Contextual approach with scaffolding: an effort to improve student’s mathematical critical thinking

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Abstract. This study aims to determine the improvement of student’s critical thinking abilities through a contextual approach with scaffolding. This study is a quasi-experiment in a senior high school in Ciamis, Indonesia. The sample is class XI taken by cluster random sampling technique to get the experimental class and the control class. The improvement of students' mathematical critical thinking skills is obtained by doing pretest and posttest in the experimental class and the control class. The test used is a matter of mathematical critical thinking skills that were previously tested. The results showed that the comparison of the increase in student’s critical thinking abilities through a contextual approach was better than the students in the control class. The novelty of this research is the contextual approach that presents problems in the context of student life combined with scaffolding that adapts the zone of proximal development to students. These actions have an impact on improving the mathematical thinking ability of the majority of students in the high category.

1. Introduction
Technology is developing rapidly, making it easy for people to access new information that has emerged from every part of the world. So that people don't get caught up in the wrong information, they need the ability to think critically. The development of critical thinking skills can be carried out by various parties in education.

Critical thinking is the ability to analyze a mathematical situation or problem through rigorous examination [1]. Critical thinking is a systematic process that allows students to formulate and evaluate their own beliefs and opinions [2]. Thus critical thinking is a process for analyzing a situation, problem, or decision on a rigorous examination step by step to obtain confidence in the information or situation that exists.

The effort that can be done to train student’s mathematical critical thinking skills is to carry out the right learning process. The curriculum in Indonesia facilitates teachers to apply various varied learning models [3]. Teachers can take advantage of the opportunity to choose mathematical models that can have high mathematical critical thinking skills. Teachers can also innovate in the learning process by combining approaches with learning models.

There is one approach that can be used by teachers in implementing learning, namely the contextual approach. The essence of the contextual approach is the relationship between the material or topic of learning with real life [4]. The contextual approach in learning is a learning concept that helps teachers associate material taught with student’s real-world situations and encourages student’s to make connections of knowledge that they have with their application in daily life [2]. The teacher must
understand how the context presented will affect the improvement of student’s mathematical abilities [5].

The Contextual Approach has seven learning principles that must be developed by the teacher in the learning process, namely: 1) constructivism, 2) inquiry, 3) asking, 4) learning society, 5) modeling, 6) reflection and 7) actual assessment [4]. In the learning process, some students can construct their own knowledge independently through the context of the problem. Therefore, it is important for teachers to consider scaffolding and effective feedback for students [5]. Research on the contextual approach has been carried out by Hajj. He showed that an effective contextual approach to student’s mathematical communication abilities [6].

Along with the development of the learning model, now there is a Scaffolding Learning Model. Vygotsky introduced the term scaffolding, namely giving assistance to children during the early stages of their development and reducing the assistance and providing opportunities for children to take on greater responsibilities as soon as the child can do it [7]. Scaffolding is an effort to solve problems cooperatively between teachers and students with the aim that later students can as soon as possible to be able to complete their tasks independently [8]. The consideration of the implementation of scaffolding is what can be achieved by each student independently and what he can achieve with guidance, namely the zone of proximal development of students [9]. One study of scaffolding learning by Sahal showed that student’s ability to understand concepts improved with scaffolding learning [10].

Communication and conceptual understanding of mathematical are bridges to achieve high-level thinking skills, so combining the application of a contextual approach with a scaffolding learning model is thought to improve mathematical critical thinking abilities. Therefore, the purpose of this study was to determine the increase in student’s critical thinking skills mathematically and to know the criteria for improving student’s mathematical thinking abilities through a contextual approach with scaffolding.

2. Methods
This study was a quasi-experiment, which involved two research groups. The first group was the experimental class that received the contextual approach with a scaffolding learning model, while the second group was the control class that obtained Conventional Learning. The research design used in this study was the pre-test and post-test non-equivalent group design.

The population of this study was all students of class XI IPA in one of the high schools in Ciamis, Indonesia. The research sample was taken using cluster random sampling technique that is a random class by taking one class as an experimental class and one class again as a control class. The instrument of this research is a test question of mathematical critical thinking abilities given to students when carrying out pretest and posttest activities. The data analyzed were normalized gain (n-gain) data obtained from pretest scores and posttest scores. Data analysis used inferential statistics to prove the research hypothesis while the descriptive statistics for the n-gain criteria.

3. Result and Discussion
Learning in the experimental and control classes was conducted in four meetings, as well as the pretest and posttest activities. This learning is carried out in the Linear Program material. The results of the pretest and posttest are the acquisition scores to determine the normalized gain (n-gain) value.

Processing of n-gain value data uses SPSS software. The first step is to do a normality test to see whether the data obtained come from populations that are normally distributed or not. Normality test using the Shapiro-Wilk test. Test the normality of data with a significance level of $\alpha = 5\%$. The significance value of the experimental class data is $0.08 \geq 0.05$, so normally distributed. The significance value of the control class data is $0.09 \geq 0.05$, so normally distributed. The second step is to test the variance homogeneity to determine whether the n-gain value of the experimental class and the control class has a homogeneous variance or not. Homogeneity testing uses the Levene’s Test for Equality of Variances test with a significance value or $\alpha = 5\%$. Based on the results of data processing, the significance value is $0.65 \geq 0.05$, so the variance of the two classes is homogeneous. The third step is
the t-test to prove the research hypothesis with a significance value (α) of 5%. The following are the hypothesis:

\[ H_0 : \mu_x \leq \mu_y \]
\[ H_1 : \mu_x > \mu_y \]

- \( H_0 \): Improving the ability of mathematical critical thinking students who use a contextual approach to the scaffolding learning model is no better than students who get conventional learning.
- \( H_1 \): Improving the ability of mathematical critical thinking students who use a contextual approach with a scaffolding learning model is better than students who get conventional learning.

