The rate of students in each group who showed various problem solving attitudes was calculated and analyzed. The second experiment group which was given

creative problem solving skills with transferring skills scored statistically higher than the first experiment and control group ($F=3.86$, $p<.05$). The results showed that the students' transferring rates of problem solving skills after learning creative problem solving through transferring strategies are higher. This study showed that it is possible for students to transfer creative problem solving strategies.

Shack (1993), researched the effects creative problem solving program on skillful students. 78 gifted students, 106 superior students and 93 middle-level students participated in the research. These students were grouped heterogeneously in the research. These students were grouped heterogeneously grouped classrooms contain gifted students, one experimental and control group. The comparison group, 3.group, is composed of superior students. They took part in 45 hour experimental program which was completed from 9 to 18 weeks with the guidance of teachers of teachers. Before and after the application to assess problem solving, both the experiment and control group answered a hypothetical questions scored with 2 independent statements for creativity of the problem, continuity of the solution, flexibility, originality and use of criterion. The students in the experiment group compared to control group made considerable improvements in problem solving skills, but no significant difference in skills level was found. After the trainings their, both gifted and middle-level students made important improvements in various situations of creative problem solving. The results showed that calculation skills taught in gifted students' program could be beneficial for both re-gifted and middle-level students.

Puccio (1994), examined the efficiency of creative problem solving training with the primary school students. First of all, he examined how creative problem solving can help them when they confront real life problems. The study includes 12 hours when creative problem solving training was given to 1. year students. Quantitative data was collected from a teacher, 2 observers and from 1. year students. The study showed that the students could apply creative problem solving in real problems and different levels.

Scott et. al.(2004), emphasized that creativity programs an important effect on performance, attitude and behaviors, especially on divergent thinking and problem solving.

Muneyoshi (2004), researched how teachers use creative problem solving in the classroom. According to the results of the research, the use of creative problem solving in the classroom raised their motivation and their motivation and self-confidence, provided positive attitudes towards learning and problem solving, helped students became more enthusiastic and active in learning. She indicated that teachers state their students cooperated more, planned their time better, produced better quality works and voluntarily studied longer hours thanks to creative problem solving. In addition, she mentioned that teachers reported a safer classroom environment and a more positive learning environment was formed with CPS.

2. Method

The purpose of this study is to examine what the prospective mathematics teachers who participated in creative problem solving training have learned during the process and to get their opinions at the end of he training.

2.1. Study Group

51, 5th year students in secondary mathematics education department of education faculty in 2006-2007 education year. Purposed sampling was used in the study (Patton,1990). The students' names were not used as the same.

2.2. Processes

Creative problem solving scenarios related to daily life and which are open-ended, challenging and divergent thinking. Scenarios include many variables and its aimed to reach a solution with the help of the variables. As they could be processes to develop creative thinking, creative problem soling scenarios were used in the study. A training about how to prepare creative problem solving scenarios was given to the prospective teachers for 14 weeks. The purpose of that training was to equip the prospective teachers with different problem solving methods and techniques. During the first 2 weeks of that training information about creative problem solving and creative problem solving scenarios was given and examples were presented. After that, 12 groups composed of 4-5 people

were formed on voluntary basis. The prospective teachers were asked to produce creative problem solving scenarios could be applied in 2 hours. The researchers acted as leaders, guides, facilitators.

2.3. Data Collection Tools

The data collecting tools in the study were diaries and semi-structured interviews. Each of prospective teachers kept diaries to write down the activity they used in the classroom that week. That diary was prepared in a specific format. The second data collecting tool was interviews. The questions in the interview form were prepared by taking educational and area (mathematics) specialists. The interviews were recorded and they lasted 15-25 minutes.

2.4. The Analysis of the Data

The data obtained were analyzed using content analysis method (Charles&Mertler, 2002).. The coding lists of the data were prepared by 3 different area specialists. The lowest balance percentage among coding was 0.70. Later, the common codes were determined, sub-themes and main themes from sub-themes were reached.

3. Results and Discussion

As a result of the content analysis, the main theme was “ Creative problem solving in mathematics education”. The sub-themes were formed as 10 sub-themes: “ The perception of creativity, the perception of creative problem solving and its development in the process, attitude towards creative problem solving training, contribution to problem solving, contribution to learning, attitude towards mathematics, creative classroom environment, closed-ended questions versus creative problem solving, divergent thinking and the quality of the scenarios.

Creative Problem Solving in Mathematics Education

This main theme includes ideas of wide scope of creativity in education to how to apply creativity in mathematics.

The perception of creativity

The prospective teachers thought creativity as putting events, concepts, ideas and objects together, namely synthesizing.

“Creativity is the ability to combine different ideas, events and objects in different ways to form a new product or serve a new purpose.” (Prospective mathematics teacher Çiğdem, from diary)

“ From my point of view, creativity is to reach a new concept by blending the present data and ideas to form a new things (Prospective mathematics teachers Gazi, from interview).

