AN ANALYSIS OF TURKISH MATHEMATICS TEACHERS' SELF-REPORTED PREPAREDNESS TO TEACH ALGEBRA IN TIMSS 2007

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The purpose of the study was to investigate Turkish mathematics teachers' self-reported preparedness to teach some particular topics in school algebra and determine possible difference among group of teachers with different teaching experience. For this purpose, the data collected from 146 Turkish mathematics teachers in TIMSS 2007 were analyzed. First of all, teachers' self-reported preparedness in each topic were analyzed with descriptive methods. Then, one-way MANOVA was run. According to the descriptive results, although majority of the Turkish teachers reported that they were very-well prepared to teach the stated algebra topic, they reported less well prepared to teach algebra compared to their counterparts around the world. On the other hand, MANOVA analysis was nonsignificant.

INTRODUCTION

Several studies have pointed out that cognitive and affective domains are related (e.g., see Ma & Kishor, 1997; Mandler, 1989; McLeod, 1992). Therefore, current reforms in mathematics education (e.g., National Council of Teachers of Mathematics [NCTM], 1989, 1990, 2000) emphasize the incorporation of affective and cognitive factors in mathematics education. However, the literature suggests that researchers have emphasis on the cognitive domain compared to the affective domain. Thompson (1992) attributes this neglect to the effect of the behaviorisms in education for a certain period of time.

It is obvious that trends in mathematics education are changing and developing over time and these developments guide the trends in mathematics education research. Like the neglect of affective domain in the past, teachers, compared to students, have been ignored as focus of studies for a long time (Even, 2008). Still, there are fewer studies about mathematics teachers' cognitions and conceptions and their effect on their teaching.

Similarly, researches in algebra, which is one of the subdomains of mathematics, struggles with similar deficiencies. Doerr (2004) noted that while there are several studies that investigated students understanding in algebra, researches about teachers' algebraic knowledge and practices are missing. Therefore, there is need to conduct studies on teachers related issues in algebra.

Notwithstanding, in recent years, there is a considerable effort attempting to eliminate such shortcomings in the related literature. Even large scale international studies like TIMSS (Trends in Mathematics and Science Study) and PISA (Programme for International Student Assessment) collect data on (mathematics) teachers' perceptions. These studies provide comparative data among the participated countries and enable researches to understand certain issue in a broad perspective. For example, TIMSS 2007 measured mathematics teachers' perceived preparedness in teaching particular topics and provided rich data for national based and international based evaluation. For this reason, the data gathered from TIMSS 2007 were used in this study. Therefore, the purpose of the present study was to investigate Turkish mathematics teachers' self-reported preparedness to teach some particular topics in school algebra and algebra in general compared to their counterparts and to determine if there is any statistically significant difference among group of teachers with different teaching experience. The following research questions have guided the study:

1) How do eight grade Turkish mathematics teachers perceive their preparation to teach algebra in general and in the predetermined topics, comparing with international average?
2) Does teaching experience affect teachers' perceptions about their preparation to teach algebra?

The significance of this study lies not only in the results that would yield a better understanding for (Turkish) teachers' perceived preparedness in algebra but also it would provide a clear picture of possible significant relation between preparation and experience. On the other hand, the study can provide significant reflections of the present mathematics curriculum that developed in 2004 after Turkish students failures in TIMSS 1999 and PIRLS 2001 (Progress in International Reading Literacy Study) and the PISA 2003.

METHODS

Data Source and Sample

This study utilizes the TIMSS 2007 Turkish data collected from 146 mathematics teachers each of whom was teaching 8^{th} grade mathematics in a different elementary school chosen by using two-stage cluster sampling design. Schools were determined at the first stage and one class from each school was chosen randomly at the second stage. Since the number of schools were determined considering probability proportional to the size of each country, the target population was all mathematics teachers teaching 8^{th} grade mathematics in Turkey.

Instrumentation

TIMSS 2007 used achievement tests and background questionnaires to measure students' learning in mathematics and science topics and to explain the educational context behind the scores. In the present study, data from 8^{th} grade mathematics teacher background questionnaire were used (Erberber, Arora, & Preuschoff, 2008).

The questionnaire included 33 questions to collect information from mathematics teachers about their demographics, experience, attitudes, pedagogical information, instruction load, resources related to teaching mathematics, mathematics course content, and comments of teaching mathematics.