\( \mu_x \): The mean parameter of n-gain from the experimental class

\( \mu_y \): The mean parameter of n-gain from the control class

Table 1 shows the results of the analysis of data n-gain using the t-test.

**Table 1. Hypothesis Pair Test Results**

| Uji | Sig. | \( H_0 \) | Keterangan |
|-----|------|-----------|------------|
| t   | 0.01 | Reject    | Improving the ability of mathematical critical thinking students who use a contextual approach with a scaffolding learning model is better than students who get conventional learning |

Table 1. shows that the increase in mathematical critical thinking skills of students who use the contextual and scaffolding approach learning is better than students who obtain conventional learning. Thus there is the influence of the use of learning Contextual Approach with Scaffolding Learning Model on student’s mathematical critical thinking abilities.

**Table 2. N-gain Criteria**

| N-gain coefficient | Criteria | Experiment Class | Control Class |
|--------------------|----------|------------------|---------------|
| \( g \geq 0.7 \)   | High     | Student \( \% \) | Student \( \% \) |
| \( 0.3 \leq g < 0.7 \) | Middle   | 12   | 17  | 33.33 | 47.22 |
| \( g < 0.3 \)      | Low      | 0    | 1   | 0.00 | 2.78  |
| **Total**          |          | 36   | 36  | 100  | 100   |

The data in Table 2. are the n-gain criteria for each level of students in both classes. The results show that the improvement of student’s mathematical critical thinking skills with high criteria in learning contextual approaches with scaffolding learning models is more when compared to the control class. The success of learning a contextual approach with a scaffolding learning model is also the absence of students who have low criteria.

The results of hypothesis testing indicate that the increase in mathematical critical thinking skills of students who use the contextual approach with a scaffolding learning model is better than students who obtain conventional learning. In addition, the improvement of students' mathematical critical thinking skills in the class of contextual approaches with scaffolding learning models is mostly high criteria. The results of this study are in line with the results of Zakiah's research. Students in each category of contextual approaches have a higher increase in metacognitive abilities than students who have direct learning, with quality improvement at a moderate level [11]. In addition, it is also in accordance with Sharma & Hannafin's research report that uses Scaffolding in the design of online high school learning.
to facilitate the development of critical thinking. The use of Scaffolding can develop assimilation from external to internal [12].

The results obtained from this study are the result of the learning process in the experimental class has advantages compared to the control class. The advantage is to integrate the approach and learning model. The basis of its integration is the basic idea of constructivism, metacognitive, Scaffolding, the zone of proximal development, and expert performance [13]. Scaffolding can improve mathematics learning outcomes in students [14].

Learning that uses the contextual approach with the scaffolding learning model has a novelty in the learning process. This combination produces innovation in learning with the following learning steps:

a. The teacher explains the learning material. Contextualization with the real world problem. Explanation of material does not arrive at solving the problem.
b. The teacher determines the zone of proximal development (ZPD) by looking at the value of students' previous learning outcomes.
c. The teacher groups students according to their ZPD. Group formation shows the existence of learning communities.
d. The teacher provides worksheets to students with levels of tiered questions.
e. The teacher encourages students to work and learn to solve questions independently and in groups. Students experience the constructivism, inquiry, and questioning phases.
f. The teacher provides assistance with guide motivation, examples, keywords, or other so students learn independently. The assistance provided is modeling process.
g. The teacher directs students with high ZPD to help students with low ZPD. At this step, students experience the process of questioning and inquiry.
h. Teachers and students conclude the lesson. The teacher gives assignments. At this step, students experience reflection.
i. The teacher gives an individual test. In this step Authentic Assessment occurs.

Students look very interested and enthusiastic about the learning situation through a contextual approach to the scaffolding learning model. In addition, the use of student worksheets provides support in the learning process. Worksheets can function to guide knowledge construction [15]. In this study, worksheets mediate the process of constructivism and student inquiry. Contextual Problems are presented in the worksheet and become one of the supporters of improving student's mathematical critical thinking skills. Contextual problems can develop a variety of mathematical abilities [16]. Worksheet presents questions sequentially based on the level of difficulty (starting from the easiest to the most difficult). All of these processes help students to master the subject matter.

Students work in heterogeneous groups based on ZPD students. Heterogeneous group conditions provide opportunities for students who have high mathematical abilities to help friends who have low mathematical abilities, so they help each other. In addition, students also get help from the teacher when they feel difficult. Vygotsky states that student’s mentality will function higher with conversation and cooperation with others [17].

Contextual approach with the scaffolding learning model emphasizes the discussion between students in one group. The teacher must be able to encourage students to discuss [18]. Discussions help make it easier for all group members to understand the material so that the resolution of the questions in the LKS is faster. The teacher only provides assistance if all group members have obstacles to solving problems. Teacher assistance continues to decrease until students learn independently. In order to increase student motivation, the teacher gives a check mark on the student's answer sheet that has been completed and correct. Although simple, check marks can increase student’s enthusiasm to solve all problems quickly and correctly.

At the end of learning, the teacher gives homework to students. Homework has an important role in helping students to be able to recall the material learned in class. The teacher provides homework with the aim of involving students in consolidating what has been taught by the teacher in the classroom and preparing students for the exam [19]. In addition, at each meeting, the teacher gives individual tests to
students. Individual tests provide benefits to students, namely increasingly trained in completing Linear Program questions and are motivated to learn the material at the next meeting.

4. Conclusion
The results of hypothesis testing indicate that the increase in mathematical critical thinking abilities of students using the contextual approach with scaffolding learning model is better than students who obtain conventional learning. In addition, the majority of students in the class of contextual approach with a scaffolding learning model have high criteria for increasing mathematical critical thinking abilities.

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