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Ali Delice, Emin Aydın, and K. Seda Çevik  
Marmara Üniversitesi, TURKEY

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**The article starts with the next page.**

# Mathematics Teachers' Use of Questions: Is There a Change of Practice after the Curriculum Change?

Ali Delice, Emin Aydın, and K. Seda Çevik  
Marmara Üniversitesi, TURKEY

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The aim of this study is to investigate the questions that are used by teachers. In broader sense the intention is to focus on questions as part of teachers' formal as well as informal assessments. We will mainly concentrate on how students are assessed and how the questions in the assessments are formed and marked. The research is mainly qualitative having both descriptive and exploratory purposes. Questionnaire and semi-structured interviews are used as the research instruments Convenience sampling was chosen as the most appropriate purposeful sampling strategy for this study. The qualitative data obtained from 86 teachers were categorised in terms of themes relevant to research questions and then these categorizations were coded. Data was collected in two phases. In the first phase a semi-structured interview was conducted to reveal the contexts in which teachers ask questions. Second phase started one month after the end of the first phase for which interviews and questionnaire were used together. Two dominant themes that emerged from this study are the effect of the institutional context teachers working within and the national examination system.

*Keywords:* mathematics assessment, mathematics questions, marking questions, curriculum change

## INTRODUCTION

Teachers' questions have been a research interest in recent years (e.g., Harrop & Swinson, 2003; Martino & Maher, 1999; Yackel & Cobb, 1996). Literature does not indicate a simple cause & effect relationships in among teacher questions, type of instruction and student learning (Klinzing et al., 1985; Hiebert & Wearne, 1993).

There has been a substantial amount of research done on the frequency, types, and categorization of teachers' questions (e.g. Cotton, 1989; Moyer & Milwicz, 2002). The most famous categorization is Bloom's taxonomy (Bloom, 1956). There are two broad types of teacher questions: low-level and high-level (Black, 2001). Findings indicate that 50%-80% of

teachers' questions are low level (Black, 2001; Gall, 1984; Kawanaka & Stigler, 1999; Sahin, 2007). High-level questions whose answers need deeper thinking and evidence (Aydın & Delice, 2010) are used only by twenty percent of teachers' questions (Brualdi, 1998; Gall, 1984; Kawanaka & Stigler, 1999; Hiebert & Wearne, 1993; Klinzing, et al, 1985). There also seems to be no relation between the level of questions asked and student learning as measured by their achievement levels (Gall, 1984; Winne, 1979).

According to Niss (1993) questions that need higher mental abilities have long dominated classroom practice. This trend does not seem to change much universally (Martin, 2003; Kogce & Baki, 2009a & 2009b). Martin (2003) used Ainley's (1987) categorization to classify classroom questions of teachers she observed in her study. She found out that only 25% of the questions are genuine, which are asked because the teacher wants to know the answer (e.g. 'How many different triangles did you find?'), 61% are test questions, which are asked when the teacher already knows the answer to find out

Correspondence to: Ali Delice,  
School of Education, Marmara Üniversitesi, Istanbul,  
TURKEY  
E-mail: alidelice@marmara.edu.tr  
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### **State of the literature**

- The types and proportions of questions used by the teachers are somewhat affected by their models of teaching and the stages of instruction.
- Classroom questions help teachers build a satisfactory understanding of mathematical concepts and procedures through “the negotiation of meaning for necessary condition of learning”.
- The act of asking a good question requires considerable amount of pedagogical content knowledge and knowledge about the learners.
- Turkish mathematics teachers do not seem to have the assessment skills to cope with the requirements of the new curriculum.

### **Contribution of this paper to the literature**

- There are differences between teachers’ ideas about question preparation with respect to institution in which they work.
- More experienced teachers’ answers include fewer details. When the experience period decreases, consideration of educational theories and taxonomies also increases?
- Before the curriculum change teachers were left to their own devices for developing their practices. Now the scene is rather different. That is, the new curriculum has concrete suggestions on patterns of behaviour that might lead to effective teaching and assessment
- Assessment practices are resistant to change due probably to the fact that ‘the methods and purposes of assessment are deeply embedded in the education system of a country’.

if the student knows it (e.g. ‘How many sides in a triangle?’) and 14% are provoking questions which are asked to draw attention to something the teacher wants the student to think about. (e.g. ‘why is that?’). Martin (2003) did another analysis with teachers’ questions using also the Bloom Taxonomy and ended up with the following findings: 56% of them were lower mental process and 44% were higher mental process (23% of which were application) questions.

