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THE RELATIONSHIP BETWEEN CANDIDATE TEACHERS' MATHEMATICAL REASONING SKILLS AND THEIR LEVELS OF USING METACOGNITIVE LEARNING STRATEGIES [1]

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Abstract

The purpose of this study was to investigate whether there was a relationship between the level of students' using mathematical reasoning skills and using metacognitive learning strategies. The study was conducted at Tokat, Gaziosmanpasa University, Faculty of Education with the students from the first class of Elementary, Elementary Science, Social Sciences, Counseling and Guidance, Computer and Instructional Technologies Education Departments during the spring semester of 2009-2010 academic education years (N=348). In this study, "Metacognitive Learning Strategies Scale" was used for determining students' metacognitive learning strategy levels and "Mathematical Reasoning Assessment Scale" was used for determining students' mathematical reasoning skills were used. Research findings revealed that there was a significant positive relationship between students' reported metacognitive learning strategies and reported mathematical reasoning skills, students' mathematical reasoning increased as the levels of students' using metacognitive learning strategies increased.

Key Words: *Metacognition, Learning Strategies, Metacognitive Learning Strategies, Mathematical Reasoning, Teacher Candidates.*

ÖĞRETMEN ADAYLARININ MATEMATİKSEL MUHAKEME BECERİLERİ İLE BİLİŞÖTESİ ÖĞRENME STRATEJİLERİNİ KULLANMA DÜZEYLERİ ARASINDAKİ İLİŞKİ

Özet

Bu çalışmanın amacı öğrencilerin matematiksel muhakeme becerileri ile bilişötesi öğrenme stratejilerini kullanma düzeyleri arasında ilişkiyi araştırmaktır. Araştırma 2009–2010 eğitim öğretim yılı Bahar yarıyılı Mart ayında Tokat Gaziosmanpaşa Üniversitesi Eğitim Fakültesi Sınıf Öğretmenliği, Fen Bilgisi Öğretmenliği, Sosyal Bilgiler Öğretmenliği, Psikolojik Danışma ve Rehberlik, Bilgisayar ve Öğretim Teknolojileri Eğitimi bölümlerinin 1. Sınıfında öğrenim gören 348 öğrenci üzerinde yürütülmüştür. Öğrencilerin, bilişötesi öğrenme stratejilerini kullanma düzeylerini belirlemek için "Bilişötesi Öğrenme Stratejileri Ölçeği" ve öğrencilerin matematiksel muhakeme becerilerini belirlemek için "Matematiksel Muhakeme Değerlendirme Ölçeği" kullanılmıştır. Araştırma bulguları, öğrencilerin bilişötesi öğrenme stratejileri ile matematiksel muhakeme becerileri arasında pozitif yönde anlamlı bir ilişki olduğunu, öğrencilerin bilişötesi öğrenme stratejilerini kullanma düzeyleri arttıkça matematiksel muhakeme becerilerinin de arttığını ortaya koymaktadır.

Anahtar Kelimeler: *Bilişötesi, Bilişötesi Öğrenme Stratejileri, Matematiksel Muhakeme, Öğretmen Adayları.*

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Introduction

The conditions of a rapidly changing life are required the individuals who can think creatively, make sound decisions, generate new ideas and solve problems. This means individuals with developed reasoning and thinking skills. It is practically impossible to introduce an individual to all the problem situations they may encounter in life and therefore, the individuals who not only get information but also uses the information to reason and solve problems might be successful in life.

Reasoning is the process of thinking thoroughly and reaching a logical conclusion. Reasoning is arriving at a conclusion using results, judgments, truths and statements and casting statements and judgments into a mould and being sure of them (Altıparmak and Öziş, 2005).

