Students’ mathematical understanding ability using contextual teaching and learning approach

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Abstract. Students’ mathematical understanding ability is one of the students’ compulsory competences in learning mathematics. In the learning process, students commonly hesitated to ask the teacher how to solve mathematical problems even though they did not understand the lesson. This research aimed to improve the mathematical understanding ability by applying Contextual Teaching and Learning (CTL). This study employed a qualitative approach using True Experimental Design. This paper explained that the experimental result of students’ mathematical understanding ability used Contextual Teaching and Learning (CTL). The test of mathematical understanding ability was administered to Year 7 students of one of the junior high school in Sigli, Pidie. The instrument was a mathematical understanding ability test. The data analysis showed that the result of the normality test scores of the students’ mathematical understanding ability of the experimental class and the control class were 0.288 and 0.125. This research found that learning by using CTL indicated to improve the students’ mathematical ability. Mathematics teachers can apply CTL in the learning as an effort of developing students’ mathematical understanding ability in other algebra lessons.

1. Introduction
The students' mathematical understanding ability can be analyzed based on (1) defining oral and written concept; (2) identifying and creating examples and non-examples; (3) using model, diagram, and symbols to present a concept; (4) changing a representation form from one to another; (5) recognizing various meanings and concept interpretation; (6) Identifying concept characters and recognizing the terms of identifying a concept; (7) comparing and distinguishing concepts. The previous study conducted by the researcher indicated that the level of students’ mathematical understanding in one of the junior high schools in Sigli, Pidie was very poor. It signified that teachers have to work hard in preparing questions and training the students to enhance their mathematical understanding. The learning of the 2013 curriculum emphasizes not only on cognitive and affective competencies but also on skills.

The development of students’ mathematical ability is significantly related to their experiences. The students’ improvement process occurs due to the daily learning [1]. The learning process should be able to stimulate the students to upgrade their knowledge found in a concept. In mathematics learning, learners have to construct their knowledge [2]. The learning material is not a direct concept; however, the learners have to find the concept from solving problems. Therefore, the students actively build and develop their knowledge or concept based on their experiences.
Mathematical understanding ability is one of five essential abilities in learning mathematics that is significantly related to the concept of understanding, fluency, strategic competences, adaptive reasoning, and productive disposition. Someone understands the concepts or facts if she/he can explain the mathematical concepts/facts in a simple way [3]. The mathematical understanding ability is necessary to be developed so the learners can solve problems in real-life applying mathematical knowledge. Students need mathematical understanding in solving mathematical problems, other disciplines, and daily life problems. It is the vision of mathematics learning improvement to fulfill the present needs [4]. As a result, the students become responsive in facing changes in their life.

One of the learning strategies which can develop learning and stimulate the improvement of students’ mathematical understanding ability is Contextual Teaching and Learning (CTL) approach. CTL is a learning approach emphasizing on students’ involvement process to discover the learning material and link them to real life, so the students can implement it in daily life [5]. There are seven components of contextual learning; one of them is constructivism or students’ depth understanding acquired from learning experiences to strengthen the knowledge context. A finding is developing conceptual understanding through observation and theory formulation individually or in a group. The learners are encouraged to investigate things and obtain some information from questions. Learning community is students training to be able to speak, share experiences, and cooperate with other people to create better learning. Modelling can be demonstration and examples, critical reflection, or components, because it can be a chance to evaluate the activities, including learning progress and difficulties. Authentic assessment is overall assessment toward all of the students’ contextual stages [6].

Learning using CTL approach is an approach connecting the abstract mathematical concepts to the concrete ones or students’ surrounding to enhance students’ confidences in understanding the mathematical concept. The CTL application enables students to acquire every concept in their learning. Teaching is not a knowledge transformation from teachers to students like memorizing concepts that seem to be separated from the students' real life. However, this approach focuses on facilitating students to connect the mathematical concept to their surroundings, so mathematics become familiar to the students. The learning process centre is on the students to motivate and optimize their learning activities that can impact on the mathematical understanding improvement.

Based on the explanation previously presented, the researcher is interested in examining how the students’ mathematical understanding ability by employing CTL approach compared to those by conventional learning.

