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RELATION BETWEEN STUDENTS' ATTITUDE TOWARDS MATHEMATICS AND THEIR PROBLEM SOLVING SKILLS

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Abstract: Developing problem solving competency is one of the most important goal of Mathematics teaching. This competency has to be developed starting from early school years. Thus, it is important that primary school teachers have a good problem-solving competency. The aim of this paper is to study pre-service primary school teachers' problem solving skills and their attitude towards mathematics. The results show that one third of the respondents like Mathematics although three quarters of them consider it useful for their future. Less than half of the students like to explain Mathematics and only one tenth of them like to compose mathematical problems. There is a quite strong positive correlation between students' attitude towards Mathematics and their problem solving skills. Students, who like Mathematics, who like to explain their solution to other and who don't like to solve more problems of the same type, have higher problems solving skills. The results show the necessity of developing a positive attitude towards Mathematics among pre-service primary school teachers. In addition, it is important to use teaching methods, which encourage collaboration, put the student in the situation of explaining his/her solution, and require creativity from students.

Key words: problem solving competency, attitude towards Mathematics, pre-service primary school teachers

1. Introduction

Developing the problem solving competence is the most important goal of Mathematics Education.

Problem solving competence could be developed by solving non-routine problems. Teachers rarely solve non-routine problem in their classroom (Silver et al, 2005; Leikin & Levav-Waynberg, 2007), this due or to the fact that these kind of problems are rarely given on national tests in Romania (Marchis, 2009) or teachers are not confident in their problem solving competence (Silver et al, 2005). Thus it is important to study pre-service teachers' problem solving skill and to develop methodologies for improving their skills.

For a successful problem solving, pupils need to be motivated, as there is a correlation between pupils' attitude towards Mathematics and their mathematical results (eg. Nicolaidou & Philippou, 2003). Pupils' motivation is strongly related with their beliefs about the utility of mathematics in their future life (Marchis, 2011), and with the interest level of solving the concrete problem. Teachers' attitude towards Mathematics influences pupils' attitude (Ford, 1994; Marchis, 2011). Thus developing a positive attitude towards Mathematics among pre-service teachers is essential.

The aim of this paper is to present the results of a research made among pre-service primary school teachers related with their problem solving competence and attitude towards Mathematics.

2. Theoretical background

Mathematical problem solving

In case of problem solving, an individual encounters a question he/she cannot answer or a situation he/she cannot solve using known methods or algorithms (Kantowski, 1977). In the scientific literature in many cases, instead the "problem" the expression "non-routine problem" is used, to emphasize the

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fact, that someone can't solve a problem only using immediately knowledge. TIMSS 2011 defines non-routine problems as "problems that are very likely to be unfamiliar to students. They make cognitive demands over and above those needed for solution of routine problems, even when the knowledge and skills required for their solution have been learned." (Mullis et al, 2009, p. 45).

In order to be able to solve non-routine problems, someone should have a reasonable level of problem solving competency. This competency is "an individual's capacity to use cognitive processes to confront and resolve real, cross‐disciplinary situations where the solution path is not immediately obvious and where the literacy domains or curricula areas that might be applicable are not within a single domain of mathematics, science or reading." (OECD, 2003, p. 156) Mathematical problem solving needs application of multiple skills (De Corte, Verschaffel, & Op't Eynde, 2000). Beliefs towards Mathematics are also important for a successful problem solving (Schoenfeld, 1985). To measure the cognitive processes essential for problem solving, it is better to avoid the need of domain specific knowledge and strategies (OECD, 2013), and try to evaluate logical reasoning skills, which are important for a successful mathematical learning (Nunes et al., 2007).

Attitude towards Mathematics

Based on a simple definition, attitude towards Mathematics is a positive or negative feeling towards Mathematics (Mc Leod, 1994). Based on a multidimensional definition, attitude towards Mathematics is "an aggregated measure of a liking or disliking of Mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at Mathematics and a belief that Mathematics is useful or useless" (Ma & Kishor, 1997, 27). Students' interest in mathematics, their beliefs in the utility of the mathematical knowledge in their future career or in their everyday life determine in a fundamental way their problem-solving behavior. „Belief systems are one's mathematical world view, the perspective with which one approaches mathematics and mathematical task. One's beliefs about mathematics can determine how one chooses to approach a problem, which techniques will be used or avoided, how long and how hard one will work on it, and so on." (Schoenfeld, 1985, p. 45)

