Book Chapter:

ANALYSIS OF STUDENTS' MATHEMATICAL ABILITY BASED ON ATTITUDES TOWARDS MATHEMATICS

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CHAPTER 6
ANALYSIS OF STUDENTS' MATHEMATICAL ABILITY BASED ON ATTITUDES TOWARDS MATHEMATICS

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Abstract. Students' attitudes towards mathematics play an essential role in the learning process. Some students in Indonesia have positive attitudes, but many are neutral and negative towards mathematics. This study aims to describe the students' mathematical ability based on attitudes towards mathematics. This study employed a qualitative approach. Data were collected by administering the Attitudes towards Mathematics Inventory (ATMI) and Mathematical Ability Test (MAT) to 296 Grade 8 students. From the ATMI score, students were classified into three groups: students with negative, neutral, and positive attitudes. As for the MAT score, students are grouped into low, moderate, and high mathematical ability. Next, student representatives from the mathematics attitudes and ability group were interviewed to confirm students' answers to the ATMI and MAT. Data analysis was carried out by percentage and descriptive qualitative. The results showed that (1) the majority of students preferred a neutral attitude (48.31%) to positive (32.43%) or negative (19.26%) attitudes towards mathematics; (2) most students had low mathematical ability (45.27%), (3) students with positive attitudes tend to have high mathematical ability, (4) students with neutral attitudes tend to have the low or moderate mathematical ability, and (5) students with negative attitudes tend to have the low mathematical ability.

6.1. INTRODUCTION

In mathematics lesson at school, there are generally students who like mathematics, some do not like mathematics, and some are not included in both (neutral). Students' views on mathematics were caused

by differences in students' attitudes towards mathematics [1], [2]. Students' attitudes towards mathematics are defined as a situation within students, a tendency to respond to mathematics [2], [3]. Attitudes are divided into positive attitudes and negative attitudes [3], [4]. This attitude has four critical components: self-confidence, value, enjoyment, and motivation [3], [4]. Students with a positive attitude always have high self-confidence, think mathematics is useful, like mathematics, are always motivated to be actively involved in the mathematics learning process. Conversely, students with negative attitudes have low self-confidence, think mathematics is useless, dislike mathematics, and avoid learning mathematics [4].

Mathematical ability is the student's ability to solve a set of math problems. This ability is vital for students to master to develop science, technology, and economics in the country [5]. Usually, the teacher gives students a set of questions to measure the level of students' mathematical ability. Here, the Mathematical Ability Test (MAT) is used, which consists of 10 essay questions. These questions are taken from the standard junior high school mathematics national exam questions. The material being tested is Grade 7, so it is appropriate to be given to Grade 8 students [6].

The previous research examining the relationship between attitudes and students' achievement showed that attitudes play an essential role in student achievement in mathematics [7], [8], [9]. In the TIMSS and PISA events, the mathematics achievement of Grade 8 students from various countries was influenced by students' attitudes towards mathematics [10], [11], [12]. The results of measuring students' attitudes towards mathematics and junior high school students' mathematics ability can differ in various places. Therefore, it is interesting to conduct similar research on Grade 8 students in Jember. This study aims to describe the students' mathematical ability based on attitudes towards mathematics. The benefits obtained from the results of this study are as input for mathematics teachers and other stakeholders to improve student attitudes towards mathematics and their mathematical ability.

6.2. METHODS

The instruments used in this study were (a) the standard attitude questionnaire (ATMI) developed by Majeed [4], (b) the Mathematics Ability Test (MAT), and interview sheets, which have been validated by three

mathematics education experts. The results of the validation of all instruments obtained an average score of more than 4 (score between 0 to 5), which means that all instruments are valid and can be used to collect data. [6]. ATMI consists of 32 items, including four components forming attitudes, and The MAT contains ten basic math problems in the form of essay problems. Examples of statements in the ATMI and problems in the MAT can be seen in Table 1.

