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Turkish Primary School Teachers' Opinions about Problem Posing Applications: Students, the Mathematics Curriculum and Mathematics Textbooks

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Abstract: Problem posing is one of the most important topics in a mathematics education. Through problem posing, students gain mathematical abilities and concepts and teachers can evaluate their students and arrange adequate learning environments. The aim of the present study is to investigate Turkish primary school teachers' opinions about problem posing applications for students, the mathematics curriculum and textbooks. A 30-item questionnaire was developed by the researcher and administered to 18 primary schools. Altogether, 277 primary school teachers participated in the study. The results showed that Turkish primary school teachers have positive views about problem posing applications related to students but negative opinions about the mathematics curriculum and mathematics textbooks.

Introduction

One of the most important aims of a mathematics education is to train students to become good problem solvers so that they can easily overcome the problems encountered in daily life. It is believed that someone who solves mathematical problems effectively can easily solve day-to-day problems. There is not only one definition of mathematical problem.

A problem involves a situation in which a person wants something and does not know immediately how to get it (Reys et al., 1998). Barkatsas (1993) defined a mathematical problem as "as a task posed to an individual or group, who will attempt to decipher the task and obtain a mathematically acceptable solution by not initially having access to a method which completely determines the solution" (Barkatsas, 1993). There are many kinds of mathematical problems described in the literature. For instance, Souviney (1994) classified problems as routine story or word problems and nonroutine process problems. Holmes (1995) classified problems as routine and nonroutine problems. Word or story problems can be solved by applying previously learned concepts and skills, such as "Allan and Nick each bought the same stamp for their collection. Allan paid 14. Nick paid 1 more. How much did Nick pay for his stamp? Allan bought a stamp for 10 and sold it to Nick for 12. Later, he bought it back from Nick for 14 and resold it to another collector for 16. Did Allan make a profit on the transaction? If so, how much?" This nonroutine problem example cannot be solved by selecting and applying one or more operations as word problems; rather, solving this problem requires flexible thinking (Souviney, 1994). In that study word problems are part of the content of the Turkish Mathematics Curriculum.

The results of previous studies generally show a connection between problem solving and problem posing (Cankoy & Darbaz, 2010; Lowrie, 2002; Stoyanova & Ellerton 1996). Problem posing related to problem solving has been considered by researchers for the past two decades. It is asserted that problem solving instruction, which is based on problem posing, thus affects problem understanding (Cankoy & Darbaz, 2010). Problem posing and its process is defined by many researchers and mathematics educators. The process of problem posing has many components, although the various definitions of problem posing in the literature do share some common features. According to Christou et al. (2005, p.149), “problem posing is an important aspect of both pure and applied mathematics and an integral part of modelling cycles which require the mathematical idealisation of real world phenomenon”.

Problem posing is defined as the creation of new problems or the reformulation of a given problem (Ticha & Hospesova, 2009). This involves the generation of new problems and questions in order to explore a given situation as well as the reformulation of a problem during the course of solving it (Silver, 1994). In mathematics classrooms, problem posing can be viewed as a teaching activity, where the teacher poses situations for students to solve (Stoyanova, 2003), and as a teaching strategy (Toluk-Ucar, 2009). Therefore, it has potentially advantages for both students and teachers.

Advantages of Problem Posing Applications/Activities

Problem posing affects both students’ learning and teachers’ teaching of mathematics (Barlow & Cates, 2006). Teachers can better understand students’ mathematical learning via problem posing tasks (Lin, 2004). Problem posing allows teachers to understand what their students are actually capable of (Barlow & Cates, 2006). Lin (2004) asserted that engaging problem posing activities are a good way to assess students’ understanding and improve future teaching.

Problem posing is beneficial for developing students’ mathematical skills and investigating their understanding of mathematics (Stoyanova, 2003). It is also a tool for developing and strengthening critical thinking (Nixon-Ponder 1995) and creativity (Silver, 1994; Leung, 1997). Problem posing is also important for the psychological and intellectual development of students (Rizvi, 2004). Problem posing is a reflective and dynamic process that enables students to reflect on their mathematical perceptions. It also allows students to connect their mathematical knowledge and abilities to each other, which helps them develop reasoning and communicating skills. Moreover, problem posing helps students to think in a flexible way and assess themselves. In problem posing activity students can realize their potential and advance their learning. Given this importance of problem posing, it is incorporated into the Turkish mathematics curricula and supporting documents.