The types and proportions of questions used by the teachers are somewhat affected by their models of teaching and the stages of instruction (Yei, et al., 1998) According to Hiebert and Wearne (1993) the context of the kind of instruction and the mathematical tasks have a role in the teachers’ selection of questions during their teaching. Teachers in ‘progressive’ classrooms do not necessarily seem to ask more quality questions (taken as a measure of effective teaching). Boaler et al. (2004) states that rather than the curriculum approaches per se

(e.g. traditional or reform-based), teachers themselves have the critical role in each approach. For example, teachers in classrooms designed in line with the requirements of the new learning tended to ask more questions than the ones in “traditional” classroom both in lower and higher order types (Hiebert & Wearne, 1993).

### **Aim of the Study**

Classroom questions help teachers build a satisfactory understanding of mathematical concepts and procedures through “the negotiation of meaning for necessary condition of learning” (Voigt, 1992, p. 43). This statement is generally true if the questions asked are formatively used (i.e. in enhancing learning). Questions asked in a written examination are mostly part of teachers’ formal practices and are more likely used for summative (i.e. grading) purposes (Türnüklü, 2003; Aydın & Önder, 2010). Since the distinction in the summative/formative dichotomy is defined in terms of purpose, to classify a given question as formal or informal is much easier than classifying it as summative or formative, hence we think, it is important to have a feeling about the underlying intentions of the teachers in asking formal and informal questions.

According to Boaler, et al. (2004) the act of asking a good question requires considerable amount of pedagogical content knowledge and knowledge about the learners. Another reason for choosing the topic for work is related to teachers’ assessment skills. We believe it is important to know how the quality of assessment of students’ performances and to what extent these assessments based on their pedagogical content knowledge. Turkish mathematics teachers do not seem to have the assessment skills to cope with the requirements of the new curriculum (Türnüklü, 2003). Their practice, we believe, is more like a combination of what they observe from their colleagues in the school and repetition of what they saw from their teachers during their education. In other words, they do what they learn informally rather than formally.

Recent changes in mathematics curricula in many countries worldwide signalled the need for changes in teaching and assessment approaches (Pfanckuch, 2001). After the change in the Turkish Curriculum, textbooks were rearranged by using new methods which mostly considered daily life applications mainly based on a the constructivist learning theory. Nevertheless, teachers continue to prepare assessments subjectively without any consideration of the curriculum change. There was no common framework used by teachers for the assessments. Even when Turkish Curriculum Board accepts the importance of that change, regulations do not seem to indicate any standardization (Official Newspaper, 2007). It should be accepted that questions

asked in the process of teaching and assessment have a critical bridging role between teaching and learning. It seems that teachers use questions mainly in classroom activities (during lecture & practice activities), in lesson materials (e.g. worksheets), exams (quizzes, midterm assessments, term assessments) and in homeworks. Since they can be also used to observe the way students construct their knowledge, preparation of questions should be done carefully. Otherwise, they may block learning activity and divert the objectives of the lesson. Using Boaler et al.'s abovementioned assertion that rather than the curriculum approaches per se (e.g. traditional or reform-based), teachers themselves have the critical role in each approach, we believe the focus of the study is important also in the context of the 'teachers vs. teaching styles' debate (Boaler et al., 2004)

The aim of this study is to investigate the questions that are used by teachers in their assessments, lessons and materials. In broader sense the intention is to focus on questions as part of teachers' formal as well as informal assessments. We will mainly concentrate on how students are assessed and how the questions in the assessments are formed. The following research questions will be explored in our research:

RQ1 Is any common taxonomy or framework used by teachers while preparing questions?

RQ2 Are there any similarities/differences between characteristics of questions?

RQ3 How the performance of students is assessed?

RQ4 Did the assessment styles change after the shift in curriculum?

RQ5 Which criteria are used for students' performance assessment?

## METHODOLOGY

This research is descriptive (because it deals with perspectives of teachers approach to questions and assessment) and exploratory (because it tries to find out what is happening) (Robson, 1993, p. 42) which uses a non-positivist paradigm which is interpretivist with a naturalistic enquiry approach. In terms of the data type, the research is mainly qualitative. Questionnaire and semi-structured interviews are used as the research instruments to answer the research questions RQ1-RQ5.

In order to answer abovementioned research questions we designed six specific questions. Q1-Q4 are the semi-structured interview questions while the rest are asked in the questionnaire:

Q1. For what contexts (parts of classwork) do you ask questions?

Q2. How do you choose the questions you ask in the places you mentioned in the above question?

Q3. Can you write questions to match with the contexts above?

Q4. Can you solve one of the questions you wrote above?