2. Method
This research aimed to investigate the mathematical understanding ability using Contextual Teaching and Learning (CTL). The aim could be achieved by analyzing the data of students’ mathematical understanding ability from the mathematical understanding test. The research data was the students’ mathematical understanding ability in the form of the score and was analyzed statistically. This study employed a qualitative approach; it was an experimental study using the learning treatment, applying CTL approach. The research type was True Experimental Design, as the sample was taken randomly. The purpose of this research was to compare the improvement of the students’ mathematical understanding ability. Therefore, the pre-test and post-test results were examined in each group. The design was Pre-test Post-test Control Group Design [7]:

| Class     | Pre-test | Treatment | Post-test |
|-----------|----------|-----------|-----------|
| Experiment| O₁       | X         | O₂        |
| control   | O₁       | -         | O₂        |

X : treatment (applying the CTL model)
O₁ : Pre-test of experiment and control class
O₂ : Post-test of experiment and control class
The population of this study was one class of Year 7 students in one of the junior high school in Sigli, Pidie. The sample was two classes consisting of experimental and control classes. The sample selection in this study was a random sampling of seven parallel classes. The results of random sampling were 24 Year 7 students for experimental class and 24 Year 7 students for the control class. The data was conducted through pre-test and post-test and also questioner. After the data collection, the researcher processed the data. The data analyzed was based on pre-test and post-test results. The data analysis involved a statistical test (t-test) using Microsoft Excel and SPPS 22.0. The preliminary tests were N-gain test, normality test, homogeneity test, and t-test [8].

3. Result and Discussion

The data analysis in this study involved N-Gain score of Students’ mathematical understanding ability in an experimental class (Contextual Teaching and Learning) and a control class (conventional learning). The analysis was to investigate whether the improvement of students’ mathematical understanding ability in both classes was the same or significantly different. The t-test is conducted when the data meet the normality and homogeneity requirement. If the data is not normal and homogenous, the t-test is replaced by the non-parametric test of Mann-Whitney.

Normalized gain is the index of learning outcomes improvement. In this study is an index of improvement in students’ mathematical understanding skills in the experimental and control class after learning implemented. Normality and homogeneity test of N-gain was used to determine the possible statistics test to examine the hypothesis. The result of n-gain score description of students’ mathematical understanding ability in both classes was presented in Table 2.

| Class     | N   | Max Score | Min Score | $\bar{x}$ | SD  | Variance |
|-----------|-----|-----------|-----------|---------|-----|----------|
| Experiment| 24  | 0.91      | 0.41      | 0.65    | 0.12| 0.10     |
| Control   | 24  | 0.80      | 0.33      | 0.52    | 0.14| 0.02     |

Based on Table 2, some conclusions relating to mathematical understanding ability were drawn, namely: the N-gain score of the mathematical understanding ability in the experimental and control class was in the middle category. The average N-gain score of mathematical understanding ability in the experimental class was 0.65, whereas the score in the control class was 0.52.

The Shapiro Wilk normality test results of N-gain data of understanding ability in the experimental and control class were presented in Table 3.

| Class     | Shapiro Wilk Statistics | df | Sign. | Conclusion |
|-----------|--------------------------|----|-------|------------|
| Experimental | 0.970                   | 24 | 0.658 | Ho accepted |
| Control   | 0.919                   | 24 | 0.057 | Ho accepted |

In Table 3, N-gain of students’ mathematical understanding ability in the experimental and control class showed the p-values of 0.658 and 0.057, respectively, $p-value > \alpha = 0.05$; therefore, $H_0$ was accepted. This means that the sample was from a normal distribution population or N-gain of students’ mathematical understanding ability in both classes was normally distributed. Based on the results, the homogeneity test of N-gain of students’ mathematical understanding ability in the experimental and control class was performed. The conclusion of the homogeneity test was described in Table 4:
The average pre-test score of the control class was 3, the ideal score should also be 64. Based on the test result of the students' mathematical understanding ability taught by contextual teaching and learning (CTL), it was concluded that the N-gain data of experimental and control class was from homogeneous variance.

The t-test was aimed to examine whether the improvement of the students' mathematical understanding ability taught by Contextual Teaching and Learning (CTL) was better than those learned by conventional learning. The hypothesis test was conducted by t-test employing SPSS 22 at the significance level $\alpha = 0.05$. The hypothesis test criteria were rejected $H_0$ if significance (1-tailed) $< \alpha = 0.05$. The relationship of the significance value (p-value) of the one-way and two-way test from the SPSS output has been described by whidiarso [9], namely: $\text{sign.} (1\text{-tailed}) = \frac{1}{2} \text{sign.} (2\text{-tailed})$. The N-gain test result of students' mathematical understanding ability was presented in Table 5:

| Ability aspect       | Lavene Statistic | df 1 | df 1 | Sign. |
|----------------------|------------------|------|------|-------|
| Mathematical understanding | 1.525        | 1    | 46   | 0.223 |

Table 4. The homogeneity test result of N-gain score of students’ mathematical understanding ability

Table 5 presents the N-gain test results of students mathematical understanding ability, the p-value was 0.003 (2-tailed), and the p-value is 0.0015 (1-tailed). The p-value is less than 0.005, and thus $H_0$ was rejected. It indicated that the improvement of students' mathematical understanding ability taught by CTL approach was better than those by conventional learning.