Table 1. Examples of statements in the ATMI and problems in the MAT

No.	Statements in the ATMI	Problems in the MAT
1.	Studying mathematics makes me feel nervous (self-confidence)	Find the result of *132 + 62.*
2.	Mathematics is important in everyday life (value)	Given the ratio of the length and width of a rectangle, *3:1*. If the circumference of the rectangle is *72 cm*, then determine the area of the rectangle.
3.	I like to solve new problems in mathematics (enjoyment)	Aldi saves in the bank for *Rp800,000* with an interest rate of *15%* per year. When taken, Aldi's savings amounted to *Rp900,000*. How long did Aldi save?
4.	I am willing to take a mathematics course in my study (Motivation)	

From Table 1, students are asked to choose one of the five answer choices on ATMI, namely Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD). As for the questions in the MAT, students are asked to answer all the questions with complete steps. This study uses a qualitative approach. Research data collection begins by giving the ATMI and MAT to all Grade 8 students at one of the public junior high school in Jember for the academic year 2017-2018. The total was 296 students (121 male and 175 females). The results of filling out the ATMI were scored (1.00 to 5.00), and all students were classified into three groups, namely the negative attitudes group (+), neutral (N), and the positive group (-). Then, the students' mathematical ability were grouped from the MAT score (0 to 100) into three groups, namely the Low (Lo) group, the Moderate (Mo) group, and the High (Hi) group. The ATMI and MAT data analysis results are presented in tabular form, which is analyzed

using frequency and percentage. Next, representatives of the ATMI and MAT groups were interviewed to confirm students' answers to ATMI and MAT. Data analysis from the interview was carried out in a descriptive qualitative manner by categorizing the data, presenting the data, interpreting the data, and drawing conclusions [13].

6.3. RESULTS AND DISCUSSION

Students' attitudes towards mathematics

In Table 2, data on students' attitudes towards mathematics are presented. The second column shows three categories of attitudes: negative attitudes, Neutral, and Positive. The third column shows the mean score interval of ATMI according to the three attitudes categories. The fourth column shows the number of students who fall into the three attitudes categories. The last column shows the percentage of students who fall into the three attitudes categories.

Table 2. Recapitulation of students' attitudes towards mathematics

No.	Attitudes category	Mean score	Frequency (f)	Percentage (%)
1.	Negative	1.00 – 2.33	96	32.43
2.	Neutral	2.34 – 3.67	143	48.31
3.	Positive	3.68 – 5.00	57	19.26
	Total		296	100.00

Table 2 shows that of the 296 students, the majority of students (48.31%) chose to be neutral attitudes towards mathematics. The next position was 32.43% of students expressed positive attitudes towards mathematics, followed by 19.26% of students with negative attitudes towards mathematics.

Students' mathematical ability

Table 3. Recapitulation of students' math ability

No.	Math ability category	The total score of MAT	Frequency (f)	Percentage (%)
1.	Low	0 - 59.9	134	45.27
2.	Moderate	60 -79.9	93	31.42
3.	High	80 - 100	69	23.31
	Total		296	100.00

In Table 3, data on students' mathematical ability are presented. The second column shows three categories of math ability, namely High, Moderate, and Low. Besides, the third column shows the total score of MAT according to the three math ability categories. The fourth column shows the number of students who fall into the three math ability categories. The last column shows the percentage of students who fall into the three math ability categories.

Table 3 shows that of the 296 students, the majority of students (45.27%) belong to the low math ability category. Next, it was followed by students with moderate math ability category (31.42%), and finally students with high math ability category (23.31%).

Students' attitudes towards mathematics and students' mathematical ability

In Table 4, data on students' attitudes towards mathematics and students' mathematical ability are presented. The second column shows that there are nine categories of mixtures of mathematics attitudes and math ability. The third column shows the number of students who fall into these nine categories. The last column shows the percentage of students who fall into these nine categories.