Q5. Can you evaluate the degree of difficulty 1-10 of the given questions and in what contexts do you think can that question be used?

a. If  $f =$  and  $g =$  then  $(f \circ g)(2) + (f \circ g^{-1})(2) = ?$

b. If  $f(5x-4) + g = 3b+5$ ,  $f(6) = 3$  and  $g(4) = 5$  then  $b = ?$

c. If  $f(5x+a) = 5x-1$ ,  $g(x + f^{-1}(x)) = 4x+1$  and  $g(3) = 9$  then  $a = ?$

Q6. The answers given by three students to the question given above is given below. Can you mark these answers out of 10 by giving reasons for your decision?

The questionnaire contains two questions some of which are open ended. These were mainly based on how teachers prepare questions for classroom activities, assessments and homeworks. In the questionnaire, teachers were asked to give examples for every type of questions to reveal what type of categorization is used. Whether teachers use questions without consideration of any taxonomy or structure is also examined. Last item in the questionnaire requires teachers to give marks to the question that they write themselves by considering how they will evaluate students' answers for that question. This would reveal whether they assess students' performance in detail. Semi-structured interviews were conducted with five teachers to get more insight into teachers' thinking, attitude and approach to the questions. All interviews are recorded to be analysed later.

Purposeful sampling, which is the dominant strategy in qualitative research, seeks information-rich cases which can be studied in depth (Patton, 1990, pp. 182-183). The most appropriate purposeful sampling strategy to this study is convenience sampling in which available individuals are taken or the cases are taken as they occur (ibid.). In this research, target population was high school mathematics teachers. 86 teachers participated in the study 40 of which were state school (SS) teachers, 12 from private schools (PS) and 34 of which were from preparation courses for university entrance examination (EPC).

The qualitative data were categorized in terms of themes relevant to research questions and then these categorizations were coded. Robson (1993, p. 385) defines a code as symbols to classify or categorize a group of words and moreover he highlights them as retrieval and organising devices to find and then bring all occurrences of a particular kind together. Coding qualitative data was helpful to comment on the overall picture in terms of the categories created in the light of the research questions and also it also gave a tidy and structured view of massive data.

## Process of Data Collection

Data was collected in two phases. In the first phase a semi-structured interview was conducted to reveal the

**Table 1.** Distributions of the participants

Years of experience	0-10	11-20	Total
School type			
State school (SS)	24	16	40
Private school (PS)	16	8	24
Exam Preparation Courses (EPC)	28	6	34
Total	60	26	86

contexts (parts of classwork) teachers ask questions (see below). Three contexts emerged as a result of the analysis of data from the first phase: (1) examination, (2) classwork and (3) homework. This data was used as an input for designing the second phase of the data collection. Data from the first phase helped to formulate the questions Q2 - Q6. Second phase started one month after the end of the first phase for which interviews and questionnaire were used together. The designated samples in different phases of data collection were the same although there was difference in rates of participation.

## DATA ANALYSIS

The qualitative data was obtained from the answers given to six questions Q1 - Q6 in questionnaire and semi-structured interviews.

There were 86 teachers in total who participated in this research. Teachers were categorized with respect to the institutions they are working in and their experience (Table 1). Teachers' answers were analysed in terms of their institutions and experiences. The existence of relatively less number of teachers existing in the 11-20 categories may be the reflection of PS and EPC administrators' preference of working with younger teachers. Data overall was analysed with respect to 'school type', 'years of experience' and 'frequency and percentage of rating'.

Answers that are given for the question about the factors teachers consider in preparing questions used in their lessons were analysed whose findings were summarized in Tables 2, 3, 4 and 5. Apart from the general analysis, frequencies and percentages of rating were given for each school type and two experience categories separately and as general sum. Findings are presented under two subheadings: (1) contexts of teachers' questions and (2) teachers' grading and marking practices.

### Contexts of teachers' questions

Under this subheading, findings from Q1 - Q3 are presented. Table 2 summarizes findings of Q2, Tables 3-5 summarize findings from Q2 and Table 6 summarizes findings from Q3. The analysis of Q1 relies on the data from the first phase, and for analysis of questions Q2 - Q6 we use data from the second survey.

We start with Q1 which asks the teachers for what contexts (parts of classwork) they ask questions. The first categorization of the data for the above question revealed two categories: teachers who showed effort to (49%) and those who do not (51%) to classify. Three contexts emerged as a result of the analysis of data from teachers who attempt to classify: questions asked (1) in the examination, (2) for classwork and (3) homework. These data was obtained from the second phase of the data collection process.

