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Preservice science and mathematics teachers' beliefs about mathematical problem solving

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Abstract

Problem solving is one of the core concepts for the learning of mathematics. In recent years cognitive factors which have an impact on problem solving are the subject of researches. Beside the cognitive factors, affective factors are also influential on learning of the mathematics. In these factors beliefs have an important role. Furthermore belief structure influences teachers as well as the students. Beliefs about the problem solving shape the behaviors of teachers in the class. The purpose of this study is to investigate preservice secondary teachers' beliefs about mathematical problem solving in terms of different variables. The research was conducted in 2011-2012 academic year in a public university of Turkey with 413 preservice physics, chemistry, biology and mathematics teachers from grade levels 1-5. In the study, Beliefs about Mathematical Problem Solving instrument which was developed by Kloosterman and Stage (1992) and adapted in to Turkish by Haciomeroglu (2011) was used. The belief structure of preserve teachers that is investigated through the instrument was examined in terms of different variables like grade levels, fields of the study, grade point average etc.

Keywords: mathematical problem solving beliefs, preservice teachers;

1. Introduction

Problem solving has been one of the key topics in education and learning activities in recent years. Preparing students for life and making them well-equipped problem solvers both in business life and in their private lives has an important place in enabling them to acquire analytic thinking skills. In this respect, mathematical problems present themselves as important tolls in order to gain such ends. The abstract nature of mathematics and its contribution to analytical thinking have the potential to make it possible for training well-equipped problem solvers.

One can talk about different variables affecting mathematical problem solving. Within the scope of this study, mathematical beliefs, which are a variable with a high potential for affecting problem solving process, will be e laborated. Schoenfeld (1992) defines mathematical beliefs as individual comprehension and emotions that shape

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individual conceptualization and mathematical behavior patterns; Raymond (1997) defines them as individual value judgments of a person that are shaped by his/her previous experience in mathematics.

Mathematical beliefs can be examined according to different dimensions. De Corte, Verschaffel and Op't Eynde (2000) categorize mathematical beliefs as beliefs related to mathematics, learning mathematics and problem solving; individual's beliefs about himself/herself in relation to mathematics, and beliefs related to learning mathematics within social context. In addition to the dimensions of mathematical beliefs, when they are constructed has also been an interesting research topic for researchers. Previous experience plays an important role in shaping the belief system. The earlier a belief is included in a belief system, the stronger it is, and the more difficult it is to change (Pajares, 1992). Moreover, belief systems affect teachers as much as they affect students. Beliefs related to the nature of problem solving are effective in shaping teachers' in-class behavior. The aim of this study is to examine beliefs of pre-service teachers related to mathematical problem solving.

2. Methodology

2.1. Sample of the study

The research was conducted in 2011-2012 academic year in a public university of Turkey with 413 preservice physics, chemistry, biology and mathematics teachers from grade levels 1-5. The distribution of students in gender, grade levels and the departments is shown in the Table 1.

Table 1. Distribution of participants in departments, grade levels and gender

Grade level	**1**		**2**		**3**		**4**		**5**		**Total**
Gender	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	
Physics	13	7	13	3	13	5	8	4	7	9	**82**
Chemistry	13	7	14	5	6	3	9	7	4	3	**71**
Biology	24	2	18	3	24	3	15	4	12	4	**108**
Mathematics	27	6	22	5	28	14	21	7	13	9	**152**
Total	**77**	**20**	**67**	**14**	**71**	**23**	**53**	**19**	**36**	**23**	**413**

2.2. Data Sources

In this study, Beliefs about Mathematical Problem Solving instrument which was developed by Kloosterman and Stage (1992) and adapted in Turkish by Haciomeroglu (2011) was used. The original instrument consists of 36 items. During the adaptation process 12 items was deleted. The adapted instrument which was used in this study consists of 24 items and five factors. These factors are mathematical skill, role of mathematics, understanding the problem, importance of mathematics, problem solving skill. 16 of items were expressed positively and 8 items negatively.

2.3. Data Analysis

Mathematical problem solving beliefs of preservice teachers were examined in terms of grade level, grade point average, gender, and department. The analysis of the data was conducted using the SPSS 15.0 software program. For the reliability analysis Cronbach Alfa coefficient was calculated (0.94). In the analysis of data one-way ANOVA and frequency analysis were used.

3. Findings

In the study, first of all, mathematical problem solving beliefs of pre-service teachers were compared according to their GPA and gender. Mathematical problem solving beliefs of pre-service teachers did not present a significant difference either according to their gender or their GPA (p>.05).

Then, mathematical problem solving beliefs of pre-service mathematics and science teachers were examined according to the department they are enrolled in and their grade level.