Reasoning, which is a complex and high level thinking skill, has an important place in Mathematics. The essence of Mathematics is reasoning. Mathematics is not a discipline that requires only computational skills. It also requires high level thinking skills. Reasoning is arriving at a conclusion using results, judgments, truths and statements and casting statements and judgments into a mold and being sure of them (Altıparmak and Öziş, 2005). Mathematical reasoning skills are vital skills that an individual must have. According to Ball and Bass (2003), the reasoning is a basic skill to understand mathematical concepts and use the mathematical ideas and procedures spontaneously. In other words, reasoning is a skill that takes place in the later phases of thinking (Umay, 2003). Therefore, teaching of Mathematics is extremely important for the improvement of reasoning skills. So, teachers play an important role to make individuals aware of their own reasoning skills and help them develop those skills. This is where metacognition, individual's awareness of their own thinking processes and their ability to control them, comes in. An individual's efforts to do reasoning and reach a conclusion, their conscious realization of the steps in the problem solving process entails the development of metacognitive skills. Metacognitive skills include a conscious control over learning, strategy selection and planning, monitoring the improvement in learning, error correction, analyzing the efficiency of learning strategies and changing learning behaviors and strategies when necessary. (Ridley, Schutz, Glanz and Weinstein, 1992, quoted: Balcı, 2007). Metacognitive skills are the skills of monitoring learning efficiently during learning. These skills facilitate learning (Senemoğlu, 2004, p. 336).

Teaching metacognitive skills are based on the assumption that an individual can control their own cognitive processes and maintain a more efficient learning by organizing them when they understand how their own cognitive processes work (Ülgen, 2004). According to the studies, the teaching of metacognition increases the level of success, provides an efficient learning and there is a strong relationship between metacognitive strategies and mathematical reasoning and problem-solving skills (Demir-Gülşen, 2000; Desoete, Roeyers and Buysse, 2001; Kramarski, Mevarech and Arami, 2002; Jbeili 2003; Mohamed and Nai, 2005; Mevarech and Fridkin 2006, Pilten, 2008).

There are very few research done in Turkey that deal with the reasoning skills of metacognition and its relationship with mathematical reasoning. What results would it yield if this research was done in Turkey in the light of the successful results of the researches done in other countries. Taking a look at the similarities and differences between the studies done abroad and in Turkey may provide a broader perspective on metacognitive learning strategies and mathematical reasoning skills. Comparing and contrasting these studies is also important since it will pave the way for future studies aiming to find whether the differences are of cultural, economic and social origins. Therefore, this study is thought to contribute to the teaching of Mathematics by determining the level of the relationship between metacognitive learning strategies and mathematical reasoning. The question "Is there a relationship between the candidate teachers' levels of using metacognitive learning strategies and mathematical reasoning skills?" lies at the core of this study.

The Aim of The Study

The aim of the study is to determine whether there is a relationship between the candidate teachers' levels of using metacognitive learning strategies and mathematical reasoning skills. Answers to the following questions were sought in the study.

1. What is the candidate teachers' level of mathematical reasoning skills?
2. What is the candidate teachers' level of using metacognitive learning strategies?
3. Is there a relationship between the candidate teachers' levels of using metacognitive learning strategies and mathematical reasoning skills?

Theoretical Background

The Teaching of Mathematics

The Mathematics curriculum changed in 2005 in order to counteract the negative effects of the previous one and it differed in some ways from the previous Mathematics curriculums until 2005. This new curriculum is based on the motto, " Every teenager can learn Mathematics". The focus is on the conceptual information rather than computational skills. The basic approach of the curriculum is that learning Mathematics is an enriching and comprehensive process. This approach privileges reasoning over mathematical skills in problem solving (Olkun and Toluk, 2003). The Mathematics curriculum for secondary education in our country aims to make students acquire such high-level thinking skills as creative and critical thinking, reasoning and problem solving skills (MEB, 2005).

The five general goals the National Council of Teachers of Mathematics in the USA (NCTM, 1989) set up for teaching of Mathematics are as follows; (1) to make students understand the importance of Mathematics; (2) to make them believe in their mathematical skills; (3) to turn them into individuals who can solve mathematical problems; (4) to enable them to do mathematical explanations, (5) to teach them how to do mathematical reasoning.