We start our analysis with the second category, that is those who did not make any classification (51% of all) for whom (in simplistic terms) there seems to no difference between a question for an exam, for homework & for classroom practice (see Table 2) or any other contexts. Their considerations about question preparation were based on generally subjective judgements. For instance, *measurement of knowledge* is mentioned by 25% by SS teachers, 50% in PSs and 44% in EPC teachers. SS teachers mostly consider Suitability to the *level of class* (8 teachers) and *curriculum relevance* (14 teachers). However, most teachers do not seem to depend on textbooks except 6 (44%) EPC teachers. EPC teachers consider *measurement of students' knowledge* and dependence on *textbook* as the most important factors (7 teachers each). EPC teachers, quite understandably, did not consider the *measurement of creativity, curriculum relevance* and or paying attention to make connections to *real life contexts* while asking questions.

Table 2 also reveals qualitative and quantitative differences with respect to teachers' levels of experience. First, 11-20 teachers considered more factors than those of 0-10. For the qualitative differences, class level that appears in factor preference of 11-20, does not appear in that of 0-10. Opposite is the case for the *originality* and *creativity* factors.

Below we present findings from Q3 which includes the second category (49%) of teachers who *classified* the questions they ask as part of their teaching. Their answers revealed three different contexts they mainly ask mathematics questions: During (1) exams, (2) classwork and (3) homework. The results are summarized in Table 3, 4 and 5 respectively. Since there were little contribution from the teachers with 11-20 years of experience, 0-10 and 11-20 categories were added together and 11-20 categories vanished for the findings of Q3.

Table 3 summarizes teachers' responses regarding factors influencing preparation of questions for *written examinations*. Teachers seem to pay attention to different details about the exam questions. *Classification of questions* is the most regarded factor, whereas *level of class* and *curriculum relevance* and *Bloom's Taxonomy* are the least considered ones in total.

Bloom's taxonomy is cited as a factor only for the SS teachers. According to types of institutions, priorities are various. For instance, SS teachers give utmost importance to *previous knowledge connection* and least to *curriculum relevance*. The generalization that teachers' choices are affected more by the practical constraints rather than the official requirements seems also to be true for the SS teachers in particular. Other choices of the SS teachers are uniformly distributed except *level of class*. PS teachers mostly agree on *Developing critical*

*thinking* and *classification of questions* as factors. *Previous knowledge connection* and *Bloom's taxonomy* are not mentioned by PS teachers. Moreover, EPC teachers mentioned only three factors: *classification of questions* (43%), *previous knowledge connection* and *level of class*.

The analysis of factors teachers consider in selection of their questions during their classroom practices is summarized in Table 4. *Previous knowledge connection* unlike in the case of exam questions, surface as the most important factor which surpassed the *classification of*

**Table 2.** Teachers' reasons for asking questions

School type	SS				PS				EPC				Total			
	0-10		11-20		0-10		11-20		0-10		11-20		0-10		11-20	
	%	f	%	F	%	f	%	f	%	f	%	f	%	f	%	f
Randomly	-	-	25	4	-	-	-	-	-	-	25	1	-	-	19	5
Class level	-	-	50	8	-	-	-	-	22	3	25	1	-	-	35	9
Measurement of knowledge	-	-	25	4	-	-	50	4	44	6	25	1	1	6	35	9
Measurement of creativity	13	3	-	-	-	-	-	-	-	-	-	-	0	3	-	-
Curriculum relevance	25	6	50	8	-	-	-	-	-	-	-	-	1	6	31	8
Originality of the question	25	6	-	-	-	-	-	-	22	3	-	-	2	9	-	-
Textbook	-	-	-	-	-	-	-	-	44	6	25	1	1	6	0	1
Real life contexts.	25	6	-	-	-	-	50	4	-	-	-	-	-	-	15	4

**Table 3.** Teachers' exam questions

	School type		SS		PS		EPC		Total	
	%	f	%	f	%	f	%	f	%	F
Previous knowledge	50	12	-	-	28	9	24	21	24	21
Curriculum relevance	17	4	50	9	-	-	15	13	15	13
Textbooks	34	8	50	9	-	-	20	17	20	17
Bloom's taxonomy	34	8	-	-	-	-	9	8	9	8
Level of class	-	-	50	9	14	4	15	13	15	13
Critical thinking	34	8	100	16	-	-	28	24	28	24
Classification of questions	41	10	100	16	43	12	44	38	44	38