Table 4. Recapitulation of students' attitudes and students' math ability

No.	Attitudes and Math ability	Frequency (f)	Percentage (%)
1.	(+,Hi)	63	21.28
2.	(+, Mo)	33	11.15
3.	(+,Lo)	0	0.00
4.	(N, Hi)	6	2.03
5.	(N, Mo)	57	19.26
6.	(N, Lo)	80	27.03
7.	(-,Hi)	0	0.00
8.	(-,Mo)	3	1.01
9.	(-,Lo)	54	18.24
	Total	296	100.00

Notes:
+ = Positive attitude, - = Negative attitude, N = Neutral
Hi = High Math ability, Mo = Moderate Math ability, Lo = Low Math ability

In Table 4, it can be seen that of the 296 students, the majority of students are included in the category of being neutral and have low basic math ability (27.03%), followed by students being neutral with moderate

(19.26%) and high mathematical ability (2.03%). This shows that students who choose a neutral attitude tend to have low or moderate math ability. Next, most students with a positive attitude category have high math ability (21.28%), followed by moderate math ability (11.15%). Here, there are no students who have positive attitudes towards mathematics who have low math ability. This shows that students with positive attitudes towards mathematics tend to have the high or moderate mathematical ability. Finally, students with negative attitudes have low (18.24%) and moderate (1.01%) math ability. Here, there is no student with negative attitudes towards mathematics who have high mathematical ability. This shows that students with negative attitudes towards mathematics tend to have low mathematical ability.

Some examples of student answers and interview snippets

Figure 1 shows an example of a students' answer with a positive attitude towards mathematics and the highest score (code S1=S+Hi). Figure 2 shows a snippet of the interview between the researcher (code R = Researcher) and the student (code S1).

From figure 1, it can be seen that S1 student can answer questions with clear procedures, using the right mathematical concepts. The concept used is the concepts of addition, multiplication, squared, perimeter, area of the rectangle, and social arithmetic (banking). Students are also able to apply these related concepts correctly so that the final answers are correct.

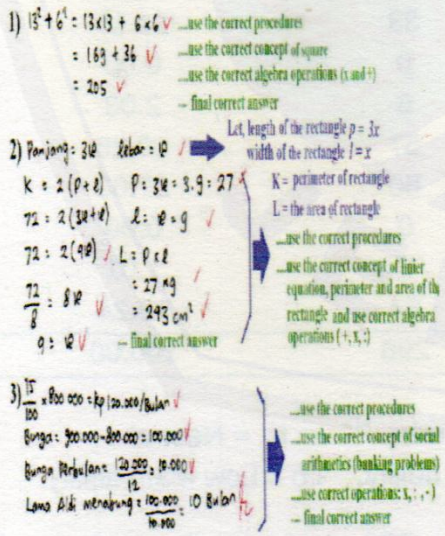

Figure 1. Examples of S1 student' answer

R	:	*How do you feel when you read the questions?*
S1	:	*I am happy, and I want to answer the questions.*
R	:	*Are you sure you can answer the questions?*
S1	:	*Sure, I can answer them, Sir.*
R	:	*Why are you sure?*
S1	:	*Because I already know how to do it*
R	:	*Are you excited to answer the questions until the end?*
S1	:	*Yes, Sir*
R	:	*Please, explain how you answer the problem?*
S1	:	*I understand the problem, keep thinking about the formula, continue to count according to the numbers from the problem.*
R	:	*Did you check your answer?*
S1	:	*Yes, I check it, Sir.*

Figure 2. Interview snippet R with S1

Figure 2 indicates that S1 student successfully answered MAT questions because s/he had good self-confidence from the start. S/he was enthusiastic about completing the task of answering math problems and can carry out correct procedures, namely understanding questions, finding concepts or formulas that match the questions, calculates, and checks the answers.

