Profile of mathematical ability of junior high school student in Cirebon based on TIMSS standards

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Abstract. This result of research on Trend In Mathematics and Science Study (TIMSS) scores of Indonesian students in 2011 puts it at the bottom. And until now there are still many references of mathematics students and mathematics researchers in Indonesia. However, there are no results of research on the position where students in the city of Cirebon currently in the TIMSS score. The method of the research is survey method by taking a random sample of 491 students taken from eighth-grade students of public and private schools showed the average TIMSS score of students who answered correctly from the sample tested reached 58% with a standard deviation of 8. The average of student correct answer in Cirebon higher than national average or international average correct answer in all level at TIMSS in 2011, thus low level, intermediate level, high level and advance level. However, the mathematical ability of students in the city of Cirebon still needs to be improved because in intermediate level, high level, and advance level still less satisfactory. In gender differences perspective, mathematical ability female student better than mathematical ability of male students for all level at TIMSS in 2011.

1. Introduction

Mathematical abilities are needed in every-day activities because mathematics ability is part of life skills, especially in the development of reasoning, communication, and problem-solving [1]. The ability to solve problems is a general goal in learning mathematics and is the heart of mathematics. The ability to be achieved according with the learning objectives of mathematics curriculum class VIII [1] is the ability to: (a) understand mathematical concepts that include competence in explaining the interrelationships between concepts and algorithms flexibly, accurately, precisely in problem-solving. Included in this competency are being able to apply mathematical concepts in performing arithmetic operations, performing algebraic operations, manipulating algebra, and measurement skills; (b) use patterns as conjectures in problem-solving, and be able to make generalizations from existing phenomena. The task of pattern exploration can contribute to the development of students' problem-solving abilities through analysis of cases [2]; (c) using reasoning (mathematical reasoning), doing mathematical manipulation both in simplifying, and analyzing the components that exist in problem-solving in mathematical contexts and outside mathematics (real life, science and technology) which includes the ability to understand problems, build models mathematics, completing models and interpreting the solutions obtained included in solving problems in real life. Mathematical material and mathematical reasoning are two inseparable things, namely mathematical material understood through reasoning, and reasoning understood and practiced through learning mathematics [3]; (d) communicating ideas, reasoning and being able to compile mathematical proofs.
using complete sentences, symbols, tables, diagrams or other media to clarify the situation or problem. Thus mathematics is not only a tool of thinking that helps us to find patterns, solve problems and draw conclusions, but also a tool to communicate our thoughts about ideas clearly, precisely and concisely [4]; (e) has an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, attention, and interest in learning mathematics, as well as being tenacious and confident in problem solving. (f) having attitudes and behaviors that are in accordance with mathematical and learning behavior, such as obeying the principles, consistent, polite, democratic, careful, thorough, and open. The attitudes contained in points (e) and (f) belong to the affective domain called mathematical disposition. Mathematical disposition is an affective domain that has an important role in mathematics learning [5]. There is a linear relationship between mathematical disposition and student success in learning mathematics. The better the mathematical disposition of students, the better the success of student learning in learning mathematics [6]; (g) use simple visual aids or technology results to carry out mathematical activities. These skills or abilities are interrelated with one another, mutually reinforcing and needing each other.

One international study that evaluates the math and science skills of elementary and middle school students is the Trend in International Mathematics and Science Study (TIMSS). This survey is conducted every four years. The last survey was in 2015. Unfortunately in 2015 Indonesia did not participate in this survey. Based on the results of the TIMSS survey in 2011, Indonesia ranked 38th out of 42 countries with an average score of 386 below the average TIMSS score which ranged at a score of 500 [7]. However, throughout the researcher's search, so far no research has been conducted in the city of Cirebon to determine the mathematical abilities of junior high school students with TIMSS standards. The results of this study will be very useful for the advancement of mathematics education in the city of Cirebon. This study aims to describe the profile of mathematics abilities of junior high school students in the city of Cirebon in solving TIMSS type math problems.

2. Methods
The method used in this research is a survey method of a cross-sectional survey model by collecting data on the mathematical ability of junior high school students in the city of Cirebon based on TIMSS standards at one time by providing a mathematical test of the TIMSS model which has been translated into Indonesian. To find out the profile of students 'mathematical abilities, researchers used a benchmarking strategy by grouping students' mathematical abilities into four categories that is advance, high, intermediate, and low. By referring to the international average TIMSS score, then what position will the mathematical achievement of students in Cirebon city be known for. The subjects in this study were public and private junior high school students in Cirebon. The sampling technique in this study used a simple random sampling technique, taking eighth-grade students from each school to be sampled.

