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Evaluation of mathematical powers of 5th grade primary school students

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Abstract

The term mathematical power is regarded as a whole of abilities in connecting, reasoning and communicating. The aim of this study is to evaluate mathematical powers of 5th grade primary students. The study is qualitative. It has been fulfilled 2009- 2010 Autumn semester. Observation and interview techniques were used to collect the data. In the process of practice, students were given arithmetical problems, and their mathematical powers were tried to determine by evaluating their way of problem-solving processes. Evaluation rubrics and observation forms prepared by the researchers were used to analyze and evaluate the data. The practice lasted 5 weeks and total 9 problems were used. The result of the study is as follows: Students are able to make connections in mathematics but they are not able to use mathematical processes out of mathematics. The students can be said to have low level of reasoning. Their ability to communicate can be determined as mid level.

Keywords: Mathematics education; mathematical power; reasoning; communication; relations.

1. Introduction

The term mathematical power was initially used by NCTM (National Council of Teachers of Mathematics) in 1989 and defined as follows: Mathematical power composes of the abilities of students to discover, anticipate, comprehend, solve uncommon problems, communicate within/through mathematics and relate the processes in mathematics and others in other field of reasoning.

Another similar classification was developed by NSF (National Science Foundation) in 1995. It determined one of the compounds of mathematical power as “application standards”. Here, the elements of this compound are determined to be the abilities to solve problems, comprehend, relate, communicate, and presenting.

The term was defined by NAEP (National Assessment of Educational Progress) in 2002 as a field where content areas and so consciousness ability develop and where the abilities to communicate and relate are used. Importance of the term in mathematics teaching is demonstrated in Figure 1.

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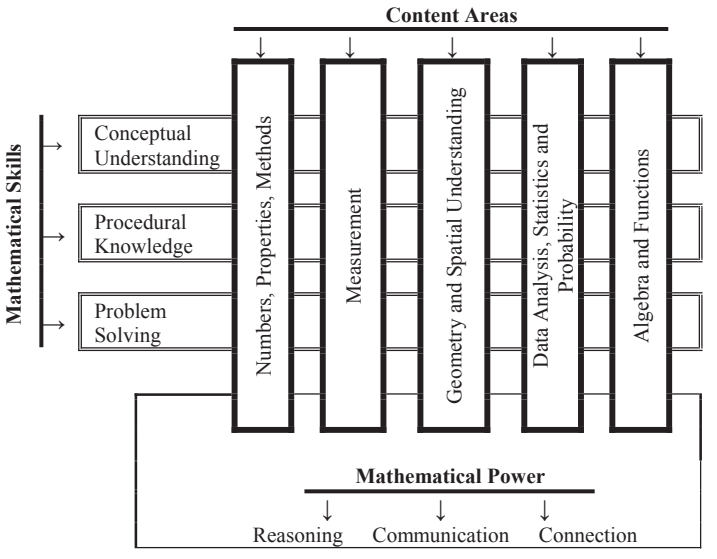

NAEP (2002).

Figure 1. Content Areas and Conscious abilities in Mathematics Teaching

When Figure 1 is examined, it is seen that like NCTM (1989) and NSF (1995), NAEP (2002) considers the ability of reasoning, communicating within/through mathematics and relating mathematical operations in different conditions among the abilities to consist mathematical power.

As the definitions above examined, mathematical power is seen to widely be defined as the collection of the abilities to relate, communicate and reason. That's why, these abilities are worth explaining.

1.1. Connection

For the students to realize the useful aspects of mathematics, they should relate mathematical terms and abilities both to each other and to their lives in and out of their school (MEB, 2005). In other words, students should attain meaningful relations between their information in mathematics and the use of this information with symbols, which, on the other hand, does not mean teachers transform the mathematical operations to their students, but this certainly means that students are supposed to discover them by themselves (Bergason, 2000).

According to NCTM (2000), the connection abilities of a primary school student are:

1. The ability to demonstrate the results of problems in different ways (graphical, numerical, algebraic, oral mathematical models) and ability to relate between these ways.
2. The ability to inspire the relation between mathematical thoughts.
3. The ability to see mathematics as a whole.
4. The ability to use mathematical information and modeling to solve problems in other diciplines.