**Table 4.** Teachers' questions during classroom practices

	School type		SS		PS		EPC		Total	
	%	F	%	f	%	f	%	f	%	f
Previous knowledge connection	25	10	33	9	41	13	37	32	37	32
Curriculum relevance	13	5	-	-	-	-	6	5	6	5
Textbooks	45	18	-	-	-	-	8	7	8	7
Bloom's taxonomy	13	5	-	-	-	-	10	9	10	9
Level of class	-	-	33	9	-	-	10	9	10	9
Developing critical thinking	20	8	-	-	25	10	21	18	21	18
Classification of questions	10	4	67	16	-	-	23	20	23	20

questions factor. This is followed by *developing critical thinking* and *classification of questions* factors. However, *level of class*, *textbooks* and *curriculum relevance* are the least rated factors for question selection used in classroom practice.

Results also indicate that SS teachers mention more factors, than the EPC and PS teachers. They seem mostly interested in *how the previous knowledge connection* and *developing critical thinking*. For all of PS teachers of 0-10 level *classification of questions*, *developing critical thinking* and *previous knowledge connection* are important factors for asking classroom questions. *Developing critical thinking* and *previous knowledge connection* are rated important also by the EPC teachers.

As indicated in Table 5 teachers' primary aim overall in the homework questions they ask is the *development of critical thinking* (although the meaning given to the item by the EPC teachers may be slightly different). *Level of class*, *previous knowledge connection* and *Bloom's taxonomy* are the other important factors. Data indicates no significant school differences: choices are similar for the three groups of teachers (again, homeworks may have a narrower meaning for the EPC teachers, i.e. the test items left for the students to solve at home).

We also wanted to find out if and how teachers' questions fit the contexts in which it is used (Q4). In order to fulfil that purpose, in the interview, we asked the teachers to write a mathematics question, say in which context they would use it (classwork/homework/examination) and explain their reasons for their choices. Answers were examined in terms of their clarity and completeness. Degree of completeness was defined as having four hierarchical

levels: (1) complete answer, (2) example(s) & context given but no reasons, (3) only purpose given, and (4) no answer. Table 6 summarizes the analysis of their answers. At the first glance we could see that teachers were generally attempted to give an answer (the percentage of 'no answer's is about 25% overall). Findings indicated that least frequent category is the *complete answers* (16%), and the most frequent one is the answers in which *only context stated* (42%). Teachers' answers were not uniformly distributed to four levels and that frequency decrease is negatively related to the degree of completeness. Data, moreover, does not show noteworthy differences in terms of either school type or experience.

Clear answers were mostly given by PS (100%), EPC (60%) and SS (50%) teachers respectively. Moreover, among the teachers who wrote questions, the 11-20 group performed better than the 0-10 group in terms of the question-purpose consistency. Some of teachers who gave unrelated or incomplete answers wrote that they did not understand the reason why that question was asked.

### Teachers' marking practices

The rest of the findings were about teachers' behaviour patterns in the process of marking students' answers. In that regard, we wondered how they approach a solution (e.g. do they solve the question, do they give partial credits, do they give reasons for their marks, how they distribute points to the questions in a test, etc.). Here we present findings from Q4 - Q6 which are summarized in Tables 7-9.

**Table 5.** Teachers' homework questions

	School type		SS		PS		EPC		Total	
	%	f	%	f	%	f	%	f	%	f
Previous knowledge connection	30	12	-	-	24	8	23	20		
Curriculum relevance	10	4	-	-	-	-	5	4		
Textbooks	10	4	-	-	-	-	5	4		
Bloom's taxonomy	20	8	33	9	14	5	26	22		
Level of class	20	8	33	9	35	12	34	29		
Developing critical thinking	35	14	67	16	47	16	53	46		

**Table 6.** Teachers' questions and the contexts in which they are asked

	School type		SS		PS				EPC				Total					
	Y's of practice		0-10		11-20		0-10		11-20		0-10		11-20		0-10		11-20	
	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f		
Complete answers	17	4	19	3	13	2	0	0	15	4	17	1	17	10	15	4		
Example(s) & context stated	26	6	25	4	25	4	0	0	27	8	33	2	21	18	26	6		
Only context stated	37	9	38	6	38	6	50	4	35	10	17	1	29	25	42	11		
No answer	20	5	19	3	25	4	50	4	25	7	33	2	19	16	35	9		



Q4 asks the teachers to solve and then mark one of the questions they were asked to formulate in Q3 (see Table 7 for the summary of findings). We wanted to explore, with this item, mainly how the teacher gives grades to their students. More specifically, we wondered, for example whether or not the teacher herself/himself solves the question before grading, s/he explains her/his reasons how s/he (if at all) gives partial credits.