However, Stoyanova (2003) indicated that problem posing activities that aim to develop students’ understanding of mathematics depend on teachers’ abilities to implement problem posing situations in mathematics classrooms. Teachers are responsible for laying the groundwork by preparing an effective problem posing environment. They should help students understand the stages of the problem posing process, such as describing the content, defining the problem, personalising the problem, discussing the problem and discussing alternatives to the problem, by asking relevant and inductive questions (Nixon-Ponder, 1995).

The Primary School Teacher Education Programme in Turkey

In Turkey, prospective primary school teachers attend university for four years. They are selected based on a national university entrance exam. The Higher Education Council is responsible for training primary school teachers and the Ministry of National Education employs them after graduation. In Turkey, all education faculties follow a standardised curriculum prepared by the Higher Education Council.

Over the four-year programme, prospective primary school teachers are taught courses such as mathematics teaching and science teaching in their third years and basic mathematics courses in their first years. In mathematics teaching courses I and II, prospective teachers learn how to teach primary-level mathematics. Although there is an emphasis on the problem solving process, problem solving strategies and problem solving types in course I, problem posing is not included in the programme. Haser (2010) found that new teachers have difficulties teaching the national curriculum without any structured support and advised that the teacher education programme should provide relevant knowledge for new teachers during their early years in schools.

Problem Posing Applications/Activities in Turkey

Turkish primary school teachers teach all subjects in first grade through to fourth grade. They started teaching problem posing in mathematics lessons in 2006 when such activities were incorporated into the new mathematics curriculum. The new curriculum was developed based on the results of international exams such as PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) as well as on research. The Turkish mathematics curriculum was redeveloped by considering social constructivist theories of education (Sahin, 2007).

In all primary schools, teachers follow the same mathematics curriculum set by the Ministry of National Education. Within this curriculum, there are learning areas, sub-learning areas, objectives, samples of activities and explanations of activities. The Turkish mathematics curriculum has four learning areas called number, data, geometry and measurement. Problem posing is incorporated in the number and measurement learning areas. The curriculum asserts that problem posing abilities should be developed daily using mathematical situations and, for instance, students are expected to pose problems that require addition with natural numbers and so on (MEB, 2009).

Mathematics textbooks were written in accordance with the programme and constructivist theory in order to reflect the curriculum’s learning objectives. All primary school teachers follow common textbooks in Mersin, the study region in this paper. The mathematics curriculum and textbooks are sources for instruction. It is commonly assumed that the accompanying teacher guides are one of the main sources for the content covered and the pedagogical styles used in classrooms (Haggarty & Pepin 2004). One problem posing activity example from the fourth grade Turkish Mathematics Course Book (Temiz et al., 2008, p. 31) such as “Let's pose and solve a problem, as follows by using your notebook”. 12, 24, 48, a roll of fabric and three pieces. In the course book, numbers and context were given to students and asked them to pose and solve problem using information.

Many studies of problem posing have been conducted with pre-service teachers (Isik & Kar, 2012; Ticha & Hospesova, 2009; Crespo &Sinclair, 2008; Toluk-Ucar, 2009; Lavy & Bershadsky, 2003) and a few with teachers (Lin, 2004; Barlow & Cates, 2006). These studies have found that problem posing activities offer opportunities for teachers because they influence teachers’ beliefs about mathematics and mathematics instruction (Barlow & Cates, 2006). Stoyanova (2003) indicated that teachers’ abilities to incorporate problem posing situations in mathematics classrooms affected students’ understanding of mathematics. Lin (2004) asserted that problem posing assesses students’ mathematical learning and helps teachers optimise the quality of their assessment and instruction. Teachers can also influence students’ problem posing actions through their own actions (Lowrie, 2002). However, there is not enough research into teachers’ views of problem posing in the literature. Considering the importance of problem posing and its contributions for both teachers and students, it is thus important to investigate teachers' ideas about problem posing. As in indicated in the study of Osman & Casella (2007) teacher education is not only about what works in the classroom, but also about preparing future teachers to contribute to producing knowledge about their profession and about teaching children.

