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The effect of web-based professional development study to mathematics teachers' problem solving strategies

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Abstract

This research analyzes the problem-solving strategies adopted by math teachers in middle school and explores the role of web-based professional development studies in improving this process. The case group is constituted by twelve math teachers teaching in middle school. These twelve teachers have been arranged a seven-week web-based professional development study in problem-solving strategies. In collecting the data, pre- and post-testing, interview and observation methods have been exercised. On the basis of content analysis, the data obtained have been examined through an inductive strategy.

Keywords: Problem solving, mathematics teachers; web based professional development

1. Introduction

The last thirty years, problem solving has become one of the most important research issues in mathematics education. Polya (2004) highlighted problem-solving process as an important opportunity for mathematics teachers and stated that: If teacher fills his time with practicing his students in routine operations, he kills their interest, obstructs their intellectual development. But if he let students to deal with problems proportionate to their knowledge and helps them to solve problems by using stimulating questions, he may give them a taste for independent thinking. However, good problem-solving skills may not necessarily arise naturally but can be taught. Students need lots of opportunities to practice problem-solving strategies (Herr & Johnson, 1994). This may be possible if the teachers use different types of problems and solution strategies in their mathematics courses. But, teachers tend to teach in similar ways that they have been educated (Thompson, 1992). In fact, it is often the teachers themselves who are not aware of the many problem-solving strategies that can be used to provide efficient and elegant solutions to many problems (Posamentier & Krulik, 1998, p.xv).

2. Theoretical Framework

The capacity and ability to solve problems is not acquired only by solving many problems. It is favored by acquiring ease and familiarity with different solving techniques and by discovering the mental processes used in solving one of these techniques. These processes can be learned and assimilated when they are known and practiced

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(Sanchez et al., 2002). Polya (2004), mentioned that leaning to different problem-solving strategies is just like one's desire to perceive an object with two different senses. Resulting a person to persuade himself.

The basic task needed by teacher in problem-solving process is, first, to introduce different strategies to students and then to teach them so that they can effectively use these strategies (Altun, 2000) and to motivate them to notice problem-solving techniques incisively (Posamentier, Jaye, & Krulik, 2007). In order to develop students' problem-solving skills teachers should provide problem-solving activities that require individual, group work or whole class effort. Teachers should also guide students' in developing and using various problem-solving strategies (MEB, 2008).

Problem solving occurs in classroom practice in three ways. These are: teaching for problem-solving; teaching about problem-solving; and teaching via problem-solving. Among them, teaching for problem solving is described as applying teaching for the situations that need problem solving. Teaching about problem-solving is mainly Polya's problem-solving situations. However, teaching via problem-solving is teaching mathematics in problem-solving contexts (Bay, 2000).

We should prepare teachers for the increasing expectations and rapidly changing economic and social environment during their pre-service training and training that they received at tertiary level. Professional development which basically includes any activity that develops an individual's skills, knowledge, expertise and other characteristics as a teacher (OECD, 1998), has become one of the most important factor in studies aiming to improve the quality of education. When teachers participate in professional development which are related to teachers' content area, it enhances their effectiveness, resulting in a higher level of student academic performance (Stronge, Tucker,& Hindman, 2004). Professional development may be supported by computers since its effective in communication. Using communication via computer to support the professional development would be very useful (Seferoğlu, 1999). Through the internet, teachers can access to online courses and seminars, follow-up discussion and mentoring, and collaborations with experts. Teachers can take place without the expense and classroom disruption created by repeated absences for face-to-face in-service trainings (Kerrey & Isakson, 2000). In addition, teachers by communicating with people from many distinct places have opportunity to share their professional knowledge and experience in the professional development programs.

There is a great emphasis on problem solving in the new national mathematics curriculum of Turkey 2005. This research analyzes the problem-solving strategies adopted by math teachers in middle school and explores the role of web-based professional development study in improving this process.

3. Method

Twelve middle school mathematics teachers, six male and six female, participated to the research. Four of the teachers have experience over 10 years, and the other four have 5-9 years experience. In this research a web site has been prepared for teaching problem-solving strategies. Through this web site, a professional development study was organized during seven weeks for mathematics teacher. By considering the subject and the purpose of the research, the web site included content and pedagogical content knowledge about mathematical problem-solving strategies. The content of the web site is designed by considering problem-solving strategies which were suggested national mathematics curriculum. Web-based professional development study was organized as asynchronously aiming to provide a flexible for teachers to follow the study in a flexible manner. Also a forum section has been established in the web site. In this study, some strategies such as looking for pattern, making systematic list, making a table, drawing a graphic and diagram, working backward, writing an equation have been comparatively explained.