Looking at the data in general, it is seen that many teachers solved the questions before marking (60%) but some of the answers contained solutions but not proper markings (14%). Nevertheless, very small number of teachers added explanations for their marks (10% of less experienced). Considerable number of teachers (53% of

all teachers, 70% of less experienced) gave points only if there is a result (regardless of their correctness).

Data does not suggest noteworthy differences due to experience. However for the school type variable there are a few points to mention: *Giving points only if there is a result* is a very extreme attitude among EPC teachers (72%) and less extreme in PS (56%) and SS (50%) teachers. *Explanation of marks* occurred in a very small rate overall but the smallest rate is in answers of EPC teachers.

We also wanted to explore whether or not there is consistency between question difficulty and marks given (i.e. difficult questions gets higher/lower marks or difficulty may not affect distribution of marks). (see Table 8 for the summary of findings). Hence, teachers'

**Table 7.** Teachers' behaviour patterns in the process of marking their questions

	School type		SS		PS		EPC		Total							
	Years of practice		0-10		11-20		0-10		11-20		0-10		11-20			
	%	f	%	f	%	f	%	f	%	f	%	f	%	f		
Question solved then marked	67	16	25	4	100	16	-	-	46	13	50	3	75	45	27	7
Question solved but answers unmarked	17	4	25	4	-	-	-	-	14	4	-	-	13	8	15	4
Question solved & marks explained	17	4	-	-	-	-	-	-	7	2	-	-	10	6	-	-
Partial points given for every step	17	4	-	-	56	9	-	-	17	5	-	-	30	18	-	-
Points given only if there is a result	50	12	25	4	56	9	-	-	72	21	-	-	70	42	15	4

**Table 8.** Marking consistency of teachers with the difficulty of questions

	School type		SS		PS		EPC		Total					
	Y's of practice		0-10		11-20		0-10		11-20		0-10		11-20	
	%	f	%	f	%	f	%	f	%	f	%	f	%	f
Consistent marking	45	11	63	10	38	9	39	11	100	6	52	31	62	16
Inconsistent marking	12	3	-	-	-	-	7	2	-	-	8	5	-	-
Equal points	45	11	31	5	38	6	32	9	-	-	43	26	19	5
Gaps between points	-	-	13	2	-	-	7	2	-	-	3	2	1	2

**Table 9.** Teachers' reasons for the marks they give

	School type		SS		PS		EPC		Total							
	Y's of practice		0-10		11-20		0-10		11-20		0-10		11-20			
	%	f	%	f	%	f	%	f	%	f	%	f	%	f		
Incorrect explanation	-	-	6	1	-	-	-	-	-	-	-	-	4	1		
Correct explanation	29	7	6	1	38	6	38	3	32	9	34	2	37	22	23	6
No explanation	58	14	88	14	25	4	-	-	64	18	67	4	60	36	69	18
Partial credit	42	10	63	10	25	4	38	3	-	-	-	-	23	14	50	13
No partial credit	42	10	37	6	38	6	-	-	100	28	100	6	73	44	46	12
Personal judgement	-	-	6	1	-	-	-	-	-	-	-	-	-	-	4	1
Answer key	29	7	90	15	-	-	-	-	-	-	-	-	12	7	58	15



answers are investigated in four categories; consistent marking, inconsistent marking, equal points and gaps between points.

In general, inconsistent marking does not seem to be commonplace for the teachers (8% of the 0-10 & 0% of the 11-20). Moreover, highest percentage in both groups is seen in *consistent marking* row (52% of 0-10 & 62% of 11-20). The fact that there is no *inconsistent marking* in 11-20 group and higher percentage for *consistent marking* (62% > 52%) may be attributed to the positive effect of experience. The analysis of data for each school types seems to corroborate the above finding. Giving equal points regardless of question difficulty level occurred in a higher rate among the less experienced teachers (43% of teachers of 0-10 group and 19% of the 11-20 group).

Finally, we wanted to investigate teachers' reasons for the marks they give. Our specific interests here are: (1) the quality of reasons provided for the marks given, (2) whether or not partial points were given and (3) the availability of an answer key or reliance on their personal judgements (based on their intuitions) during markings. Data from teachers is summarized in Table 9.

Data from Table 9 indicates that teachers in general (63%) did not tend to provide explanations for their marks and almost all of the explanations provided were correct. There was also a general tendency for not giving partial points to students' answers (65%). For answer key vs. personal judgement duality teachers tended to be on the former side: total of 22 teachers used answer keys whereas only one teacher relied on her/his personal judgement. Nevertheless, use of answer keys is not a common practice in general. Only SS teachers prepared keys before giving grades. Answers of 90% of experienced and 28% less experienced SS teachers contained keys. Findings do not suggest noteworthy differences between experienced and less experienced teachers.