This study aimed to find out primary school teachers' views about problem posing applications in terms of the student, the mathematics curriculum and the mathematics textbook, in Turkey. Teachers decide where and when to use textbooks and design their lessons in accordance with curriculum objectives. The mathematics curriculum and textbooks guide teachers to establish a problem posing learning environment in their classrooms. As indicated in the study of Jackson & Leroy (1998) thoughts of the eminent elementary teachers would seem to have important implications for teacher education programs. For that reason, primary school teachers' views of problem posing applications were investigated in this study.

Methods

In order to gather teachers' views about problem posing descriptive research was adopted for this study. Descriptive research determines and describes the way things are and it is concerned with assessing views (Gay et al., 2006). Thus, descriptive research was selected in order to reach a large sample of Turkish primary school teachers and ensure that the results of this study could be generalised. As the views and experiences of primary school teachers in the classroom affect students' learning, it is necessary to learn their views about problem posing to improve teaching and learning process in classrooms.

Sample

Simple random sampling is used to select the sample in such a way that all individuals in a defined population have an equal and independent chance of being selected (Gay et al., 2006). The participants of the study consisted of primary school teachers who work in a state primary school.

A total of 277 primary school teachers completed the questionnaire. As seen from Table 1, the number of female and male teachers and the distribution of teaching age are similar. The majority of teachers have been teaching for 20–29 years and 30 years or more. In the city centre, primary schools have 20 or more experienced teachers. Almost all teachers have graduated from a primary school teacher education programme with very few from science faculties and other graduate programmes such as high school teaching and psychological counsel. Overwhelmingly, the sampled primary school teachers had not taken any seminars or courses on problem posing.

Characteristics		Frequency	Percentage
Gender	Male	134	48
	Female	143	52
Years of teaching	1-9 years experience	7	2
	10-19 years experience	19	7
	20-29 years experience	116	47
	30 and more years experience	135	49
University Department of graduation	Primary school teacher education	243	88
	Science faculty	0	0
	Literature faculty	3	1
	Other	30	11
Which class he or she teaches	First class	60	22
	Second class	59	21
	Third class	53	19
	Fourth class	52	19
	Fifth class	53	19
Taking seminar or course about problem posing	Yes	0	0
	No	277	100

Table 1: Demographic information about primary school teachers who attended the study

Instrumentation

To assess primary school teachers' views about problem posing a 30-item questionnaire was developed by the researcher. In descriptive research, the most common instrument is a questionnaire (Gay et al., 2006). The questionnaire used in this study consisted of two parts. In the first part, participants' individual demographic information was collected, including gender, age, years of teaching, which class they teach, graduate status and whether they took problem posing courses or seminars. In the second part, there were 30 items about problem posing applications related to students (14 items), to the mathematics curriculum (12 items) and to the mathematics textbooks (4 items). A Likert-type scale with five choices – "strongly agree", "agree", "uncertain", "disagree" and "strongly disagree" – was used.

To develop the questionnaire items, first the literature was reviewed. The questionnaire was developed from different sources including articles on problem posing, the Turkish Mathematics Curriculum and textbooks. Then, an open-ended pilot questionnaire was used to survey 15 primary school teachers in order to understand their general views about problem posing applications. To ensure the content validity of the items, views of field experts (one measurement-assessment expert, one curriculum developer, two mathematics educators and 10 primary school teachers) were taken. At the end, a further pilot questionnaire surveyed 20 primary school teachers. As a result, some items of the questionnaire were modified to ensure clarity. Cronbach's alpha was calculated to be .85 for the last pilot.

Data Collection

I selected a questionnaire as a means of data collection to show teachers' experiences and views about problem posing applications/ activities. First, data collection research consent was obtained from the Mersin National Education Directorate and then from the school directors. Questionnaires were delivered to 18 primary schools in Mersin and data were collected from 277 primary school teachers. As indicated by Page, Adams & Hyde (2011), a questionnaire provides statistical and individual text-based data and participants are able to complete the questionnaire in their own time. Further, the sample teachers had previous experience of questionnaires.