3. Result and Discussion
To provide a meaningful description of the meaning of ability on a scale concerning students' mathematical knowledge and skills, TIMSS presents four levels on a scale as an international standard. The four levels to represent the range of international abilities of students are the advanced standard (625), high standard (550), medium standard (475), and low standard (400). The following is an overview of four levels of international scale benchmarks. (1) Advanced standard: Students can give reasons based on information, draw conclusions to make generalizations, and solve linear equations; (2) High standards: Students can apply their understanding and knowledge in a variety of ways relatively complex situation; (3) Intermediate standards: students can apply basic mathematical knowledge in a variety of situations, and (4) Low standards: Students have knowledge of integers and decimals, operations, and basic graphics [8].

Quantitative data analysis using the items response theory (IRT) [9] scoring method obtained the average TIMSS score of junior high school students in Cirebon City reaching 498. The achievement of the average TIMSS score of Cirebon City students, national, and international is presented in Table 2 below.
Tabel 1. TIMSS Student Score in National and International Benchmarks

| Participants          | Score | Performance Category |
|-----------------------|-------|----------------------|
| International         | 500   | Intermediate         |
| Cirebon City          | 498   | Intermediate         |
| National (Indonesia)  | 386   | Low                  |

From Table 2 it can be explained that the TIMSS score of students in Cirebon City which reached 498 was included in the middle category which was 2 points lower with the international TIMSS score but was still the same in one intermediate category. Meanwhile, when compared with the national TIMSS score of 386 which is in the low category, the TIMSS score of junior high school students in Cirebon City is superior to the TIMSS score of junior high school students nationally.

3.1. Mathematical Ability of Student in Low Level

The average percentage of students who answered questions correctly at the low level reached 85.7%, higher than the average international score of 75%, and the national score of 43% at TIMSS 2011 [10].

Figure 1. Example 1

Students who answered correctly in Example 1 were 52%. The concept is that for every number $a (a \neq 0)$ with the power of $n$ (a positive integer) is a multiplication of a times $n$. A small number of students are still confused about the concept of positive exponents integers. About 1.2% might assume that $3^3 = 3 + 3$, so they choose the incorrect answer (a). About 11.1% of students might assume that $3^3 = 3 \times 3$, so they choose the incorrect answer (b). And about 1.3% of students might assume that $3^3 = 33$ this is no logic. From the completion of students in examples 1 and 2 we can also find out that the student's sense of number is still weak. Many students can not read exponents numbers correctly.

The height of 100 students in a school were measured to the nearest 5 cm. This table shows the results.

| Height (cm) | 145 | 150 | 155 | 160 |
|------------|-----|-----|-----|-----|
| Number     | 16  | 40  | 25  | 19  |

Complete this bar chart to show the same information.

Figure 2. Example 2

Students who answered correctly in Example 2 were 78%. This problem is included in the domain of data and chance content with the cognitive domain being tested is knowing. The purpose of this problem is to see the students' ability to read graphs. Thus there are still 22% of students who have not been able to read charts properly.
3.2. Mathematical Ability of Student in Intermediate Level
The average percentage of students who answered the questions correctly in Cirebon City at the middle level reached 56% higher than the percentage of the international average which reached 46% and the national average which reached 15% in TIMSS 2011 [9].

For every numbers k, than k+k+k+k+k = ...
   c. k + 5           c. k^5
   d. 5k              d. 5(k + 1)

Figure 3. Example 3

If seen from the students' answers, as many as 52.3% chose the answers b. 5k which is the correct answer to the problem. As many as 8.4% of students answered the answer choices (a). k + 5. 32.3% of students answered (c). k^5, and 7% of students answer the answer choices (d). 5(k + 1). This problem reveals the students' understanding in carrying out basic operations in algebraic forms. The students' mistake is shown in the incorrect answer which assumes that k + k + k + k is k + 5 or k^5.

3.3. Mathematical Ability of Students in High Level
The average percentage of students who answered the questions correctly in the city of Cirebon at a high level reached 55% higher than the average international percentage which reached 17% and nationally 2% at TIMSS 2011 [10].

Line PQ and BC are paralel.
What is the value of x?

Answer : ............... 

