The enhancement of student’s mathematical understanding ability through the Aptitude Treatment Interaction (ATI) learning model

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Abstract. Some teachers pay little attention to the difference in students’ abilities in conducting the learning. Fast-learners feel bored when learning because there is a tendency to repeat the lesson, while slow learners will feel left out because learning tends to be dominated by intelligent students. Therefore, the teachers must accommodate students with different abilities, using a learning model that treats students according to their abilities. The Aptitude Treatment Interaction (ATI) learning model is a solution to assist teachers in helping students master the material taught according to the student’s ability level. This study aims to determine the differences in the increase in the mathematical comprehension of students who take learning using the ATI model and those who take conventional learning. This study involved 51 Year 7 students from one private Islamic Junior High School in Banda Aceh, Indonesia, namely: 25 students in the experimental class and 26 students in the control class. The instrument used was a test of the students’ mathematical understanding ability. Students’ mathematical understanding ability was analyzed using an independent sample t-test. The results showed that students’ mathematical understanding ability who took learning using the ATI model was better than those who took conventional learning.

1. Introduction
Mathematical understanding is an essential aspect of learning mathematics principles. When students learn mathematics, it must be accompanied by comprehension; this is a vision of learning mathematics. So, it can be said that comprehension is one of the goals in learning mathematics because if students understand the material taught by the teacher, the learning outcomes obtained will also be maximized [1].

Facts in the field show that students’ mathematical comprehension skills are still not optimal. Students even do not understand the mathematical concepts that have been taught. Students are also still used to memorizing formulas without understanding the material that has been studied well. This fact causes students to have difficulty in selecting or classifying formulas to solve a mathematical problem. In addition, students also have difficulty in distinguishing between examples and not
examples related to the material. Lack of students’ understanding of a mathematical concept impacts the learning outcomes obtained are less satisfactory [2].

Algebraic Form material is an essential part of mathematics taught in Year 7 of Junior High School. Algebraic Form material can be an introductory material for studying other mathematics materials, such as Linear Equation Systems, Functions, Line Equations Straight, etc. Also, questions related to Algebraic Forms are often found in the National Examination questions, National Selection Examination for State Universities (SNMPTN), and other important moments. Therefore, students are required to be able to understand the material well in algebraic forms.

Students’ mistakes in performing algebraic operations include errors in the application of operations between variables, errors in applying the multiplication distribution properties, errors in interpreting the rules of scribbling, errors in not combining like terms, and errors in not simplifying fractions [3]. It follows the researchers’ findings that students have difficulty operating algebra so that the answers obtained are wrong. The question is “Simplify $42n + 35m + 7 - (-50m - 20n + 9)$ !”.

![Figure 1. Students’ Answers to Algebraic Form Problems.](image)

In Figure 1, it can be seen that students do not understand well the addition operation in algebraic form. Students directly add up the algebraic forms that have different variables. Students feel confused in operating the algebraic form; for example, when the researcher asks the result of $x + x$ and $x.x$, he answers that both are $x^2$. The student also adds $42n + 35m + 7 = 84$ because he thinks that the algebraic form can still be determined even though the variables are different.

One of the things that causes a lack of mathematical comprehension of students is that the teacher’s learning does not pay attention to students’ abilities. The material achievement for students is not optimal. The teacher still provides the same learning service for all students so that high-ability students can quickly grasp the material to rapidly work on practice questions. Meanwhile, low-ability students still lag behind medium and high-ability students when the lesson continues to the next material [4]. Following the above statement, it can be concluded that the teacher still provides the same service to all students, even though it is known that each student has different levels of ability.

Therefore, it is necessary for the teacher’s efforts to teach and accommodate students’ different abilities, using a learning model that pays attention to students’ abilities. The Aptitude Treatment Interaction (ATI) learning model is a learning model that divides students into groups of the high, medium, and low-ability students, and each group is given treatment according to its characteristics [5]. Based on it, the teachers have to understand the character of their students in the classroom. It will make the teachers easily give their students material based on differences from students’ ability in processing information related to the subject matter discussed, and the target of national educational goals can be achieved [6].

The syntax in the Aptitude Treatment Interaction (ATI) learning model measures each student’s ability (aptitude testing), then grouping students into three groups (high, medium, and low) according to the classification obtained from the aptitude-testing results. After that, give treatment (treatment) for the high, medium, and low groups. For high-ability students, students learn independently (self-learning) using relevant books in a separate room. For medium and low ability students, they will get regular teaching like usual. However, for low-ability students, they will get special treatment like re-teaching and tutorials. Last, conduct individual evaluation [7].