Table 2. Anova results of problem solving beliefs according to department and grade level

Source	Sum of Squares	df	Mean Square	F	Sig.
Department	10,529	3	3,510	9,866	**,000**
Grade level	6,844	4	1,711	4,810	**,001**
Department * Grade level	23,519	12	1,960	5,510	**,000**
Error	139,800	393	,356		
Total	5674,259	413			

According to the analysis results, mathematical problem solving beliefs of pre-service teachers present a significant difference according to the department they are enrolled in (F=9.86, p>.05). Likewise, grade levels of pre-service teachers also create a significant difference in their mathematical problem solving beliefs (F=4,81, p>.05). Mutual effect of department and grade level on mathematical problem solving beliefs of pre-service teachers is also significant (F=5.51, p<.05).

When multiple comparisons are taken into consideration, it was seen that there is a meaningful difference between pre-service mathematics teachers and pre-service science teachers in terms of their mathematical problem solving beliefs. However, there was no meaningful difference among pre-service science teachers in this respect.

Table 3. Tukey Test results for problem solving beliefs according to departments

		Mean			95% Confidence Interval	
Department	**Department**	**Difference (I-J)**	**Std. Error**	**Sig.**	**Lower Bound**	**Upper Bound**
1	**2**	-,1552	,09107	,323	-,3901	-,1552
	3	-,0548	,08749	,923	-,2806	-,0548
	4	,2274*	,07590	**,015**	,0316	,2274*
2	**1**	,1552	,09107	,323	-,0798	,1552
	3	,1004	,09543	,719	-,1459	,1004
	4	,3826*	,08493	**,000**	,1635	,3826*
3	**1**	,0548	,08749	,923	-,1709	,0548
	2	-,1004	,09543	,719	-,3466	-,1004
	4	,2823*	,08109	**,003**	,0731	,2823*
4	**1**	-,2274*	,07590	**,015**	-,4233	-,2274*
	2	-,3826*	,08493	**,000**	-,6017	-,3826*
	3	-,2823*	,08109	**,003**	-,4915	-,0731

1- Biology, 2-Physics, 3-Chemistry, 4-Mathematics

When the mathematical problem solving beliefs were compared according to grade level, there was a significant difference between freshmen and the sophomores, junior, and seniors; however, there was no significant difference between freshmen and fifth year students.

Table 4. Tukey Test results for problem solving beliefs according to grade levels

(I) Grade level	(J) Grade level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
1	2	-,4102*	,09008	**,000**	-,6570	-,1633
	3	-,3826*	,08632	**,000**	-,6191	-,1460
	4	-,4109*	,09206	**,000**	-,6632	-,1586
	5	-,1770	,09433	,332	-,4355	,0815
2	1	,4102*	,09008	**,000**	,1633	,6570
	3	,0276	,09072	,998	-,2210	,2762
	4	-,0007	,09620	1,000	-,2643	,2629
	5	,2331	,09838	,126	-,0364	,5027
3	1	,3826*	,08632	**,000**	,1460	,6191
	2	-,0276	,09072	,998	-,2762	,2210
	4	-,0283	,09269	,998	-,2823	,2257
	5	,2056	,09495	,195	-,0547	,4658
4	1	,4109*	,09206	**,000**	,1586	,6632
	2	,0007	,09620	1,000	-,2629	,2643
	3	,0283	,09269	,998	-,2257	,2823
	5	,2339	,10019	,136	-,0407	,5084
5	1	,1770	,09433	,332	-,0815	,4355
	2	-,2331	,09838	,126	-,5027	,0364
	3	-,2056	,09495	,195	-,4658	,0547
	4	-,2339	,10019	,136	-,5084	,0407

4. Results and discussion

The belief structure of the preservice teachers that is investigated through the instrument was examined in terms of grade levels, fields of the study, grade point average, and gender. Mathematical problem solving beliefs of pre-service teachers did not present a significant difference either according to their gender or their GPA. When the departments students were enrolled in are taken into consideration, there is a significant difference between pre-service science teachers and pre-service mathematics teachers in terms of their mathematical problem solving beliefs. This is an expected situation; however, it is surprising that there is no meaningful difference among pre-service science teachers, because pre-service biology teachers do not take mathematics classes, unlike pre-service physics and chemistry teachers. However, that they all study mathematics for university entrance examination and for the Public Personnel Selection Examination, an exam they all take after graduation, can be seen as the reason behind the lack of difference. Similarly, while there was a meaningful difference between freshmen and the sophomores, junior, and senior, there was no meaningful difference between freshmen and fifth year students. This can be explained by the exams these students take in order to enter the university and after graduation, too.

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