NCTM introduced the idea of mathematical power in the 1990s. In order to have an idea of what mathematical power means, the sentences that describe the skills the individuals with mathematical skills have should be referred to. According to Broody and Coslick (1998), mathematical power involves such skills as the positive attitude towards learning and using Mathematics and feeling confident about new challenges, developing logic for the solution of problems, confirmation and problem-solving (quoted: Yeşildere, 2006, p. 14). NCTM (1991) defines mathematical power as " individual's ability to use their skills of estimation, invention and logical reasoning to solve unusual problems, communicate through Mathematics, establish a link between Mathematics and other disciplines" (quoted: Mandacı- Şahin, 2007, p. 3). It is clear from both Mathematics curriculum of 2005 and the goals set by NCTM that cognitive skills are emphasized as much as contents in the teaching of Mathematics. The cognitive skills in especially the Mathematics curriculum of 2005 are as follows; Communication, Association, Reasoning, Problem solving (MEB 2005).

Communication; The fact that Mathematics is regarded as a language naturally follows that it can also be used as a tool for communication. Using Mathematics as a tool for communication is important in terms of what students have learned, their ways of thinking and their expression of their ideas.

Association; Mathematics is not a scientific discipline that is isolated from daily life, is full of abstract ideas and unintelligible formulas. A lot of students are biased against Mathematics. In order for them to overcome their prejudices, they must see both the relations of topics to each other within Mathematics and the relations between Mathematics and other disciplines and Mathematics and real life.

Problem Solving; Problem solving is a process in which one is engaged in finding solution to a problem using their knowledge. When solving a problem, an individual should, in the first place know about the problem, then develop a strategy concerning the problem and try to solve it using the strategy they developed and make an assessment of whether it worked or not. When this whole process is assessed, it becomes clear that problem solving has got much to bear on advanced thinking skills.

Mathematical Reasoning: Students are expected to advanced and complicated thinking skills as "critical thinking" and "creative thinking" instead of less demanding tasks such as "recalling" and "simple thinking". Creative thinking differs from traditional thinking in that it requires looking at things differently (Ersozlu, 2008, p. 21). It requires an individual to see the relations between incidents and objects through their own peculiar view and reinterpret them in their own words. Rawlinson (1995, p. 20) defines creative thinking as "establishing relations between things or ideas which have never been established". Individuals who know reasoning and logical questioning methods evaluate incidents and ideas critically instead of taking them as they are. Critical thinking is a process that involves advanced thinking skills and in which current ideas are analyzed and assessed. The individuals who can do reasoning can be said to have advanced thinking skills and form their opinions on solid knowledge. An idea cannot be thought of as a product of reasoning no matter how complicated it is unless it is founded on knowledge, justified and contains logical approaches (Umay, 2003). So, what reasoning is should be clarified first in order to have a clearer view of what ideas can be called reasoning.

Reasoning, which is a complicated process and is a high level thinking skill, has got an important place in Mathematics. Mathematics is reasoning (NCTM, 1989). Mathematics, by nature, teaches seeing patterns, reasoning, making guesses, justified thinking and reaching conclusions while teaching numbers, operations, algebra, geometry, proportion, field measurement and many other topics (Umay, 2003).

Metacognition And Metacognitive Learning Strategies

The idea of metacognition first appeared with Flavell (1979). Flavell (1979) defines metacognitive knowledge as " an individual's knowledge of their own cognition or of cognition in general". Metacognition can be defined as an individual's thinking on his or her own thinking processes. According to Reeve and Brown (1985), metacognition is an individual's competence to have a control over and manipulate their own cognitive processes; According to Sternberg (1988), it is a highly administrative process in which an individual uses planning, monitoring and assessment in order to solve problems; According to Shanahan (1992), it is understanding and controlling cognitive activity; According to Butterfield, Albertson and Johnston (1995), it is understanding the factors that influence cognition and monitoring and controlling cognition with the accompaniment of small models (quoted: Özsoy, 2008). Blakey and Spence (1990, p. 11–13) define metacognition as thinking about what one knows and what one does not, organizing thought and managing it.