This study described the difference of the students’ mathematical understanding ability improvement taught by CTL approach and conventional learning on the topic of algebraic forms. A class applying CTL approach was an experimental class, and the one implementing conventional learning was a control class. Based on the research findings, the students’ mathematical understanding ability had better improvement than those in the control class. The average N-gain score of students’ mathematical understanding ability taught by contextual teaching and learning was 0.65, whereas the score in the control class was 0.52, indicating a difference of 0.13.

According to the explanations, CTL approach could develop the students’ mathematical understanding ability through asking to know; understanding from modelling; and applying a concept, procedure, principles and mathematical ideas from invention and constructivism. It was different from students' understanding that was taught by direct learning. Johnson [10] asserted that learning applying CTL approach was an education process that might help students to find meaningful learning through academic materials by connecting them to their context of life, including their socio-culture.

The pre-test result showed that there was no significant difference between the prior knowledge of the students in the experimental and control class. It was based on the pre-test score in both classes; the average pre-test score of the experimental class was 32.29 (the highest score = 41, the lowest score=22), the ideal score should be 64. The average pre-test score of the control class was 32.00 (the highest score 40, the lowest score=20), the ideal score should also be 64. Based on the test results, the prior knowledge of the students in the experimental and control classes was not significantly different.

After providing treatment, the students' mathematical understanding ability in the experimental and control class was different. It was based on the result of the hypothesis test. The post-test score of the students’ mathematical understanding ability in the experimental class was 52.83 (the highest score = 62, the lowest score=44), the ideal score should also be 64. Whereas the post-test score of the students’ mathematical understanding ability in the control class was 48.46 (the highest score =58, the lowest...
score=35), the ideal score should also be 64. From the explanations, the difference in the score in both classes was 4.37.

The average score of the students’ mathematical understanding ability in the experimental class was better than those in the control class. The N-gain of the students’ mathematical understanding ability in both classes showed differences. The average of the experimental class was 0.65 (the highest score = 0.91 and the lowest score=0.41). It had significant differences to those in the control class, the average of the students’ mathematical understanding ability in the control class was 0.52 (the highest score=0.80 and the lowest score 0.33).

Some relevant studies support these research findings that mentioned contextual teaching and learning had better achievement in improving the students’ mathematical understanding ability. One of them was Sariningsih [11], it revealed the students’ mathematical understanding ability was better by contextual approach than those by conventional learning. Besides, Mauke [12] analyzed the differentiation of conceptual understanding and problem solving, employing both CTL and conventional learning model. The research findings indicated that the conceptual understanding and problem solving applying CTL were significantly different. Similar research was conducted by Fatmawati [13]; it was concluded that contextual teaching and learning implementation could improve the students' mathematical understanding better than conventional learning. The pre-test score of the experimental class was 35.55. However, the post-test score was 53.69; it has an increase (19.40). The N-gain interpretation indicated that all of the control classes were on the low category. However, 31 students of the experimental class had low gain interpretation, and four students had middle N-gain (0.14).

Berns and Erickson [14] defined CTL as a learning process helping students to understand the lesson and connect its applications to real-world situations; encourage students to link the knowledge and its application to their lives as a family member, a citizen, and an employee; and engage in a hard work that requires learning. This is in line with Nurhadi [6] who argued that contextual approach was a learning concept that helps teachers relate the lessons to the real-world situations and motivate students to create connections between knowledge and its application to their lives as family and community member.

4. Conclusion

Based on the research findings, it can be concluded that the improvement of students' mathematical understanding ability taught by contextual teaching and learning approach was better compared to those by conventional learning. Thus, it is suggested that teachers should implement contextual teaching and on learning in mathematics learning to improve students' learning outcome. Also, it is recommended for other researchers to conduct studies on developing learning applying contextual teaching and learning in other relevant mathematics topics.

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