Qualitative research methods were used for this study. The data was collected by using various instruments such as pre- and post-test, semi-structured interviews, observations and written documents.

Pre- and post-test was carried out before and after, web-based professional development study for the participating teachers. The test is composed of 8 questions. The aim for using this test was to identify problem-solving strategies that teachers used during in actual classroom practices. Pre- and post-test were created by considering opinions of two mathematics education researchers together with the researcher. The content of the questions were aligned with the national mathematics curriculum. The questions were adopted from the pool of

questions that were included in previous research. During the research, the researcher loaded several questions to the forum section, so that teachers explained their opinions to the questions. Semi-structured interviews were conducted with six of the participants. Questions that were used in the interview have been prepared to cover all dimensions of the research problem. The interviews, tried to uncover not only teachers' opinions about mathematical problem-solving strategies, but also their opinions about the importance of problem-solving strategies and the importance of the web-based professional development study in the strategies they use. After completing the web-based professional development study, three of the six teachers that have been interviewed were selected to observe their classroom practices. Observations have been performed one month after the completion of the web-based professional development study. Each teacher was observed during three weeks, six hours in total, in their own classes. The data have been examined by content analysis in an inductive strategy.

4. RESULTS

The strategies and the percentage use of them by teachers in pre- and post-test are given below in Table 1.

Table 1. The strategies and percentage usage in the teachers' pre- and post-test

	Q 1		Q 2		Q 3		Q 4		Q 5		Q 6		Q 7		Q 8	
Strategies	**Pr**	**Po**	**Pr**	**Po**	**Pr**	**Po**	**Pr**	**Po**	**Pr**	**Po**	**Pr**	**Po**	**Pr**	**Po**	**Pr**	**Po**
Looking for a pattern					18	33	0	8	83	100			8	18	92	92
Making systematic list			58	75	27	8	8	8					17	0		
Drawing a diagram			0	8	9	18	42	42	8	24	18	27	25	18	0	8
Making a table	17	33	8	25	18	50	0	33	0	50	0	25	0	18	17	50
Drawing a graphic	0	42									0	8			0	8
Working backward													0	18		
Writing an equation	92	67	75	50	73	58	17	25	17	8	100	75	67	100	8	8

When compared to the pre-test, there has been an increase in the diversity of problem-solving strategies in the post-test. Participants used strategies like writing equation, looking for a pattern, drawing a diagram and making systematic lists more frequently as compared to remaining strategies in the answers that they gave for pre-test. In post-test, although there were differences across the problems, it is observed that participants used all of the strategies explained to them. Among these strategies, there has been an increase in the use of strategies such as drawing a diagram, making a table, drawing a graphic, looking for a pattern strategy, in particular. However, the number of participants who tended to solve problems by writing equation significantly decreased. Also, using multiple strategies in the answers has increased in the post-test when compared to the pre-test.

In addition, the quality of the strategies that the participants were using for solving problems has improved in terms of their content and explanatory power. For example, the participants who used making systematic list to answer the second question of the pre-test generally did not use a systematic approach while making their lists. However, the most important issue while making systematic list is the creation of lists in a specific order. Considering the special order while making a list eliminates the possible errors in using the strategy. It is observed that all the teachers who selected to use making systematic list in their problem solving in the post-test carefully built the specific order

The lists of Teacher D's can be seen below when he used for the same question in the pre- and post-test. He suggested two different lists for the same questions in the pre- and post-test as indicated in Figure 1. The answer that Teacher C gave for the question eight at the post-test can be seen in Figure 2. He used both looking for a pattern and making a table in the answer. He also provided explanations that could help in understanding the pattern.