The components of metacognitive knowledge are the knowledge of personal parameters, the knowledge of task parameters and the knowledge of strategic parameters. The knowledge of personal parameters means that one has a personal knowledge of their own cognitive processes and it is also the general knowledge of the knowledge process and how one learns (Kazu and Ersozlu, 2007). The knowledge of task parameters is an individual's knowledge about the essence of the task and what the process requires. An example of someone using the knowledge of strategic parameters would be that of a student who is aware of the pre-knowledge of the topic of "equations" before they learn it and who know how this pre-knowledge is going to affect the topic they are about to learn and plan what to do to make up for their shortages. In addition to having metacognitive knowledge, metacognition requires that an individual have the knowledge of how to use their metacognitive knowledge, namely; metacognitive arrangement.

Metacognitive experience or metacognitive strategies can be defined as the knowledge of how to use metacognitive knowledge to reach cognitive goals and the ability of using this knowledge consciously. The ability to arrange and control cognition is very important since it enables students to use knowledge flexibly and properly. When the literature is investigated, it is seen that metacognitive strategies fall into three groups; planning, monitoring and assessment (Flavell, 1979; Schraw, 1998; Blakey and Spence, 1990; Jing, 2005): *Planning:* It is the process in which suitable strategies are chosen to realize learning goals; *Monitoring:* It is related to revising the process that is aimed at reaching the goal; *Evaluation:* It is the process in which comprehension is examined. It receives the feedback from planning, monitoring and the adopted strategies.

The success of the strategies depends on the individual's knowledge of what strategy to use for a given situation, the knowledge that can compare a strategy with others in terms of the effort it required or the prerequisites and the strategic knowledge of what strategy takes less time and is more effective. Metacognitive skills facilitate learning and provide efficient learning. They provide the necessary mental control over cognitive strategies, memory strategies and recalling strategies (Oxford, 1993, p. 22). It is obvious that using metacognitive strategies effectively is instrumental in selecting information and recalling it later and thus, it will affect success directly.

The Relationship Between Metacognition, Problem Solving and Mathematical Reasoning

When we glance at some researches done in recent years and the curriculums for Mathematics, we see that great importance is attached to high level thinking skills such as problem solving and reasoning. This has been dealt with earlier in this paper.

It can be seen in the earlier researches that the problem solving is not a skill that is comprised of only cognitive processes. Swanson (1990) investigated the effects of a high level of metacognitive knowledge and skill on problem solving in his research and compared the children with a high level of metacognitive knowledge and the children with a low level of metacognitive knowledge. The findings of the research showed that the children with a high level of metacognitive knowledge were far more successful than the children with a low level. What is more, the children with low levels of skills and high levels of metacognition were as successful as the highly skilled children. These findings show that metacognition is very important for problem solving skills. It is even more important than skill.

Montague (1992) mentions about three metacognitive skills that support cognitive functions used in the problem solving process, govern and regulate the process:

1. The self-information (teaching) to help students identify the components of the problem before the solution
2. The self-question directed at students in the essential dialogues in order to find out about the analysis method of the problem
3. The self-monitoring to encourage the control of students in the process.

When the steps are looked into in the light of the information about what thinking and reasoning are, it is thought that reasoning is again predominant in the comprehension, analysis, discovery, planning, application and confirming/assessment steps (Umay, 2003). In short, the necessity of reasoning and metacognitive skills in the steps where an individual needs to think a bit higher becomes obvious in the classification of the skills, which require high level thinking such as problem solving, regarding the problem solving process.