The prospective teachers indicated that educational system is the most important factor affecting the development o creativity.

“Creative thinking skills are necessary for creativity. Therefore, students should acquire higher thinking skills by leaving convergent thinking. Thus the most important factor affecting creativity is education.” (Prospective mathematics teacher Ahmet, from interview)

The perception creative problem solving and its development in the process

The prospective teachers considered creative problem solving as process in which open-ended questions were used and which was challenging and which required divergent thinking.

“Creative problem solving scenarios consists of open-ended questions. We knew mathematics problems to have only one answer. However, with the questions at the end of a creative question, we can achieve very different and divergent ideas by making them open-ended. Creative problem solving is trying to find the most suitable solution by commenting from different aspects.” (Prospective mathematics teacher Ömer, from interview)

“However, alike it was seen, creative problem solving is a meaningful process which requires longer ways of solution, effort and which is time consuming with divergent thinking.” (Prospective mathematics teacher Şenay, fro diary)

“I think creative problem solving is a process taking a lot of time. As the question is an open-ended one, we need to assess various alternatives well enough to solve the question. However y this way, when faced with some problems in real life, faster and more logical solutions can be found.” (Prospective mathematic teacher Serhat, from diary.

“Creative problem solving is a process which develops mind. This process helps finding different ways of solutins and developing in this aspect.” (Prospective mathematics teacher Serdar, from interview)

Attitude towards Creative Problem Solving Training

The prospective teachers showed a positive attitude towards CPS training. They emphasized that the training was interesting and motivating.

“ I understand how much creative thinking is important with the problem we confronted. I realized that both creating and solving a creative problem was time consuming, not easy but when done, it was enjoyable.” (Prospective mathematics teacher Şenay, from interview)

“ I felt disconnected for a while as I had not core across such a problem. But It was interested because it suited in the adopted educational system.” (Prospective mathematics teacher Murat, from interview).

“ I believe creative problem solving in mathematics can motivate students, as the solution is not certain and the students tries to find the most suitable answer by commenting on the data given” (Prospective mathematics teacher Murat, from diary).

Contribution to Problem Solving

The prospective teachers believed that creative problem solving scenarios would increase their problem solving skills. They mentioned their it this it would be advance their problem solving skills by making contribution to their divergent thinking in a problem.

“ Since the students reflected divergently in creative problem solving; that is, since they developed different point of views, creative problem solving scenarios contributed to problem solving a lot.”(Prospective mathematics teacher Gürkan, from diary).

“ A creative problem solving different that classical problem solving, increases our problem solving skills. We can assume we did mental exercise in the activities. This creative problem solving can contribute us by giving us the ability to look from different angles and to think divergently in a problem. (Prospective Mathematics teacher Orhan, from interview)

“ Creative problem solving certainly makes a contribution to students’ skill in problem solving. Because the students do not think convergent when they face a problem. They produce different ways of solution and apply them. Their at looks to life improves. They learn to use logic while dealing with problem.” (Prospective mathematics teacher Osman, from diary).

Contribution to learning

The prospective mathematics teachers argued that creative problem solving would contribute to learning and help meaningful learning be realized.

“ Students should comment on knowledge for learning to be realized, creative problem solving improves that ability.” (Prospective mathematics teacher Emine, from diary).

“CPS contributes students’ learning in a positive way. Previous and new learning way form instability, when compared by the students. This instability, as Piaget says, provides accurate and temporary learning.” (Prospective mathematics teacher Orhan, from interview).

“The individual certainly will seek ways of self development, producing alternatives; These will ease the students’ learning and direct them how to reach the goal shortcut.” (Prospective mathematics teacher Ayşe, from diary).

Attitude towards mathematics

It was indicated by the prospective teachers that the students would develop positive attitude towards mathematics by motivating them and raising their interest for mathematics thanks to CPS.

“While mathematics is regarded as a hard, unbearable subject in general, with the help of such kinds of activities to develop creativity the students’ interest increased and they developed a positive attitude towards mathematics.” (Prospective mathematics teacher Şenay, from diary).

“Approaching questions with creative problem solving may contribute to students’ interest in mathematics. Because they will see that the solution is not based on formulas but their ideas.” (Prospective mathematics teacher Serkan, from interview).

“The students can produce alternatives for each question they come across as they do not through memorizing. This enables them to show positive attitude toward the lesson and to be successful.” (Prospective mathematics teacher Serhat, from interview).

“If the student can acquire different views with CPS, that is ; find solutions, his/her attitude towards mathematics is positive.” (Prospective mathematics teacher Gürkan, from interview).