In particular, teachers were asked about their perceived preparedness in 18 topics in total, including 5 topics in number, 4 topics in algebra, 6 topics in geometry, and 3 topics in data and chance. For the present study, the following four topics in algebra were considered:

- numeric, algebraic, and geometric patterns or sequences (extension, missing terms, generalization of patterns),
- simplifying and evaluating the algebraic expressions,
- simple linear equations and inequalities, and simultaneous (two variable) equations,
- equivalent representations of functions as ordered pairs, tables, graphs, words, or equations.

Teachers were asked to mark one of the alternatives in the four-point scale: "not applicable, very well prepared, somewhat prepared and not well prepared" which were coded as 1, 2, 3, and 4 respectively.

Variables and Statistical Analysis

In the present study, as fit for purpose of the study, teaching experience and teachers' perceived preparedness to teach algebra topics stated above were taken into the consideration. While teaching experience was considered as the independent variable, teachers' preparations in specific topics in algebra were taken as dependent variables in analysis of possible mean differences in perceived preparedness among the group of teachers who have different in teaching experience.

Since the teachers wrote their exact year of teaching experience in the questionnaire, this variable was not a categorical variable. Therefore, for the appropriate statistical analysis, the data have been split into four categories and coded as "1" for having less than three years of teaching experience, "2" for 3-5 years, "3" for 6-10 years, and "4" for more than 10 years. Table 1 shows the frequencies, percentages, means, standard deviations and minimum and maximum values of teaching experience in each category.

Number of years	**Ω**	**%**	***M***	***SD***	**Min**	**Max**
Less than three years	25	17.1	1.3	.48	1	2
3-5 years	35	24.0	4.3	.79	3	5
6 -10 years	31	21.2	8.0	1.24	6	10
More than 10 years	44	30.1	22.8	6.23	11	37
OMITTED	11	7.5				
Total	146	100.0				

Table 1: Teaching Experiences of the 8th Grade Mathematics Teachers in TIMSS 2007 Turkish Data

In this study, for the first research question, percentages of teachers who perceived themselves as very well prepared on algebra are provided and compared with international average.

Furthermore, to answer whether the more experienced teachers perceived themselves as more prepared to teach the stated algebra topics, possible mean differences between the groups of teachers with different teaching experience were analyzed through one-way multiple analysis of variance (MANOVA). Since there was one categorical independent variable and four continuous dependent variables, one-way MANOVA was chosen for the analysis. In addition, one-way MANOVA was preferred because it considers four dependent variables in combination and protects against inflated Type I errors due to multiple tests of likely correlated dependent variables (Tabachnick &Fidell, 1996). All statistical analyses were carried out using the software SPSS.

For the omitted and not administered data, the listwise deletion method was used. Accordingly, MANOVA analysis was run for 130 teachers out of 146 teachers.

RESULTS

Descriptive Results

In "TIMSS 2007 International Mathematics Report" (Martin, Mullis & Foy, 2008), the percentages of teachers who perceived themselves as "very well prepared" to teach four algebra topics were given for each participated country. Based on the obtained results of four algebra topics, preparedness to algebra in general was computed. In addition, the international averages for each topic and algebra in general were calculated too.

Accordingly, while the international average of teachers who perceived themselves as "very well prepared" to teach algebra is 82%, only 66% of Turkish mathematics teachers perceived so. Comparison of Turkish teachers and international average for each algebra topics were reported in Table 2.

	Patterns or Sequences	**Algebraic Expressions**	**Linear Equations and Inequalities**	**Equivalent Representations of Functions**
Turkey	52	81	77	40
International Avg.	70	89	88	80

Table 2: Percentage of teachers who reported very well prepared to teach algebra topics

It is seen that although the majority of the Turkish teachers perceived very well prepared to teach algebra topics, the percentages are considerably lower than the international averages. The highest percentages were for algebraic expressions (81%)

followed by linear equations and inequalities (77%) and the lowest were for patterns and sequences (52%) followed by equivalent representations of functions (40%) for Turkish teachers. Similar patterns exist in the international average too. However, while the lowest percentage for Turkish teachers was for equivalent representations of functions, the lowest percentage of international average was for patterns and sequences.