1.2. Reasoning

Reasoning is an activity comprising of various thinking styles (Peresini and Webb, 1999). Reasoning cannot be created without critical and creative thinking. Namely, reasoning is the ability occurred in further steps of thinking (Umay, 2003). In this respect, reasoning can be defined as a process of thinking in a reasonable method, and attitudes and thoughts are to be based on reasonable thinking (Webster, 1986).

Mathematics is one (perhaps the first one) of the areas in which reasoning is needed most intensively. Mathematical reasoning is the fundamental of mathematics. While Mathematics teaches numbers, operations, algebra, geometry, rate and ratio, calculation of area and many others, it also teaches discovering patterns, reasoning, anticipating, reasonable thinking and reaching a consensus as well (Umay, 2003).

When student evaluation standards of NCTM (1989) are examined, the expected abilities of students in the evaluation of mathematical reasoning are classified as follows:

Students must be able to:
1. reason to reach the whole in the discovering patterns and creating assumptions;
2. reason to develop reasonable arguments for mathematical entities;
3. use proportional reasoning and spatial reasoning when solving mathematical problems;
4. use reasoning to prove that results are true, decide whether arguments are valid or relevant, and to create new arguments in the way of deduction;
5. define general properties and structures by analyzing given situations.

1.3. Communicating

Some points to give idea about the ability to create mathematical communication are those that students are able to speak, write, demonstrate and visually define mathematical thoughts, understand, interpret, and evaluate mathematical thoughts presented in a verbal written or visual form and use his/her mathematical mind, present thoughts, define the relation and model the situations (NCTM, 2000).

Mathematical communication is also significant from the point of being a means of learning. Students learn mathematics while talking and writing about what they have already done (NAEP, 2002).

According to NCTM (2000), the communicating abilities of a primary school student are as follows:

Students should be able to;
1. organize and reinforce their mathematical thoughts through communication;
2. mathematically communicate with their teachers, their friends and other people in a proper way;
3. analyze and evaluate the mathematical thoughts and strategies of others;
4. use mathematical language in order to declare their mathematical thoughts properly;

Under the shade of these basic theoretical principles, the purpose of this study is to define in detail mathematical power of a 5th grade primary school student. Specifically, the following question was asked: "What are the mathematical power skills of 5th grade primary school students?

2. Method

The study is qualitative. It has been fulfilled 2009- 2010 Autumn semester. Observation and interview techniques were used to collect the data. Mathematical problems were applied on all the students at the fifth grade in a randomly chosen primary school. Observation and interview were done with 6 students chosen among them. In the process of practice, students were given arithmetical problems, and their mathematical powers were tried to determine by evaluating their way of problem-solving processes. Evaluating rubrics and observation forms prepared by the researchers were used to analyze and evaluate the data. The practice lasted 5 weeks and total 9 problems were used.

3. Results (Findings)

This section includes the data and interpretations about the students' levels of ability to making connection (Table 1), ability to reason (Table 2), and ability to communicate (Table 3), which are determined as the units of mathematical power.

Table 1. Level of Making Connection Skills of Students

Problem No	Observed Skills	Observed Frequency According to Grades Taken					
			0	1	2	3	4
1	▪ Ability to demonstrate the results of the problems in different forms (graphical, numerical, algebraic, oral mathematical models)	f St. No	-	-	1 (5)	2 (1-2)	3 (3-4-6)
	▪ Ability to relate between these forms;	f St. No			2 (1-5)	3 (3-2-6)	1 (4)
2	▪ Ability to realize and use the relations between mathematical thoughts	f St. No	-	1 (5)	4 (1-2-3-6)	1 (4)	-
	▪ Ability to see mathematics as a whole;	f St. No	-	2 (5-1)	2 (2-6)	2 (3-4)	-

3	▪ Ability to use mathematical knowledge and modeling in other disciplines;	f St. No	1 (5)	4 (1-2-3-4)	1 (6)	-	-

As Table 1 is examined, it can be determined that student got the highest performance in the ability to demonstrate the results of the problems in different forms (graphical, numerical, algebraic, oral mathematical models), and the ability to relate between these forms. These abilities are needed in the 1st problem. It has been determined that all the students performed a fair or higher level for these abilities and at least one student with complete performance exists for both abilities. This situation suggests that students are aware of at least two different demonstrations of mathematical data, and that they can relate them with each other.

In Table 1, students are seen to have the greatest difficulty in the 3rd problem. The lowest performance was in the ability to use mathematical knowledge and modeling in other disciplines. This situation makes us think that students have difficulty using mathematics in daily life.