Data Analysis

The data obtained from the questionnaire were analysed using the SPSS 15 software package. Descriptive statistics including frequencies, means and standard deviations were used to describe all items. For interpretations of means, the (n-1)/n formula was used and the 0.8 interval was calculated. Means were interpreted such as:

- (1–1.80) is strongly disagree
- (1.81–2.60) is disagree
- (2.61–3.40) is uncertain
- (3.41–4.20) is agree
- (4.21–5.00) is strongly agree

Data are presented in the tables below and the findings are generated by considering this data.

Findings

Primary school teachers' views on problem posing applications/activities can be organised into three categories in accordance with the research aims: views about students, the mathematics curriculum and mathematics textbooks. The findings of the study are thus presented in three parts. The first part is about teachers' views on students, the second is about their views on the mathematics curriculum and third part is about their views on mathematics textbooks. In Table 2, primary school teachers' views on problem posing in terms of students are presented.

Sub category: student items	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Mean	Standard deviation
Problem posing applications show the knowledge levels of students	121	138	7	7	4	4.32	.77
Problem posing applications impel students to think	189	82	2	0	4	4.63	.64
Problem posing applications develop the problem solving abilities of students	180	88	3	0	6	4.57	.72
Problem posing applications contribute to the development of student creativity	167	102	3	2	3	4.54	.66
Problem posing applications help students evaluate themselves	114	131	16	12	4	4.22	.85
Problem posing applications help students understand the daily problems that they encounter	141	115	9	8	4	4.37	.80
Problem posing applications develop students' reasoning and estimation skills	156	112	5	1	3	4.50	.66
Problem posing applications heighten students' self-reliance	114	141	15	5	2	4.29	.71
Problem posing applications help show the mathematical perceptions of students	147	113	9	3	5	4.42	.76
Students have some issues with problem posing activities	146	122	4	1	4	4.46	.68
Problem posing applications make mathematics more enjoyable for students	38	169	26	39	5	3.70	.93
Problem posing applications develop students' connection abilities	104	132	23	16	2	4.15	.85
Problem posing applications help students express themselves	117	143	12	1	4	4.32	.70
Problem posing applications encourage students to think critically	119	139	11	3	5	4.31	.76

Table 2: Primary school teachers' views on problem posing applications/activities related to students

Almost all participants strongly agreed or agreed that problem posing studies show the knowledge levels of students (93%, N=259), impel students to think (98%, N= 271), develop the problem solving abilities of students (97%, N=268), contribute to the development of student creativity (97%, N= 269), help students evaluate themselves (88%, N=245), help students to understand the daily problems that they encounter (92%, N=256), develop students' reasoning and estimation skills (97%, N= 268), heighten students' self-reliance (92%, N=255), show the mathematical perceptions of students (94%, N=260), develop students' connection abilities (85%, N=236), help students express themselves (94%, N=260) and encourage students to think critically (93%, N=258). Over 95% (N=268) of participants declared that they strongly agreed or agreed that students have some issues with problem posing activities. More than half (N=38 strongly agree and N=169 agree) indicated that problem posing application makes mathematics more enjoyable. Almost all primary teachers have the same positive view that problem posing applications make important contributions to students' learning.

Sub category: mathematics curriculum items	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Mean	Standard deviation
Problem posing activities in the mathematics curriculum are not thought provoking	31	82	46	103	15	3.03	1.15
Explaining tables in the mathematics curriculum about problem posing studies are not understandable	17	98	68	83	11	3.09	1.02
The time allowed for problem posing applications in the mathematics curriculum is not enough	62	150	24	34	7	3.81	.99
There is inadequate information in the mathematics curriculum on how teachers will evaluate posed problems by students	39	132	47	54	5	3.52	1.01
While preparing problem posing applications, environmental and local factors are not considered in the mathematics curriculum	54	132	44	40	7	3.67	1.02
Problem posing objectives are adequate in the mathematics curriculum	39	111	48	68	11	3.35	1.11
There are not enough explanations about problem posing strategy, methods and techniques in the mathematics curriculum	32	134	46	56	9	3.44	1.03
Problem posing objectives are explicit and tangible in the mathematics curriculum	31	135	52	47	12	3.45	1.03
Problem posing activity samples are not enough in the mathematics curriculum	37	133	43	53	11	3.47	1.06
Problem posing objectives are acceptable for all levels of students	30	150	41	43	13	3.50	1.03
Problem posing activity samples are acceptable for all levels of students	33	143	40	51	10	3.49	1.03
Problem posing explanations are not based on concrete data	16	107	53	89	12	3.09	1.05