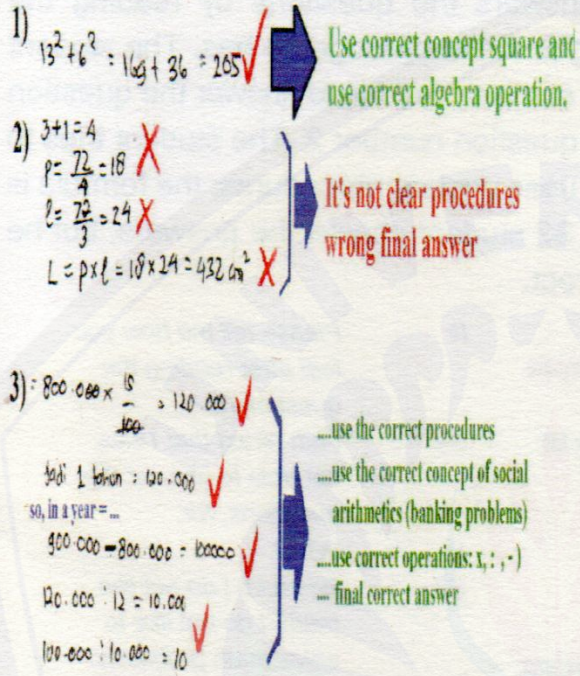

Figure 3. Examples of S2 student' answer

R	:	*How do you feel after reading the questions?*
S2	:	*I felt a little happy but also a little worried.*
R	:	*Why are you feeling that way?*
S2	:	*Because if it's easy, I'm happy, but if it's hard, I'm afraid I'm wrong.*
R	:	*Do you think the math you are learning is useful or not to answer the problem?*
S2	:	*Helpful*
R	:	*How do you answer the questions?*
S2	:	*I read the questions, continued to answers according to my knowledge.*
R	:	*Did you check your answers?*
S2	:	*I checked ... but I'm not really sure my answers are all right.*

Figure 4. Interview snippet R with S2

Figure 3 shows an example of a student's answer with a neutral attitude towards mathematics and a moderate score (code S2 = SNMo). Figure 4 shows a snippet of the interview between the researcher (code R = Researcher) and S2 student.

Figure 3 shows that S2 students can answer several questions well, especially on the sum of two squared numbers and social banking arithmetic questions. In geometry problem, namely determining the

perimeter and area of a rectangle, S2 tried to answer, but he failed to answer correctly. So, the student can only answer easy questions, namely questions that the rules are known. As for the difficult question, namely, problem-solving, S2 student failed to solve the problem.

Figure 4 shows that S2 students already have self-confidence, but it is still not steady, namely between being happy and worried about facing math problems. Student S2 states that learning mathematics useful for solving problems. The student answers the questions by reading the questions, then answers according to the knowledge he has. The student can answer some of the questions correctly but fail to answer the question that is considered difficult, namely question number 2. The student tries to answer question number 2, but he uses unclear procedures; the formula is not clear, so the answer is wrong. S2 student checks the answers, but he is not sure all the answers are correct.

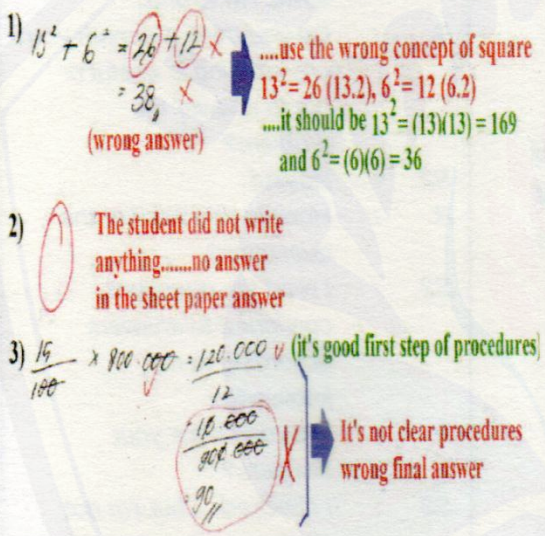

Figure 5. Examples of S3 student' answer

R	:	*Please tell me how you feel after reading the questions?*
S3	:	*I am afraid that I was not able to answer the questions, Sir.*
R	:	*Why?*
S3	:	*Because I do not like math, I do not like to solve math problems, challenging problems.*
R	:	*Did you answer all of the questions?*
S3	:	*No, I did not.*
R	:	*Why?*
S3	:	*Because they are difficult for me*
R	:	*How did you answer the problems?*
S3	:	*I answered according to my ability, Sir.*
R	:	*Did you check your answer?*
S3	:	*No, I didn't, Sir...*

Figure 6. Interview snippet R with S3

Figure 5 shows an example of a student's answer with a negative attitude towards mathematics and the lowest score (code S3=S-Lo). Figure 6 shows a snippet of the interview between the researcher (code R = Researcher) and student S3. From figure 5, it can be seen that the S3 student failed to answer the questions. In the first problem, because students did not understand the concept of squared numbers, where $13^2=(13)(2)=26$, it should be $13^2=(13)(13)=169$. In question number 2 on geometry material, the student did not answer it because students did not understand the concept of perimeter and area of a rectangle. In the third question, the student could only find interest on savings but failed to find time to save.