In conclusion, starting from the definitions of the metacognition and reasoning, it can be said that these two concepts are in close relationship. When the definition of metacognition "becoming aware of oneself and other thinking and learning processes" is considered, it is thought that the individuals, who are aware of their own thinking processes, will have increased reasoning skills. In addition, many similarities were found between the strategies for improving metacognition (Blakey and Spence, 1990) and the strategies for improving reasoning (Math-CATs, 2007) in the literature scan.

Method

The Model of The Research

This research was designed to determine the relationship between the candidate teachers' reasoning skills and their levels of using metacognitive learning strategies. In this sense, this research is quantitative research and was designed according to the relational survey.

Population and Samples

The population of the research is students from the Education Faculty, Gaziosmanpasa University in the 2009–2010 Academic Year and the sample is the first year students (N=348), 209 of whom are female and 139 male at the Education Faculty, Gaziosmanpaşa University. The reason why first year students were chosen for the sample of the research was to determine the relationship between their levels of using mathematical reasoning levels and using metacognitive learning strategies levels up to this point and those of the candidate teachers'.

Data Collection Tools

a) Mathematical Reasoning Rating Scale

A scale with two parts, one multiple-choice questions and the other with open-ended questions, were designed to reveal the reasoning skills of the students.

While the multiple-choice mathematical reasoning scale was being prepared, the item pool was created in the first place after the literature was reviewed. Expert views about the items in the pool was consulted and the items which were suggested to be irrelevant by the experts were removed from the scale and it was made ready for use with the remaining 24 items. The multiple-choice test was applied to the 125 students and the obtained data was analysed by using SPSS 15 package program to calculate the item discrimination indexes, item difficulty indexes and item total correlations. 4 items whose selectiveness was below 0.20 were excluded from the scale. The Kuder Richardson (KR-20) reliability coefficient of the test was calculated to be 0.74 and the difficulty of the test 0.60. This can be interpreted as an indication of the easiness of the test.

The test with open-ended questions was applied to the 125 students after necessary changes were made to it in compliance with the suggestions of the experts. 6 open-ended items were used in this pre-application test. The answers from randomly chosen 15 students were assessed and marked separately by the researcher and a branch expert and the Pearson Correlation coefficient was found to be 0.85. The expediency, content validity and scientific accuracy of the scale were done in parallel with expert (4 branch experts and 2 pedagogues) opinions.

In the Mathematical Reasoning Rating Scale with multiple-choice items, each student who answered a question correctly was given 3.8 points and 0 points for a wrong answer. The Rubric Scale was used to determine the student performance part B of the Mathematical Reasoning Rating Scale with open-ended questions. Bloom's taxonomy was drawn upon to establish the performance criteria of this scale and the expected performance levels of these criteria were used. Performance levels were determined as follows:

0= no sign of performance (those with no idea on the topic in question),

1= less than satisfactory (those who did wrong reasoning or tried to solve the problem in the wrong way and got nowhere),

2= Average (those who did wrong reasoning or tried to solve the problem in the wrong way and got wrong results),

3= Successful (those who did correct reasoning and tried to solve the problem in the correct way but got no results or wrong results),

4= Very successful (those who did correct reasoning and tried to solve the problem in the correct way and got correct results).

The mathematical reasoning levels of the students were determined by adding the points taken from both parts of Mathematical Reasoning Rating Scale. The highest point that can be taken from the part A is 76 and the lowest is 0. The highest point that can be taken from the part B is 24 and the lowest is 0. The highest point that students who gave correct answers to all the questions in both parts of the Mathematical Reasoning Rating Scale is 100.