Creative Classroom Environment

The prospective teachers believed that CPS increased the communication in the classroom and a democratic environment where students could express their views. Thus, they thought a creative classroom environment could be achieved. Their view supporting that is as follows;

“In the process of CPS, the students have more communication as there are discussions, they express their views and they criticize others’ views with respect (Prospective mathematics teacher Senem, from interview).

“It enables students to be tolerant as it produces a discussion environment.” (prospective mathematics teacher Halit, from diary).

“Every member of the classroom finds the opportunity to assess themselves with the communication in the classroom.” (prospective mathematics teacher Gürhan, from interview).

“It is really crucial to create positive classroom environment. Everyone puts forward his/her ideas and opinions without hesitation. Therefore, creativity process works well.” (prospective mathematics teacher Akif).

Closed-ended questions versus CPS

The prospective teachers learned the differences of questions asked in closed-ended structure and CPS scenarios. While there are few variables and there is one solution to be reached as a result of the relationship between these variables in closed-ended questions. The questions are related daily life which requires divergent thinking and they are open-ended and they present many alternative ways to solution in CPS. The views of prospective teachers are as follows;

“One way of solution is expected and one goal is determined in closed-ended problems. In the CPS scenarios problems are about real life, the individuals adds himself and there can be more than one goal. More than one goal

can be aimed with questions like ‘If you were their shoes, what would you chose or why?’ (Prospective mathematics teacher Ayhan, from interview).

“In my way of thinking, closed-ended problems are those which have certain result, and are solved according to certain rules. But in CPS, as the limits are no certain, the answers as well as he results may be shaped according to the limits the person put himself. In a creative problem solving, the individual tries to limit himself by thinking and focuses on the way to solution rather than the solution. Closed-ended problems aim to measure and evaluate students or to make the student understand the subject as the target behavior. Because they have certain results and they do not require personal comments. However, the goal in creative thinking is to motivate the students think and do something.” (prospective mathematics teacher Murat, from interview)

“Closed-ended problems have one solution. The solution is emphasized. But, open-ended questions are asked in CPS. Various alternative way of solving a problem are searched.” (Prospective mathematics teacher Sevgi,from diary).

Divergent thinking

The training applied improved the prospective mathematics teachers’ divert thinking skills and realized the importance of divergent thinking in open-ended questions.

“I realized how important to be able to solve a problem with many techniques, not only one,is.” (Prospective mathematics teacher Serkan, from interview).

“Seeing solutions of different groups and analyzing those will broaden students’ points of views.” (Prospective mathematics teacher Aynur,from interview).

The quality of the scenarios

According to the prospective mathematics teachers, the questions used in CPS scenarios must be open-ended, challenging and related to daily life.

“We must be careful to prepare the scenarios closely related to daily life. Questions like ‘what if you were him/her?’ should be asked. Scenario must cause a chaos in the brain as it contains the creative problem solving that students can find the solution.” (Prospective mathematics teacher Sabri,from interview).

“I always make sure that the data are meaningful, consistent and related, many inputs are given, they are related to daily life and there are restriction while preparing a scenario.” (Prospective mathematics teacher Akın,from diary).

Conclusions and Remarks

One of the most important goals of mathematics education is to improve students’ problem solving skills. As a result of the research, the training prepared for the prospective mathematics teachers and CPS scenarios must be us in mathematics education. The training achieved it goals and contributed to the development of necessary pedagogical content knowledge of the prospective mathematics teachers for developing students’ CPS skills. Scott et. al. (2004), emphasized that creativity program had considerable effects on performance, attitude and behaviors, divergent thinking and problem solving. Creative problem solving training applied affected attitudes, divergent thinking and problem solving. Haylock (1987), considered one aspect of creative thinking in mathematics as divergent thinking skill. On the other hand, Silver (1993), claims that creative thinking can be developed by open-ended questions. Meissner (1999), puts emphasis on the idea that creative thinking can be developed through challenging questions. Fisher (1995), draws attention to the necessity of question related to daily life in creative thinking. All these 3 characteristic are put together in CPS scenarios. The questions in CPS scenarios are open-ended, challenging and daily life problems. The prospective mathematics teachers explored those characteristics of CPS scenario. As a result of this, it was concluded that CPS scenarios have the quality to develop students’ creative thinking. Shaw and Runco (1994,p.34) thinks ‘ Creativity, is producing something new and different through lending what is possessed.’. According to this definition, the prospective mathematics teachers understand creativity. Their

perception of creativity concept right shows that they conceptualized and internalized the training given. According to Kandemir(2006), creativity develops in a democratic classroom environment. CPS scenarios create a democratic classroom environment and play important role in the development and creativity. Furthermore, CPS supports permanent and meaning learning. Baer(1988), draws attention to this fact by mentioning the permanence. In conclusion, as Shack(1993) also indicated CPS training can be used in any grade of secondary schools to develop students' mathematical and CPS skills. Application of new and different teaching techniques in mathematics education will help achieve the goals which mathematics education intends.

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