From figure 6, it can be seen from the interview that from the beginning S3 student had stated that he did not like mathematics; he did not like solve math problems, especially difficult problems. The student believes that many of the answers are wrong because they could not answer the questions. The student also did not check answers because he did not understand the questions well.

From the above results, the following points can be discussed. First, the majority of students prefer a neutral attitude to positive or negative attitudes towards mathematics. This is the same as the results of a study by [7], [14]; most junior high school students choose a neutral attitude towards mathematics, especially in the components of self-confidence, enjoyment, and motivation. The reason is that students like mathematics when facing easy material or problems, but students hate mathematics when studying difficult material or problems. A positive attitude towards mathematics in elementary school can become neutral and even negative when students are in junior high and high school. This is reasonable because students at the elementary school, junior high school, and early high school levels still have unstable attitudes towards mathematics. Only in class XI and XII senior high school, students already have a permanent attitude towards mathematics [15].

Second, more students have low math ability than students with moderate and high math ability. This result is in accordance with the results of research from [16] that the majority of students in grade 8 SMP in Yogyakarta fall into the low math category, as well as junior high school students in Ciamis [17]. The mathematics ability of Indonesian students in

the eyes of the world is also very low, as in the PISA and TIMSS [10], [11], [12].

Third, students with positive attitudes towards mathematics tend to have high mathematical ability and successfully solve math problems. This is in accordance with previous research [2], [5] that students with positive attitudes towards mathematics have good self-confidence and have high motivation to learn mathematics. This motivation drives students to be enthusiastic about learning mathematics to solve math problems successfully [18].

Fourth, students with a neutral attitude towards mathematics tend to have low or moderate math skills. The reason is that students with a neutral attitude have unstable self-confidence. Sometimes, students believe in their ability if they do easy math problems, but their self-confidence is low when working on difficult questions. This is in accordance with the opinion [14], [19] that students with unstable mathematics attitudes still have less than optimal, sometimes moderate, but sometimes low achievement.

Fifth, students with negative attitudes towards mathematics tend to have low math ability and fail to solve math problems. Students with negative attitudes do have low self-esteem, do not like mathematics, and are not motivated to learn mathematics [19]. Such students also have weak mathematical connections and have low math abilities, so they fail to solve math problems [20]. This result is in accordance with the opinion of [21], [22] that the factors that cause students to fail to solve math problems are poor self-confidence, poor motivation, and weakness in mathematical concepts.

The results showed that Grade 8 students' attitudes towards mathematics and science played a major role in achieving optimal achievement in both fields [23]. However, students' attitudes towards mathematics can remain (40%) and change from elementary school to the end of high school (60%) [15]. Therefore mathematics teachers in junior high schools need to improve students' positive attitudes towards mathematics. Some of the ways are to show that mathematics is interesting and important to learn, guide students to be actively involved in the learning process in the classroom, and provide reinforcement for students who do a good task [24]. After the student's attitude increases to be very positive towards mathematics, the students' mathematical ability in solving problems also increases.

6.4. CONCLUSION

The research results concluded that most junior high school students preferred neutral attitudes to positive or negative attitudes towards mathematics. More students have low mathematical ability compared to students with moderate or high math ability. In addition, students with positive attitudes tend to have the high mathematical ability. Students with neutral attitudes tend to have low or moderate mathematical ability, and students with negative attitudes tend to have the low math ability. Positive attitudes towards mathematics determine students' success in solving math problems. Conversely, the failure of students to solve math problems is determined by negative attitudes towards mathematics. These results suggested that math teachers increase positive student attitudes so that students' ability to solve mathematical problems can be improved.

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