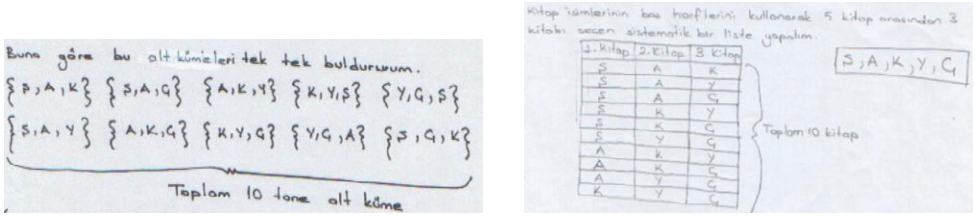

Figure 1. Making systematic list strategy used by Teacher D in second question of pre- and post-test

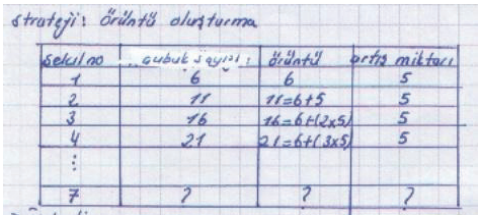

Figure 2. Making Looking for a pattern strategy used by Teacher C in eight question of post-test

Teachers who were interviewed generally stated that while solving problems in classes, they are inclined to write an equation to solve problems. Two cases have arisen as a reason for this: First, the strategy used by the teachers provides a relatively fast solution. Second, teachers were encouraged to use this strategy in their prior education.

Regarding this case, Teacher B said the following: “I may use equations much more... But students who were trained 4-5 years with a teacher, who encouraged them to solve the problems by writing an equation, always try to use equations to solve problems. Because they have become accustomed to it ...” Teacher A has expressed the following opinions on the forum section of the web site: “According to the students the correct answer to each question is unique and this can be found with one strategy. They were told that the aim of studying mathematics is to find correct answer and there is only one strategy to reach that unique answer.” Teacher F expressed: “Previously I tried to solve problems and tried to make the students understand it, but then I agree on this: I understand that problems can be explained with another method to a student, and for teacher needs to discover a method.” Teacher H has reflected his expression on the influence of web-based professional development to his own working practices: “I began to use problem-solving strategies that we learned both during this training process, and we have learned in the past, but we thought it was not necessary to use these strategies ... it is not possible for someone if he could not group the known and the unknown to form equations and solve them. I started to show my students that there are other strategies that students can use while solving problems.”

In the observations after web-based study, it is seen that teachers with their students tried to determine the best strategy for solving problems and discussed about what to do while implementing this strategy. During observations, it is seen that teachers tended to use different strategies. Teacher H began to solve by asking to students what to choose for determining the strategy. While implementing the strategy he was asking questions such as what to do or how the strategy should be carried out. While making a table for a solved question, questions like “Which information should be used from the table?”, “What kind of a table should be created?” were asked to the students and their opinions were taken. It is observed that Teacher E by looking at the pre-test and post-test answers, was using strategies like looking for patterns and making tables more. A similar situation has been observed in the classroom observations. Teacher E tends to use various strategies while solving problems and try to uncover the relationship between them.

5. Conclusion

As a result of this research, it is seen that teachers give more importance to problem solving in their classrooms. However, it was observed that a high ratio of teachers used problem solving as an instrument. In other words they

taught mathematics in problem-solving contexts. Teachers preferred this not only for their students to understand mathematics easily, but also for themselves to teach mathematics easily, because for teachers the result of problem solving is more important than problems solving itself. Labuda (2004) stated that as result of a study that he carried out with twelve students, teachers had very limited information about problem solving. According Labuda this situation undermines their classroom applications. Teachers have stated that after these studies, their information about different problem-solving strategies has increased. In a research which was carried out by Kopecky (2005), Donaldson (2006) and Watson (2007), teachers stated that after the professional development study that they were attending; their conceptual and pedagogic information was increased. Thee algebraic representation is concise, general, and effective in the presentation of patterns and mathematical models. However, an exclusive use of algebraic symbols may blur or obstruct the mathematical meaning or nature of the represented objects and cause difficulties in some students' interpretation of their results (Friedlander & Tabach, 2001). After this research it is seen that teachers tended to solve problems by using algebraic statements. In the former national mathematics curriculum of Turkey different solutions strategies weren't emphasized for problem solving. This kind of view is still valid among the teachers. There are some reasons related to this situation. The situation is related to teachers' former education background. In addition to that in national examinations and in text books which equations should be used in solving problems is generally asked and students are guided in this way. In a similar way to exams, the desire to solve more problems in less time is the main factor that determines the strategies to be used. After web-based professional development study, they tended use various problem-solving strategies. A high ratio of teachers stated that after a professional development study, the usage of different problem-solving strategies has increased. Similar cases have emerged in studies conducted by Labuda (2004), and Thompson (1989).

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