The third step of ATI is a characteristic that distinguishes this learning model from other learning models, where students will be given treatment according to their abilities. Based on these steps, it is
hoped that it will foster student understanding because they will pay attention to students following their respective portions. It is consistent with one of the ATI goals, which is better to understand different treatments for different individuals [8].

Learning mathematics using the ATI learning model emphasizes grouping students according to their abilities. It encourages student activity, motivates students to develop ideas, encourages students to think, observes, understands, tries, suspects, finds, and reviews to be very influential towards students’ understanding of mathematical concepts [9]. ATI learning model also can stimulate students to think creatively [10].

One of the studies regarding the ability to understand mathematical concepts through the ATI model aims to know the ATI learning model’s effect on understanding mathematical concepts. The result can be said that there is a significant effect of the ATI learning model on understanding mathematical concepts [11]. Another research is the impact of the learning model (ATI) on students’ ability to understand mathematical concepts using quasi-experimental methods. The results of his research state that there is an effect of applying the learning model (ATI) compared to conventional learning to improve students’ ability to understand mathematical concepts [12]. One of the other research concerns applying the ATI learning model to improve elementary school students’ mathematical concept understanding [13].

Based on the three studies above, it can be concluded that there has been no research that examines the improvement of students’ mathematical understanding abilities through the ATI learning model in JHS by using a quantitative method with the pretest-posttest control group design. Therefore, the formulation of the problem in this study is (1) Is the increase in the mathematical understanding of students who take learning using the Aptitude Treatment Interaction (ATI) model better than the comprehension ability of students who take conventional learning?

2. Methods

The method used in this study was an experimental research method with a pretest-posttest group design using an experimental group and a control group. The population in this study were all Year 7 students of SMPIT Al-Azhar Banda Aceh. It consists of three classes with a sample of two levels: 25 students from the experimental class who participated in learning using the ATI model and 26 students from the control class who took conventional learning. The sampling technique used in this study is random sampling. The instrument used was a test of mathematical comprehension ability. This study’s giving of tests was to determine students’ understanding after the ATI model was applied. Individual evaluation test questions are prepared based on mathematical understanding indicators, and a rubric for assessing students’ mathematical comprehension is made, which contains the hands of mathematical comprehension. The data analyzed included the results of the pretest and post-test. Data were analyzed using an Independent sample t-test using SPSS version 2.2.

3. Result and Discussion

N-gain data Analysis

| Ability               | Score     | Experiment N | \( \bar{x} \) | SD  | Control N | \( \bar{x} \) | SD  |
|-----------------------|-----------|--------------|---------------|-----|-----------|---------------|-----|
| Mathematical Understanding | Pretest   | 25           | 37.72         | 1.11 | 26        | 34.59         | 1.58 |
|                       | Postest   | 25           | 72.28         | 1.46 | 26        | 62.63         | 1.77 |
|                       | N-gain    | 25           | 0.56          | 0.21 | 26        | 0.44          | 0.16 |

Ideal Maximum Score = 100
Based on Table 1, it can be seen that the pretest score of students’ mathematical understanding ability for the experimental and control classes is not much different. It shows that the initial skills of the two classes before being given treatment are the same. The post-test average score of students’ mathematical comprehension abilities obtained by the experimental class was higher than the control class. It shows an increase in the score of students’ mathematical understanding abilities after being given treatment. The average N-gain score of mathematical comprehension ability in classes using the ATI model and conventional classes is classified into the moderate category.

Table 2. Data of Normality Test Results of N-Gain Score of Students’ Mathematical Comprehension Ability.

| Class          | Kolmogorov-Smirnov Statistic | Df  | Sig.   | Result          |
|----------------|-----------------------------|-----|--------|-----------------|
| Experiment     | 0.144                       | 25  | 0.196  | H0 is accepted  |
| Control        | 0.150                       | 26  | 0.136  | H0 is accepted  |

Based on Table 2 above, it is found that the N-gain of the students’ mathematical understanding ability in the experimental class and control class has a significant value of 0.196 and 0.136, respectively. This significant value is greater than \(\alpha = 0.05\). It can be concluded that H0 is accepted, meaning that the sample comes from a normally distributed population or, in other words, the N-gain value of the students’ understanding ability in the experimental class and the control class is normally distributed.