## DISCUSSION

In the discussion of the findings, first, we will discuss questioning practices of Turkish mathematics teachers in general. Later, we will look at differences that the data revealed with respect to the schools teachers work in (we label it as the 'effect of institution') and with respect to experience. Our real concern, however, is to explore if the data says anything significant in the context of the changes in the curricular system of teacher education and redesign of the programs of primary and secondary education based on the constructivist principles.

For the discussion of findings regarding questioning practices of Turkish mathematics teachers overall, answers were analysed in three different occasions they mainly ask mathematics questions, which were examination, classwork and homework. For the

preparation of exam questions *classification of questions* is the most regarded factor, for classroom questions. *Previous knowledge connection* and *development of critical thinking* are the main motives for asking questions during *classroom discourse* and for *homeworks*. Questions prepared for examinations, because of its 'high stakes' status, are perceived as having an utmost importance. Extra care is needed during their preparation and time spent for their preparation is much longer compared to the other question types. Whereas questions for classwork and homework are perceptually 'lighter'. It seems that during teacher-student interactions, questions are generally asked for a 'smooth' flow of teaching (by making students realize 'connections between knowledge') and to increase motivation and rather than for understanding what is going on in students' minds. As the responses given to *developing critical thinking* and *Bloom's taxonomy* suggests, teachers seem to give importance to the development of higher mental processes in their homework questions.

The common attitude of teachers for not adding explanations for the marks is one of the characteristics of the emerging models of teacher assessment in England: 'The Intuitives' (McCallum et al., 1995, p.63) were the ones who object to the national system of assessment. Those teachers also tended to be summative in their assessments who not seemed too eager to give any points to incomplete answers or correct answers with calculation errors and gave points only if there is a result (regardless of their correctness) and very little who give *points only if there is a result*. The key characteristics of these teachers was their over-reliance on memory and reactionary attitude towards any attempts to systematize assessment (McCallum et al., 1995, p.64) may partly explain why some teachers did not prefer to use answer keys in their markings.

Results indicate that there are differences between teachers' ideas about question preparation with respect to institution they work in. The comparison of the questioning practices of teachers with 0-10 and with 11-20 years of experience is important, again, for being able to see (although in a limited sense) what the differences are, if any, between teachers who took their training after and before the start of the new system that took effect in faculties of education in 1998-99 academic year. If, on the other hand, we approach the data with the intention to explore the difference solely due to experience (within the boundaries of the expert-novice paradigm (Borko & Livingstone, 1989)), the differences of practices can still be of use.

It is almost certain that the positive traces of the changing paradigm can be observed more likely in the 0-10 group, following the argument of Fullan and Stiegelbauer (1991) that teacher education does have an impact. Although the new school curriculum was initiated in 2005 by the Ministry of National Education

(MoNE), the changes in the teacher education system took effect seven years prior to that with conclusion of the World Bank/MoNE joint project of National Education Development (NED) that took place between the years 1994-1998. Hence it can be assumed that the graduates of the new teacher education system were (although not at a very satisfactory level) better equipped with the skills and knowledge to cope with the requirements of the new curriculum based on constructivist principles on learning (we must regrettably note that the quality of teacher education throughout the country is not uniform). Hence the data contained from the teachers with 0-10 experience can be more useful for our interest of the influence of the new mathematics curriculum on teachers' practices.

Teacher training is a key component in shaping teachers' views of teaching. Nevertheless, it is not logical to expect that all of the teachers' teaching behaviours are in line with what they learned in their education. Ernest (1989) argues that there are strong pressures from curriculum and national system of schooling that may cause differences between teachers' beliefs and practices. Institutions are among such pressure agents. That is, institutions are organizations that have a power to similarize practices of teachers working within (Bingölbali, 2005). It may be that, in a particular institution, certain acts and particular outcomes are valued over others (Holland, et al., 1998, p.52). SS teachers' over consideration of *curriculum relevance* or EPC teachers' not giving partial points to question are practices are most likely the result of formation of similar patterns of behaviour of people working in the same institution.