The arithmetic average of the Rating scale was calculated as 55.74 and its standard deviation as 14.73. The mathematical reasoning was examined in 3 levels. One standard deviation below and one standard deviation above the average were taken in order to decide on the limits of these levels;

0 – 41.01 => the students with low level mathematical reasoning skills

41.02 – 70.47 => the students with average level mathematical reasoning skills

70.48 – 100 => the students with high-level mathematical reasoning skills

b) Metacognitive Learning Strategies Scale

"Metacognitive Learning Strategies Scale" developed by Namlu (2004) was used as the instrument to determine metacognitive learning strategies. The scale is comprised of 21 items and 4 factors. Planning Strategies, the first factor of the scale, contains α=0.69 and six items (1,2,3,4,5,6), three of which are negative; The second factor, Organizational Strategies, contains α=0.73 and six items (7,8,9,10,11,12); The third factor, Controlling Strategies, contains α=0.67 and five items(13,14,15,16,17); The fourth factor, Assessment Strategies, contains α=0.48 and four strategies (18,19,20,21). The scale was designed as four point likert scale and scoring was as follows; "Always, (4)", "Very often, (3)", "Sometimes, (2), "Never (1)". The negative items were scored inversely. In this study, the Cronbach Alpha internal consistency quotient for he whole scale was calculated as 0.89, Factor 1 (Planning Strategies) as 0.79, Factor 2 (Organizational Strategies) as 0.62, Factor 3 (Controlling Strategies) as 0.67, Factor 4 (Assessment Strategies) as 0.73.

Scoring for metacognitive learning strategies scale was designed as follows; "Always, (4)", "Very often, (3)", "Sometimes, (2), "Never (1)". The lowest point that can be taken from the scale is 21 and the highest is 84.

The arithmetic average of the Metacognitive Learning Strategies Scale was calculated as 54.52 and its standard deviation as 7.5. The frequency of using the Metacognitive Learning Strategies was examined in 3 levels. One standard deviation below and one standard deviation above the average were taken in order to decide on the limits of these levels;

21,00 – 47,02 => the students with low levels of using metacognitive learning strategies

47,03 – 62,02 => the students with average levels of using metacognitive learning strategies

62,03 – 84,00 => the students with high levels of using metacognitive learning strategies

The Process of Data Collecting Tools and Analysis

Mathematical Reasoning Rating Scale and Metacognitive Learning Strategies Scale were applied to the first-year students of Elementary Education, Social

Sciences Education, Elementary Science Education, Computer and Instructional Technologies Education (CITE), Psychological Counseling and Guidance (PCG) at Gaziosmanpaşa University, Faculty of Education in the Spring season of 2009-2010 Academic Year (N=348). Measuring tools were applied to the candidate teachers consecutively and they were given 25 minutes for the part A of Mathematical Reasoning Rating Scale, which included 20 multiple-choice items and 15 minutes for the part B of the Mathematical Reasoning Rating Scale, which included 6 open-ended items and 15 minutes for the Metacognitive Learning Strategies Scale, which included 21 items. The scales were as they were used in the pilot application previously. The students had 55 minutes in total to answer the questions.

The quantitative data obtained from the measuring tools were analyzed and such statistical techniques as arithmetic mean, standard deviation, independent groups t test, Pearson correlation and one-way variance (ANOVA) analysis were used. The package program SPSS 15.0 was used to analyze the data obtained from the pilot and the real application. Whether the data was significant was evaluated at level $p < .05$.

Results

Findings and Interpretations on the first sub-problem

The First Sub-problem: What is the level of the candidate teachers' mathematical reasoning skills? The analysis results of this sub-problem are given below.

Table 1: *The Averages and Standard Deviations According to The Students' Mathematical Reasoning Levels*

	N	$\overline{X}$	Ss	Response rate	Level
Elem. Ed.	174	59.22	14.49	%59	Average
PCG.	71	57.33	14.30	%57	Average
Soc.Sc.Ed.	47	40.15	14.37	%40	Low
Elem.Sci.	44	68.27	14.43	%68	Average
CITE	12	68.63	17.70	%69	Average
TOTAL	348	57.73	16.48	%58	

As it can be seen in Table 1, the mathematical reasoning levels of the students from Social Sciences Education are low and the rest of the students have average levels of mathematical reasoning. However, the averages of the students from Elementary Science Education and CITE's averages are close to the limit of high level mathematical thinking. The other departments have average level of mathematical reasoning except of social science education. For all of these students who enrolled these departments except of social sciences have to know mathematical knowledge well because of their majors. So, the social sciences education has low level mathematical reasoning is an expected finding. In addition to these findings, the mathematical reasoning level of the students in general is 58%.