Table 3: Primary school teachers' views on problem posing applications/activities in the mathematics curriculum

It is important to note that in the mathematics curriculum category of the questionnaire (Table 3 above), the majority of participants (76%, N= 212) strongly agreed or agreed that the time allowed for problem posing studies is not enough, while approximately 61% said that there is inadequate information on how teachers can evaluate posed problems by students, that there are not enough explanations about problem posing strategy, methods and techniques and that problem posing activity samples are not enough. Additionally, more than half of participants (67%, N=186) had negative views, stating that while preparing problem posing studies, environmental and local factors are not considered. Approximately 60% of participants declared that problem posing objectives are explicit and tangible, while 65% indicated that problem posing objectives and activity samples are acceptable for all levels of students. The fact that problem posing activities are not thought provoking was equally significant to teachers. A total of 41% of teachers strongly agreed or agreed and 37% teachers disagreed. Over half (54%) of teachers (N=150) agreed that problem posing objectives are adequate in the mathematics curriculum. Primary school teachers' views on problem posing applications in the mathematics curriculum are both negative and positive views.

Sub category: mathematics textbooks items	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree	Mean	Standard deviation

Problem posing applications are adequate in mathematics textbooks	26	66	30	134	21	2.79	1.16
Problem posing applications are explicit and tangible in mathematics textbooks	25	103	37	100	12	3.10	1.12
Problem posing applications are acceptable for all levels of students in mathematics textbooks	31	137	38	60	11	3.42	1.06
Problem posing applications are based on concrete data in mathematics textbooks	32	123	42	68	12	3.34	1.10

Table 4: Primary school teachers' views on problem posing applications/activities in textbooks

In Table 4, teachers' views on mathematics textbooks are presented. Nearly half of participants (48%, N=134) disagreed that problem posing applications are adequate in mathematics textbooks. The agreement with the fact that the frequencies of problem posing studies are explicit and tangible in mathematics textbooks was neutral. The majority of teachers (61%, N=168) strongly agreed or agreed that problem posing applications are acceptable for all levels of students in mathematics textbooks, while more than half of teachers (56%, N=155) strongly agreed or agreed that problem posing applications are based on concrete data in textbooks. Primary school teachers' views on problem posing applications in textbooks are both negative and positive.

Discussion and Conclusion

Problem posing is one of the most important mathematical activities. Thanks to problem posing applications, teachers can assess their students' mathematical knowledge and abilities. Thereby, they can their revise their lesson structure and could improve mathematical learning of students. Problem posing is also a key indicator of good problem solving performance and creativity as well and helps to develop other mathematical abilities such as reasoning, connection and problem solving.

Problem posing has attracted the attention of researchers over the past three decades, and it has been taught in Turkish primary schools since 2006. However, over last two decades these kinds of studies have been sparsely found in the literature. Being not enough research in the literature about primary school teachers' views about problem posing applications/activities was motivation to conduct this study. It was thought that teachers' views on problem posing could be investigated in three different components of problem posing applications. These components were student, mathematics curriculum and mathematics textbooks which are items that have an impact on problem posing applications.

It is clear that problem posing activities depend on teachers' abilities to implement problem posing situations in mathematics classrooms and that students' understanding of mathematics is influenced by this (Stoyanova, 2003). Furthermore, teachers should help students understand the problem posing process (Nixon-Ponder, 1995) because this is a good way to assess students' mathematical learning and it also helps teachers improve their instruction techniques (Lin 2004).