On the other hand, the percentages of Turkish teachers who perceived themselves as not well prepared to teach or somewhat prepared should not be ignored. Therefore, the percentages of alternative answers were given in Table 3. For the topics, patterns and sequences and equivalent representations of functions, the percentage of teachers who reported somewhat prepared and not well prepared could not be underestimated.

	Patterns or Sequences	**Algebraic Expressions**	**Linear Equations and Inequalities**	**Equivalent Representations of Functions**
Not Applicable	10.4	-	-	28.0
Very Well Prepared	52.1	81.2	76.9	39.8
Somewhat Prepared	27.8	11.2	16.1	24.5
Not Well Prepared	9.7	7.6	7.0	7.7
Total	100.0	100.0	100.0	100.0

Table 3: Percentages of Turkish mathematics teachers' perceived preparedness to teach the algebra topics.

MANOVA Results

Before conducting one-way MANOVA, the following assumptions are met:

a) independent random sampling: Since TIMSS used random sampling technique, the observation is independent of another.
b) level and measurement of the variables: while the independent variable in this study, teaching experience, was categorical, the four dependent variables were scale variables.
c) linearity of dependent variables: to examine multicollinearity, correlations between all of the four dependent variables were checked with Pearson product-moment correlations. According to Tabachnick and Fidell (1996), problems occur at higher correlations (.90 and higher). Since the highest correlation between the four dependent variables is .70, the problem was not detected.
d) Normality: All of the dependent variables are normally distributed. ($p>.05$)

e) Homogeneity of variances: The results of Box's Test (F (30, 31082) = 1.37, p = .08) were nonsignificant which means that the group variance-covariance matrices were equal.

One-way MANOVA conducted to explore the experience difference on teachers perceived preparedness about their preparation to teach the algebra topics stated above. The results for the MANOVA were statistically nonsignificant for the teaching experience main effect, Wilks's Λ= .93 F (12, 326) = .77, p = .68. In other words, there were no statistically significant differences on teachers' perceived preparedness in teaching algebra topics among group of teachers with different teaching experience.

CONCLUSION

Based on the descriptive data, it is clear that Turkish teachers perceived themselves as less well prepared to teach all of the stated algebra topics and algebra in general compared to their counterparts around the world. This is an important observation as it may be the reason for Turkish students' low scores in algebra since many researches showed that teachers' confidence in their teaching affect their teaching efficacy and effective teaching affect students' achievement (Ingvarson, Beavis, Bishop, Peck, & Elsworth, 2004; Richardson, 2011; Vanek, Snyder, Hull, & Hekelman, 1996)

On the other hand, while the percentages of teachers who perceived themselves as very well prepared to teach algebraic expressions and linear equations are high, the percentages of very well prepared teachers to teach patterns and sequences and equivalent representations of functions are considerably lower. One possible explanation for this would be the coverage of Turkish elementary mathematics curriculum (Talim ve Terbiye Kurulu [TTKB], 2009). Compared to patterns and sequences and functions, algebraic expressions and linear equations are given more importance in the curriculum. For this reason, teachers spend more time and energy to teach those topics. Therefore, it is possible that their engagement to the topics increased their understandings and perception to teach them (Lee, Baldassari & Leblang, 2005). Similarly, in teacher education programs, elementary mathematics teachers might have not been well prepared to teach patterns and sequences or functions in elementary school level. Because, pure content courses in these topics are found to be ineffective in teachers' confidence in their teaching (Beswick, 2011).

Before analyzing the data, it was expected that teachers who have more experience in teaching perceived themselves as significantly higher prepared to teach algebra topics. Although there are several researches reporting positive effect of experience on teachers' confidence in teaching (Adams, Hutchinson & Martray, 1980; Griffin, 1983), a few studies (e.g., Wessels & Nieuwoudt, 2010) found no significant effect of experience on teachers' confidence to teach like we found in this study. Since there is not a consensus on this issue in the literature, it needs to be further investigated. Notwithstanding, this result may indicate that Turkish mathematics teachers' did not

able to upgrade their understanding in algebra topics over time. However, to rich such a conclusion, further researches are needed.

The findings of the study imply that regardless of their teaching experience Turkish mathematics teachers would require additional support to improve their understanding in algebra topics, especially in patterns and sequences and functions and efficacy to teach them. Therefore, professional development programs for strengthening teachers' understandings in algebra and for enriching their teaching with providing multiple materials should be organized. This may develop their perception to teach algebra and in turn may develop students' algebraic understandings.

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