Although the relationship between knowledge and teaching practice is not straightforward (Thompson & Thompson, 1994, 1996) there is evidence that teachers' practice has an active role for internalization of their pedagogical content knowledge (Cohen and Manion, 1994, pp. 132-167). Gödek (2004) points out that teacher training programs should provide opportunities for teachers to practice what they have learned. Carefully designed partnership schemes can serve this purpose (Lieberman & Miller, 1990), although there are problems (Aydin, 2009). What is not 'reflectively' practiced (Schön, 1983) will be forgotten much easily (Aydin, 2002). Hence after the education if teachers cannot find the opportunities to apply their knowledge into practice, high stakes start to operate. That is, practice shapes beliefs (Aydin, 2002).

Teachers' choices are affected more by the practical constraints rather than their educational backgrounds. Although new teacher training program is a step forwards in developing skills for teaching mathematics, there still are internal problems. Despite the fact that the courses given in the program seem well suited for the teacher candidate, some problems arise due to the content of the course and the course instructors' background. One problem stems from design of courses

which allegedly develop 'pedagogical knowledge'. In the content of the 'measurement and evaluation' course, for example, the main focus has long been 'teaching' knowledge centered on the classical testing theory. This, however, does not ever match with the reality of the classroom. What candidates really need are content specific assessment skills (Aydin & Delice, 2010).

Since every type of institution has different aims in terms of math education in Turkey, teachers may not have chance what they have learned at university. EPCs, for instance, try to make students faster question solvers. They naturally are not interested in measurement of creativity and asking questions that involve real life applications. Students are encouraged to memorize and share knowledge that they have acquired (Tynjala, 1999) instead of searching for and applying new knowledge (Bereiter & Scardamalia, 1993). However, PS teachers regard daily life connections which include creativity based on the constructivist approach. Without the cooperation of universities and schools, teachers may have to obey the institutions that they have worked in and forget what they have gained during the university education.

Teachers' having different considerations can also be related to the experience. Data indicated that the less the period of experience, the more teachers act in line with the requirements for the curriculum shift. Berliner (1988) outlines in the five -stage model of teacher development that expert teachers have automated routines which can be the reason of non-adaptation to the curriculum changes. Sanchez et al. (1999) found out that experts have tendency to ask higher-order questions, including the analysis or synthesis of information while novices commonly ask rhetorical questions. However, data from this study indicated that more experienced teachers' answers include fewer details. This is related to the relationship between expertise and experience. When the experience period decreases, consideration of educational theories and taxonomies also increases. Since the percentage of 1-5 year teachers are highest in SSs, consideration of Bloom's taxonomy exists. Not every steps, but 20% of teachers used analyses and synthesis steps (upper levels); 20% of them used knowledge and application (lower levels) steps. As can be seen, even Bloom's taxonomy is considered by some teachers, they do not seem to be conscious about the meanings of the stages. Experience, only, is not enough to lead to a more advanced schema in terms of pedagogical knowledge (Aydin, 2002), but is the experience that is 'reflected on' (Berliner, 1988).

## RESULTS AND SUGGESTIONS

Two dominant themes that have emerged from this study is the effect of the institutional context teachers working within and the national examination system.

The institutional context surfaced in several ways: the requirement for reports; the way teachers operate within the school; and the professional education of the teacher (Pfannkuch, 2001).

Criteria teachers used seem to be affected by the requirements of institutions they work, educational background and experience period. Questions are not prepared based on the curriculum shift. Questions, as a very important factor in learning, seem to be used without any theoretical background. We believe that more emphasis needs to be given to questioning practices during their training period. Moreover, a parallelism needs to be established between universities and schools to ensure that teachers are able to apply what they learned during their training.

Transparency is a crucial requirement for a democratic society. Hence, society demands from the teachers to be as objective as possible in their assessments. While assessing students' performance, it may be useful for the teachers to think about the criteria actual marking process. In an institution, individual attempt to be objective may not be enough. It is important that all teachers behave in the same way and decision be given in a consensus and precautions need to be taken to ensure similar practices. Consideration of educational taxonomies or theories may provide more effective and objective decisions which would ultimately increase reliability and validity. Feedback should be an integral part of the assessment process: For example after the results of an examination made public, it would be better to provide students the opportunity to see what their faults are.

Before the curriculum change teachers were left to their own devices for developing their practices. As a result, teachers' classroom practices had mainly been shaped by the combination of what they had seen in other teachers' practices in the same school and what they had been exposed to in their education. Now the scene is rather different. That is, the new curriculum has concrete suggestions on patterns of behaviour that might lead to effective teaching and assessment (MNE, 2005). However, reflections of assessment related suggestions in teachers' classroom practices were less in magnitude than teaching related suggestions. There is evidence that assessment practices are resistant to change due probably to the fact that 'the methods and purposes of assessment are deeply embedded in the education system of a country' (Pfannkuch, 2001).

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