Figure 4. Example 4

This question belongs to the domain of geometry content and the cognitive domain of applying. In this question students are asked to calculate the magnitude of the unknown angle x° if several angles are known. To answer this question students need to understand the number of angles in the 180° triangle, and the magnitude of the angles on one side is the same. The angle P + A + Q = 180°. So that P + 600 + 800 = 1800 and P = 1800 - (600 + 800) = 40°. The angle x° = P, so x = 40. The results of this study indicate that only 37% of students answered correctly and most of them 63% answered incorrectly. There are many possible causes so that students have not been able to answer correctly, including students who do not understand knowledge related to angles in triangles, and the relationship between angles. Another cause is students are less accustomed to reasoning [10].

3.4. Mathematical Ability of Student in Advance Level
The average percentage of students in the city of Cirebon who answered questions correctly at the advanced level reached 38% higher than the average international percentage which reached a percentage of 3% and nationally reached 0% at TIMSS 2011 [10].
Figure 5. Example 5

The question is included in the domain of number content and the cognitive domain of reasoning. The test examines students' ability to reason about fractions as part of the whole in real daily problems and explains the reason for an answer. Only 23.4% of students answered the questions correctly, and the rest mostly answered incorrectly. Among the students' answers were correct: "Peter spent more money to buy shoes because \(\frac{3}{5}\) of \(\frac{2}{3}\) is \(\frac{2}{5}\), while \(\frac{3}{5}\) of 1 is \(\frac{3}{5}\). \(\frac{3}{5}\) is bigger than \(\frac{2}{5}\), so Peter spends more money." Among the incorrect student answers: "Tom spends more money on shoes because Tom is spending \(\frac{1}{3}\) and \(\frac{3}{5}\) while Peter only spends \(\frac{3}{5}\." From the incorrect answers, it seems that students do not understand that fractions are part of the whole. Another possibility is that students cannot do fraction reduction operations and cannot compare which fractions are large and which are smaller. Although the problem is included in the content domain, it is necessary to have a high reasoning ability and to master the basic concepts of fraction operations to answer it.

3.5. Mathematical Ability of Students Based on TIMSS Domain
The percentage of student answers that are correct when viewed in terms of domains is as follows. In the content domain, 46% of students answered correctly in the domain of numbers, 40% of students answered correctly in the algebraic domain, 54% of students answered correctly in the geometry domain, and 59% of students answered correctly in the data and chance domain. Whereas in the cognitive domain 65% of students answered correctly in the domain of knowing, 41% of students answered correctly in the domain of applying, and 46% of students answered correctly in the reasoning domain.

3.6. Mathematical Ability of Students Based on Gender Differences
When viewed in terms of gender differences, the math ability of male students reaches 54%. Percentage of achievement for each level from low, middle, high, and advanced level for male students in a row that is 73%, 55%, 52%, and 35%. While the mathematical ability of female students the percentage reached 60%. The percentage of achievement for each level from low, middle, high, and advanced level for female students is 81%, 62%, 57%, and 40% respectively. Similar to the results shown in the TIMSS score of Indonesian students, female students in Indonesia tend to be superior to male students. In this study, the percentage difference was 6 points. When viewed from gender differences, 61% of male students answered correctly in the domain of knowing, 38% answered correctly in the domain of applying, and 43% answered correctly in the reasoning domain. While 67% of female students answered correctly in the knowing domain, 42% answered correctly in the applying domain, and 48% of students answered correctly in the reasoning domain.

3.7. Mathematical Ability of Students Overall
The average correct answer of the total mathematical abilities of junior high school students in Cirebon city based on the TIMSS standard of 50% correctly answered with a standard deviation of 8. With confidence function in excel, we get the margin of error is 0.6. Thus with a significance level of \(\alpha = \)
0.05, then we can be sure of the samples tested with 676 responden (intervals confidence) that the ability of students in answering TIMSS questions ranged from 49.6% and 50.4%.

4. Conclusion
The results of the analysis of the mathematical ability data of junior high school students in the city of Cirebon based on TIMSS standards, researchers obtained the following conclusions: The average of correct answer students higher than correct answer in national average or international average at TIMSS in 2011 for all level, thus low level, intermediate level, high level, and advance level. But the mathematical ability of student still needs to be improved again because it found several weaknesses, for cognitive aspects that are good only at the level of knowing, while at the level of applying and reasoning is still less satisfactory. In gender differences perspective, math ability female student better than math ability of male students for all level at TIMSS in 2011.

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