When three problems are evaluated together, it is true to say that students are successful in some relating abilities whereas they have great difficulty in others. This situation suggests that it is difficult to have a general evaluation from point of relating abilities. However, it can be said that students are able to relate things inside mathematics but they cannot use that knowledge out of mathematics.

Table 2. Level of Reasoning Abilities of Students

Problem No	**Observed Skills**	**Observed Frequency According to Grades Taken**					
			0	**1**	**2**	**3**	**4**
4	▪ Ability to use inductive reasoning in the discovering patterns and creating assumption	f St. No	1 (5)	3 (1-2-4)	2 (3-6)	-	-
	▪ Ability to develop reasonable arguments for mathematical entities;	f St. No	1 (5)	2 (3-4)	3 (1-2-6)	-	-
5	▪ Ability to use proportional reasoning and spatial reasoning when solving mathematical problems;	f St. No	-	2 (3-5)	2 (4-6)	2 (1-2)	-

Table 2 (continued). Level of Reasoning Abilities of Students

Problem No	Observed Skills	Observed Frequency According to Grades Taken					
			0	1	2	3	4
6	▪ Ability to use reasoning to prove that results are true, decide whether arguments are valid or relevant, and to create new arguments in the way of deduction;	f St. No	2 (2-5)	3 (3-4-6)	1 (1)	-	-
	▪ Ability to define general properties and structures by analyzing given situations;	f St. No	2 (2-3)	3 (4-5-6)	1 (1)	-	-

As Table 2 is examined, it can be determined that students got the highest performance in the ability to use proportional reasoning and spatial reasoning when solving mathematical problems. Among the abilities asked through the questions 4, 5, and 6, which are for the evaluation of students' reasoning abilities, it is only in this ability that their performances are higher than the average.

In Table 2, students are seen to have the greatest difficulty in the 6th problem. The lowest performance was in the ability to use reasoning to prove that results are true, decide whether arguments are valid or relevant, and to create new arguments in the way of deduction, and in the ability to define general properties and structures by analyzing given situations. This situation makes us think that students have difficulty using reasoning based on deduction.

When three problems are evaluated together, it is true to say that students are successful in some reasoning abilities. There is no student with the ability of reasoning who performed fully in the problems requiring reasoning ability. The number of students who are below the average is too much. These situations make the general performances lower.

Table 3. Level of Communicating Abilities of Students

Problem No	Observed Skills		Observed Frequency According to Grades Taken				
			0	1	2	3	4
7	▪ Ability to organize and consolidate their mathematical thoughts through communication;	f St. No	-	1 (5)	2 (2-3)	3 (1-4-6)	-
8	▪ Ability to mathematically communicate with their teachers, their friends and other people in a proper way;	f St. No	-	1 (2)	4 (3-4-5-6)	1 (1)	-
	▪ Ability to analyze and evaluate the mathematical thoughts and strategies of others;	f St. No	-	2 (5-2)	3 (3-4-6)	1 (1)	-
9	▪ Ability to use mathematical language in order to declare their mathematical thoughts properly;	f St. No	-	-	3 (2-3-5)	3 (1-6-4)	-

As Table 3 is examined, it can be determined that students had fair performance in the ability to communicate in all three problems (7, 8, and 9). There is no student who performed in the highest or lowest level in all three problems. Their performances intensify in fair level.

4. Conclusion

Some of the findings obtained from the research are as follows:

- It is seen that students are able to perform well in some relating abilities, but are extremely poor in some others. As regards connection abilities, students are able to relate things within mathematics (able to show the results in different forms, able to relate between these forms), but unable to use them out of mathematics (ability to use mathematical background to solve problems in other disciplines).
- Students can be said to have low level of reasoning ability. No student was encountered in the research who had a full performance of reasoning ability. The abilities in which students had the greatest difficulty were those required in "proving that the results are correct, deciding whether discussions are valid, and being able to use reasoning based on deduction" and "defining general properties and structures by analyzing given situations". On the other way, the abilities in which students had the smallest difficulty were those required in using proportional reasoning and spatial reasoning when solving mathematical problems.

Students can be said to have fair levels of communicating abilities for every problem. In each three problem which were prepared to understand this ability, neither a student who had the highest level of performance nor the one with the lowest level of performance was encountered. Their performances intensify in fair level.

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