In that study the majority of participants have been teaching for more than 20 years and graduated from primary school teacher education programmes. The data gathered from these 277 primary school teachers showed that teachers have positive ideas about the impacts of problem posing applications on students but almost all indicated that their students have some issues with problem posing activities. This finding is in line with those of English (1998). Furthermore, these primary school teachers agreed that problem posing applications help show the knowledge levels of students and their mathematical perceptions, impel students to think and develop problem solving abilities (Cankoy & Darbaz, 2010) and contribute to the development of creativity (Leung, 1997). These activities also help students evaluate and express themselves and understand the daily problems that they encounter, develop students' reasoning and estimation skills, heighten students' self-reliance, develop students' connection abilities and encourage students to think critically (Nixon-Ponder, 1995). In addition, primary school teachers indicated that problem posing applications make mathematics more enjoyable. According to teachers' views, problem posing help students develop abilities and they are an effective way to assess them. That finding seems to parallel findings of Lin (2004) study.

It is also important to note that teachers have positive and negative views about the mathematics curriculum and textbooks in that study. In particular, teachers have issues with the mathematics curriculum. They declared that there is not enough time for problem posing applications and that they need extra information to evaluate the problem posing applications of students as well as problem posing methods and techniques. They also said that there are inadequate explanations about the work of problem posing and about the environmental and local factors in the mathematics curriculum related to problem posing. However, problem posing objectives are explicit and tangible and they are acceptable for all levels of students. Considering mathematics textbooks help students think, develop understanding and engage in mathematical problems and students spend much of their time in classrooms exposed to and working with prepared materials such as textbooks (Haggarty & Pepin, 2004), based on the results of this study textbook writers should improve these aspects. The textbook writers should add adequate, explicit and tangible problem posing activities into the textbooks. Furthermore, curriculum developers should consider the primary school teachers' views about problem posing activities placed in the Turkish Mathematics Curriculum and redevelop activities related to problem posing.

Classroom-based research can be conducted with students. Students' views should be considered in order to understand their views about how problem posing applications are introduced in textbooks. The mathematics curriculum and mathematics textbooks should be investigated in detail in terms of problem posing activities.

Classroom observations could also be carried out in order to understand constructivist reflections in the classroom and the kinds of problem posing activities used there. As indicated in the study of Park (2005) student engagement had positive effects on student academic growth, so it is important to prepare problem posing activities which engage students. In the curriculum and in mathematics textbooks, problem posing activities that have been developed based on constructivist theory should be reconsidered. One of the limitations of this study is that participants comprised teachers with more than 20 years of teaching experience. Thus, the views of beginner teachers should be investigated in future research. As indicated in the study of Steenbrugge et al. (2010) mathematics learning difficulties of students in the context of problem posing can be studied with primary teachers.

As a result of study it can be seen that primary school teachers took no university courses and any seminars related to problem posing during their in-service time. Therefore, if we want teachers to perform problem posing activities effectively, they should be well prepared for this subject. They can obtain that skill either in teacher education or through in service. In order to teach the teachers about problem posing applications in education programmes, courses or seminars could be given by academic researchers or workshops can be performed or problem posing applications can be incorporated into teacher trainee programs. Besides, problem posing as content should be integrated into mathematics method course such as mathematics teaching course or a course called problem posing can be placed in teacher education programme. Hill (2000) asserted that primary mathematics method program enhances pre-service primary teachers' capacity, and provides an incentive for them to learn and teach mathematics for relational understanding. A model for systematically improving the mathematics preparation of elementary teachers (Berk & Hiebert, 2009) can be developed and implemented.

Moreover, small-sample qualitative studies could be conducted with primary school teachers in order to delve into their views on problem posing applications. Classroom observations could be carried out to understand what kinds of problem posing applications are being performed in classrooms and what other kinds of issues students are encountering. Donche & Petegam (2011) asserted that teacher educators have some responsibilities for preparing innovative practices for student teachers to facilitate learning. Therefore, teacher educators should design their lessons in order to develop pre-service teachers' abilities and subject matter knowledge of problem posing applications. Teacher educators, researchers or a researcher team consisting of mathematics educators, primary school teachers and researchers can prepare an instructional CD or a guide book could be prepared for teachers to assist with their problem posing instruction in their classrooms.

Furthermore, similar studies using the same or similar questionnaire can be conducted with primary school teachers of other countries to uncover their views about problem posing applicaition/activities and in the future teachers views can be compared. According to results of comparative studies if teachers have the similar issues related to problem posing applications/activities, teacher educators can come together and work on these issues and a number of solutions can be produced.

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