Table 3. The Variance Homogeneity Test for the N-Gain Score of Students’ Mathematical Comprehension Ability.

| Aspect of Ability | Levene Statistic | df1 | df2 | Sig. |
|------------------|------------------|-----|-----|------|
| Mathematical Comprehension | 2.393            | 1   | 49  | 0.128 |

Table 3 above shows that the N-gain value of the students’ mathematical understanding of the experimental class and the control class has a significant value > 0.05. Namely, 0.128 means that H0 is accepted, so it can be concluded that the N-gain data for the experimental class and control class comes from homogeneous variance.

Table 4. Test Results of the Difference in the Average N-Gain Score of Students’ Mathematical Comprehension Ability.

| t-test for Equality of Means | Description | Conclusion            |
|-----------------------------|-------------|-----------------------|
| T                           | Df          | Sig. (2-tailed)       |                        |
| 2.302                       | 49          | 0.026                 | H0 is rejected         |

Based on table 4 above, it can be seen that the sig. (2-tailed) is 0.026 so that the sig value is obtained. \((1-tailed) = (\text{sig. (2-tailed)}) / 2 = 0.026 / 2 = 0.013\). Because of the sig. \((1-tailed) \leq \alpha = 0.05\), namely 0.013, means that H0 is rejected. It can be concluded that the N-gain average of the experimental class’s mathematical comprehension ability is better than the control class N-gain average. The increase in students’ mathematical comprehension ability who take learning using the Aptitude Treatment Interaction (ATI) model is better than students who receive conventional learning.

The data analysis results above indicate that the increase in students’ mathematical understanding skills using the ATI model is better than students who receive conventional learning. It shows that learning using the ATI model influences improving students’ mathematical understanding abilities. The ATI model’s characteristic is that students are grouped and given treatment according to their abilities to get treatment according to their respective portions. High-ability students are considered to
be more independent to study with their group mates using the available textbooks. In contrast, medium and low-ability students must get an explanation of the teaching material from the teacher. Low-ability students get additional guidance when working on their worksheets.

Grouping students based on cognitive abilities can provide benefits, such as improving student achievement, making it easier for teachers to teach in class, controlling the process of giving instructions, and reinforcing high achieving and low achieving students. Low-achieving students feel more comfortable with equal ability peers, and high-achieving students can also look after and support their interests. Besides, students can respect each other, participate in group work between students, and help teachers adjust teaching materials and methods according to students’ needs and levels. Finally, it can optimize the use of time, space, and materials for students, and students can work quickly or later according to their ability level [14].

Besides, teachers’ guidance or assistance to low-ability students also allows them to understand the material being taught. Students are guided slowly so that, little by little, the teacher can allow students to solve their problems independently. It is following Vygotsky’s theory of scaffolding. The study results stated that learning with the guided discovery method through scaffolding was carried out well, and changes in student attitudes were seen in this learning process. Guided discovery through scaffolding can also help build student understanding where assistance is given at the right time and in the right amount to become independent in their settings [15]. It is that affects increasing students’ mathematical understanding abilities. Therefore, guidance or assistance to low-ability students affects increasing students’ mathematical understanding ability.

This study’s results are also in line with the research results, which states that the ATI model’s application effectively improves students’ understanding of mathematical concepts [16]. Other research results also show that the Aptitude Treatment Interaction (ATI) learning model affects students’ mathematics learning outcomes. The average mathematics learning outcomes of students taught using the Aptitude Treatment Interaction (ATI) learning model were higher than the average mathematics learning outcomes of students taught using conventional learning models [17].

4. Conclusion
Based on the results of the study, it can be concluded that the increase in the mathematical comprehension ability of students who take learning using the Aptitude Treatment Interaction (ATI) model is better than the increase in the understanding ability of students who take conventional learning. ATI model is expected to be applied and developed by teachers in learning so that students’ mathematical understanding is well achieved. Nevertheless, the ATI model’s implementation takes a long time, requiring good planning and proper time management. The teacher has to make three groups according to students’ abilities, so they have to know it well. If the teacher is wrong in grouping students, the treatment that the students get is also wrong. This research only uses the ATI model in Algebraic Form to know about students' mathematical understanding. Future research can use the ATI model in math to learn about another student’s mathematical abilities like communication, reasoning, problem-solving, etc. Furthermore, they can apply many learning methods when giving material to medium and low ability students. They can create other learning methods that are more interesting and fun in delivering material.

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