Many pupils start their school years with a positive attitude towards Mathematics, but this become less positive during school years (Ma & Kishor, 1997). This tendency could be explained by the increase of task difficulties and the pressure put on pupils to cope with these demanding tasks (Philippou & Christou, 1998). Pupils' attitude towards Mathematics is influenced, among other factors, also by the teacher and teaching: teachers' content knowledge and personality, teaching methods and materials used by teacher, teaching topics with real life enriched examples (Duatepe-Paksu & Ubuz, 2009; Yilmaz, Altun & Olkun, 2010) and teachers' attitude towards Mathematics (Ford, 1994).

3. Research

Research design

Research goal

The goal of the research is to study pre-service primary school teachers' problem solving competence and their attitude towards Mathematics. We would like to find answers to the following questions:

- What attitude pre-service primary school teachers have towards Mathematics?
- How pre-service primary school teachers solve non-routine problems?
- Is there any correlation between pre-service primary school teachers' problem solving skills and their attitude towards Mathematics?

Research hypothesis

We would like to study the validity of the following hypothesis:

- There is a correlation between pre-service primary school teachers' problem solving skills and their attitude towards Mathematics.

Research tools

The research tool is a questionnaire and a problem sheet. The questionnaire contains 11 items: 3 demographical questions and 8 items related with the topic of the research; these 8 items are measured on a 4 point Likert scale from 1 – "not typical for me" to 4 – "very typical for me". The problem sheet contains 5 logical problems, which don't require any mathematical notions or methods. Thus these problems can really test students' problem solving competence. Students also were asked to explain their method of obtaining the solution.

Research sample

51 pre-service primary school teachers have filled in the questionnaire and solved the problem sheet during November 2013. They are in their 2nd respectively 3rd year of studies: 27 (52.9%) 2nd year students and 24 (47.1%) 3rd year students. In the research only one male student has participated, due to the fact that almost all the students with Preschool and Primary School Pedagogy specialization are female.

Results and discussion

Students' attitude towards Mathematics

Table 1 contains the percentages of those selecting choices from 1 – "not typical for me" to 4 – "very typical for me" in case of the affirmations given in the questionnaire.

Table 1. Pre-service teachers' attitude towards Mathematics (1 – it is not typical for me; 2 – a bit typical for me; 3 – it is typical for me; 4 – it is very typical for me)

Affirmation	1 (%)	2 (%)	3 (%)	4 (%)
I like Mathematics.	11.8	54.9	23.5	9.8
Mathematics will be useful for me in the future.	2.0	21.6	54.9	21.6
Mathematics is boring.	49.0	41.2	7.8	2.0
I like to solve non-routine problems.	11.8	37.3	39.2	11.8
I don't like to solve more problems of the same type.	29.4	39.2	21.6	9.8
After I understand a method, I like to solve more problems with the same type.	2.0	19.6	45.1	33.3
I like to explain my solution to others.	35.3	23.5	27.5	13.7
I like to compose Mathematics problems.	47.1	41.2	11.8	0.0

In the following discussion, we add columns 1 and 2 in order to get the percentages of those respondents answering "no" to the affirmation and we add columns 1 and 2 in order to get the percentages of those respondents answering "yes". We could observe that only 33.3% of the respondents like Mathematics, even if a much higher percentage (76.5%) admit, that Mathematics will be useful in their future. Only 9.2% of the students consider Mathematics boring, so this is not a reason of not liking Mathematics.

It is good that 51% of the respondents like to solve non-routine problems. However, this is a bit contradicted by the fact that 74.8% of the students like to solve more problems of the same type after they understand a method. This could be explained by the fact that students usually get routine problems at the exams, and they like to exercise the learnt methods by solving more problems with each method.

41.2% of the students like to explain their solution to other. Explaining the solution needs an adequate level of confidence, maybe this is the reason that only less of the half of the students like to explain Mathematics to their colleagues. Explaining to others is useful, as someone can better understand the problem, thus it should be encouraged. Only 11.8% of the respondents like to compose their own problem. Composing their own problems helps students in developing a positive attitude towards these problems and familiarizing with the mathematical terminology (Edwards et. al, 2002). For a future

primary school teacher composing problems is an important skill, as someone not always finds the required problems for a lesson in workbooks. In addition, teachers should encourage their pupils to compose mathematical problems.