Findings and Interpretations on the second sub-problem

The Second Sub-problem: What is the candidate teachers' level of using metacognitive learning strategies? The analysis regarding this sub-problem is given in the table below.

Table 2: *The Averages and Standard Deviations of The Points The Students Got According to Their Levels of Using Metacognitive Learning Strategies*

	N	$\overline{X}$	Ss	Response rate	Level
Elem. Ed.	174	55.02	7.41	%66	Average
PCG.	71	53.39	7.54	%64	Average
Soc.Sc.Ed.	47	55.57	7.55	%66	Average
Elem.Sci.	44	58.52	7.54	%70	Average
CITE	12	52.00	7.87	%62	Average
TOTAL	348	55,10	7,61	%65	

As it can be seen in Table 2, the candidate teachers from all the departments have an average level of using metacognitive learning strategies. When the averages of the points in the scale are considered, it can be seen that the candidate teachers from the Elementary Science Education department use metacognitive learning strategies at the highest level and those from the CITE department use them at the lowest level. The percentages of the points the candidate teachers got from the metacognitive learning strategies scale in descending order are as follows; Elementary Science Education 70%, Social Sciences Education 66%, Elementary Education 66%, PCG 64% and CITE 62%. It was observed that Elementary Science candidate teachers use metacognitive learning strategies at the highest level with a percentage of 70% and CITE candidate teachers at the lowest level with a percentage of 62%. The candidate teachers' using metacognitive learning strategies in general is 65%.

Findings and Interpretations on the third sub-problem

The third sub-problem: What is the relationship between the candidate teachers' levels of using metacognitive learning strategies and mathematical reasoning skills? The analysis regarding this sub-problem is given in the table below.

Table 3: *The Correlative Analysis of The Relationship Between The Students' Mathematical Reasoning Skills and Using Metacognitive Learning Strategies*

Sub-dimensions of metacognitive		**Mathematical Reasoning**
Planning	r	0.251*
	p	0.000
Organization	r	0.545*
	p	0.000
Controlling	r	0.463*
	p	0.000
Assessment	r	0.422*
	p	0.000
Metacognitive Learning Strategies	r	.621*
	p	.000

*p<.01

The relation between the candidate teachers' levels of using the sub-dimensions of metacognitive learning strategies and their mathematical reasoning levels is given in Table 3. A positive but weak relationship (r=0.251 p<.01) was found between the planning sub-dimension and mathematical reasoning level. A positive and average relationship with organizational (r=0.545, p<.01), controlling (r=0.463, p<.01) and assessment (r=0.422, p<.01) sub-dimensions was found. It was determined that the relationship between the candidate teachers' metacognitive learning strategies and mathematical reasoning levels was positively and averagely significant (r=0.621, p<.01).

Discussion

When the candidate teachers' mathematical reasoning levels are considered, the fact that the students from Social Sciences department have low levels of mathematical reasoning skills may be because they took mostly social sciences subjects during their high school education. The students from Elementary Education and PCG departments have average levels of these skills and this may be because they took social sciences and mathematics classes at high school. The students from Elementary Science and CITE departments have a near-high levels of mathematical reasoning and this again may be because they took mostly mathematics classes during their high school education. Therefore, it can be said that the result was not surprising.