Table 2 contains the average and standard deviation in case of the affirmations given in the questionnaire.

We could observe that the highest average has the affirmation "After I understand a method, I like to solve more problems with the same type.", so many students like to practice a learnt method by solving more problems of the same type. The lowest averages have affirmations "Mathematics is boring." and "I like to compose Mathematics problems.", so in general students don't consider Mathematics boring and they don't like to compose their own problems.

Table 2. Pre-service teachers' attitude towards Mathematics

Affirmation	Average	Standard deviation
I like Mathematics.	2.31	0.812
Mathematics will be useful for me in the future.	2.96	0.720
Mathematics is boring.	1.63	0.720
I like to solve non-routine problems.	2.51	0.857
I don't like to solve more problems of the same type.	2.12	0.781
After I understand a method, I like to solve more problems with the same type.	3.10	0.781
I like to explain my solution to others.	2.20	1.077
I like to compose Mathematics problems.	1.65	0.688

Students' problems solving skills

The problem sheet contains 5 logical problems, for each correct solution and explanation students could obtain 1 point; thus the maximum points which could be reached is 5. In case of each problem, students could get 0.25 points for the correct answer and 0.75 points for the correct logical reasoning while describing the solution. Figure 3 shows how many students have obtained each score between 0.25 and 5. We could observe that only one student has reached the maximum score.

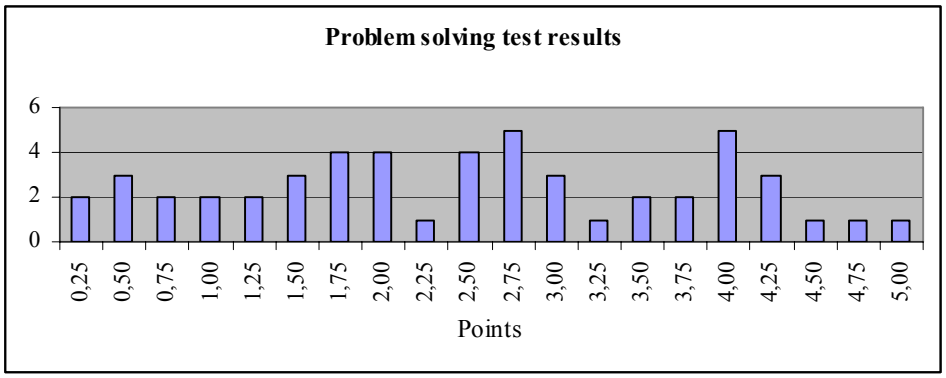

Figure 3. Problems solving test results

Figure 4 shows how many percentages of students obtained a score in intervals 0-1, 1.25-2, 2.25-3, 3.25-4 and 4.25-5 respectively. We could observe that only 12% of students have obtained a score above 4 points, the most represented categories are score between 1.25-2 and 2.25-3 (25%-25%).

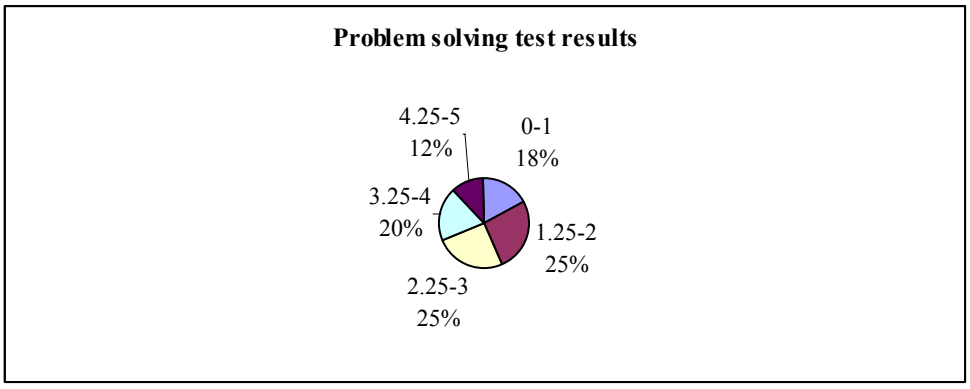

Figure 4. Problems solving test results

We have counted the number of problems correctly solved and logically correctly explained by each student (see Figure 5). We could observe, that more than one third of the students (35,3%) couldn't give a correct argumentation to any of the problems, almost one third of the students (27,5%) gave a logically correct explanation to one problem; and only one student have solved and explained correctly all of the problems.

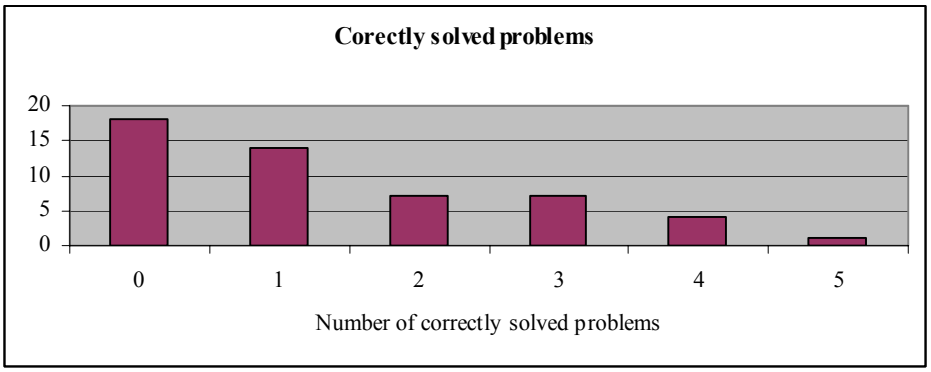

Figure 5. Problems solving test results

There is a mild positive correlation between the number of correctly solved and explained problems and the item "I like to explain my solution to others.". It is important that students explain their solution, as communication is essential for successful mathematics learning (e.g., Campbell, Adams, & Davis, 2007).

Table 6. Pearson correlation coefficients

Affirmation	Explanations given by students
I like to explain my solution to others.	0.317*

* significance level.05, ** significance level .01

Studying correlations between students' attitude towards Mathematics and their problems solving skills

Table 7 contains Pearson correlation coefficients comparing students' responses to the items of the questionnaire and their results at the problems solving test. In case of each student we have calculated an average over the 8 item (in case of items "Mathematics is boring." and "After I understand a method, I like to solve more problems with the same type." we switched 1 with 4 and 2 with 3), that

compared this averages with problem solving results. The obtained Pearson correlation coefficient is given in the last row of the table.

Table 7. Pearson correlation coefficients

Affirmation	Problems solving results
I like Mathematics.	0.356*
Mathematics will be useful for me in the future.	0.122
Mathematics is boring.	-0.194
I like to solve non-routine problems.	0.284
I don't like to solve more problems of the same type.	0.227
After I understand a method, I like to solve more problems with the same type.	-0.393**
I like to explain my solution to others.	0.317*
I like to compose Mathematics problems.	0.075
Taking in account all the affirmations	**0.408****

* significance level.05, ** significance level .01

We could observe that there is a quite strong positive correlation (significance level .01) between the responses to all the items and problem solving test results. This shows that students with a positive attitude towards Mathematics and non-routine problems have a more developed problem solving competence.

Studying the items one by one, we could observe that there is a quite strong negative correlation (significance level .01) between item "After I understand a method, I like to solve more problems with the same type." and students' problem solving competence. This means, that students, who like to solve more problems of the same type usually have lower problems solving competence. This lower problem solving competence makes these students to be unconfident in solving non-routine problems, thus they want to learn methods, algorithms and apply those.

In addition, it is a mild positive correlation (significance level .05) between items "I like Mathematics." respectively "I like to explain my solution to others." and students' problem solving competence. Students, who like Mathematics or like to explain their solutions to others usually, have a higher problem solving competence.

4. Conclusions

From the results, we could conclude that one third of the respondents like Mathematics although three quarters of them consider it useful for their future. Less than half of the students like to explain Mathematics and only one tenth of them like to compose Mathematical problems. These two percentages are very low taking in account that these students will teach Mathematics for primary school pupils, so they need to have good explanation skills and need to be able to compose interesting problems for their lessons.

There is a quite strong positive correlation between students' attitude towards Mathematics and their problem solving skills. Students, who like Mathematics, who like to explain their solution to other and who don't like to solve more problems of the same type, have higher problems solving skills.

The results show the necessity of developing a positive attitude towards Mathematics among pre-service primary school teachers. In addition, it is important to use teaching methods, which encourage collaboration, put the student in the situation of explaining his/her solution, and require creativity from students.

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