When the findings on the first problem and the second problem are considered, it can be observed that the students from the Elementary Science department reportedly metacognitive learning strategies at the highest level and the students from the CITE department use them at the lowest level. This is consistent with Mevarech and Fridkin (2006) who found in their research that individuals with high levels of mathematical reasoning skills get high points from metacognitive learning strategies scale and Özsoy and Ataman (2009) who said that the group with a high performance on problem solving get high points from the metacognitive learning strategies scale. It is an expected result that the candidates from Elementary Science have high levels of using metacognitive learning strategies since they have advanced mathematical reasoning skills. This case is also supported by the literature. The candidates from the CITE department, too, had advanced mathematical reasoning skills but they failed to get high points from the metacognitive learning strategies scale although they were expected to get high points. This may be because they were reluctant to take part in the research and they did not take proper care while answering the metacognitive learning strategies scale.

Lastly, although the relationship between the candidates' level of mathematical reasoning skills and metacognitive learning strategies is at an average level, it can be argued that the relationship between them can be regarded as high since it is very near the limit of high level. Mathematical reasoning signifies the ability to see the differences and similarities between incidents, operations, concepts and situations and enables logical handling of the relations between them. Metacognitive learning strategies enable an individual to relate previous knowledge to new knowledge, select conscious thinking strategies and plan, monitor and assess thinking processes. The fact that there is a positive and near-high relationship between levels of mathematical reasoning and using metacognitive learning strategies shows that the candidate teachers use general metacognitive learning strategies at higher levels as their levels of mathematical reasoning increase. It can be argued that mathematical reasoning increases the levels of using metacognitive learning strategies since it enables thinking about mathematical concepts and creating logical links between mathematical relationships.

According to an experimental research by Kramarski et al. (2001) on whether teaching metacognitive learning strategies affect mathematical reasoning, it was determined that metacognitive learning strategies increased mathematical reasoning. Kramarski and Hirsch (2003) concluded in their research in which they taught a group employing metacognitive learning strategies that it had a positive effect on mathematical reasoning. Mevarech and Fridkin (2006) said in their research that the group which they taught using metacognitive learning strategies showed better performances of mathematical reasoning than the group which they taught using a traditional approach. Pilten (2008) stated that education based on metacognitive learning strategies was effective in improving mathematical reasoning strategies. All these findings are in parallel with that of the present research.

When metacognitive learning strategies are considered according to their sub-dimensions, it becomes clear that the candidate teachers whose mathematical reasoning levels are high use the organization, controlling and assessment sub-dimensions at high levels and this can be interpreted as the proof that the level of using these sub-dimensions increases as mathematical reasoning level increases.

Conclusion

The results of the present research which aims to determine the relationship between the level of the candidate teachers' mathematical reasoning skills and using metacognitive learning strategies are, in the light of the findings, as follows:

1. The results regarding the first problem: When the candidate teachers' mathematical reasoning skills are considered, it was found that those from the Social Sciences department have low, those from the Elementary Education and PCG departments have average and those from the Elementary Science and CITE departments have near-high levels of mathematical reasoning skills.
2. The results regarding the second problem: When the candidate teachers' levels of using metacognitive learning strategies are considered, the

candidate teachers from all the departments, all of the sample, have average levels of using metacognitive learning strategies.

3. The results regarding the third problem: The relationship between the candidate teachers' levels of using metacognitive learning strategies and mathematical reasoning skills is positive and at a near-high level at a near-high level. It was observed the candidate teachers' levels of using metacognitive learning strategies increase as their mathematical reasoning levels increase.

A positive relationship was found between levels of mathematical reasoning and the sub-dimensions of using metacognitive learning strategies (planning, organization, controlling, assessment). It was seen that the levels of using especially the organization, controlling and assessment sub-dimensions increase as mathematical reasoning levels increase. The following suggestions are made in the light of the research results.

The teaching of metacognitive learning strategies should be given priority in order to improve students' mathematical reasoning skills. Involving first and fourth year students from elementary and secondary Mathematics education departments can be carried out a similar research. The research can be carried out by means of such techniques as interviews and direct monitoring of the subject students and by examining their thinking processes in depth.

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