Analysis of students' mathematical critical thinking ability on the problem of algebraic factorization and implementation of cooperative learning in the type of student teams achievement divisions to improve students' critical thinking ability

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Abstract. Critical thinking in learning is very necessary because critical thinking is an asset for students to be able to develop knowledge widely. The cooperative learning model of the student team achievement division type is one of the learning models used to optimize learning. This study aims to study students' critical thinking ability and the application of the cooperative learning model type student teams achievement division on algebra factorization material. This research uses a mixed method that combines quantitative and qualitative methods. This study involved 64 respondents who were divided into control and experimental class. The control class consisted of 32 students and the experimental class consisted of 32 students. The results showed that there was a significant difference, as seen from the independent t-test scores on the post-test. The data analysis shows that the value of the independent sample t-test from the post-test is sig. 0.011 (p ≤ 0.05), Therefore significant. Thus, there is an effect of the application of cooperative learning type student teams achievement divisions in increasing students' critical thinking skills in solving problems in algebraic factorization material.

1. Introduction

Teachers have important roles and responsibilities in the activities of the learning process in the classroom so that learning objectives can be achieved optimally. One of the subjects that must be studied in school according to the curriculum is mathematics. Mathematics is a universal science that has an important role in various disciplines and advances human thinking. Therefore, the learning process there must be thorough preparation starting from determining indicators, learning models, teaching aids, learning resources, forms of assessment, and everything that can support the learning process activities to run well.

Critical thinking in learning is very necessary because critical thinking is an asset for students to be able to develop knowledge widely. The ability to think is also the basis of a learning process. Critical thinking ability are reflective thinking ability that focus on patterns of making decisions about what to believe and what to do [1].Critical thinking in mathematics is an ability that involves the prior knowledge, mathematical reasoning, and cognitive strategies for generalizing, proving, or evaluating less well known mathematical situations [2].

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Critical thinking skills can be divided into eight functions where each function represents an important part of the quality of thinking and the overall result, namely: (a). Question at issue, (b). Purpose, (c). Information, (d). Concepts, (e). Assumptions, (f). Point of view, (g). Interpretation and inference, (h) [3]. Implication and consequences. Critical thinking can be trained in the learning process by selecting the right learning strategy. Practicing critical thinking can be done by questioning what is seen and heard, the next process is asking why and how about this. The information obtained must be processed properly and carefully before it can be concluded. In this paper, the observed critical thinking skills include eight functions, namely: (1). Question at issue, (2). Purpose, (3). Information, (4). Concepts, (5). Assumptions, (6). Point of view, (7). Interpretation and inference, (8). Implication and consequences. The eight functions of critical thinking skills are converted into 8 indicators.

Critical thinking ability can be found in learning, one of which is in cooperative learning. Cooperative learning in [4] and [5] is a general term for various small groups in which students work together to maximize each others learning. One type of cooperative learning is student teams achievement divisions. In student teams achievement divisions, heterogeneous groups are created. Students in the group are motivated to carry out learning and learn to help each other to make it happen goals and be successful [6]. STAD is cooperative learning where students help themselves and their group friends learn in small, heterogeneous groups, defined by [7] and [8]. This method is done when students prepare for the end of a course or weekly exam by teaching the course content, worksheets, test applications presented by teachers to each other through activities they do together [9].

To solve the problem in this study, the researcher applied one method, namely cooperative learning type student team achievement division on algebra factorization material. Thus, the purpose of this study was to analyze students' critical thinking skills and the application of the cooperative learning model type of student teams achievement divisions to improve students' critical thinking ability.

2. Research Methods
This study uses a mixed method which is a combination of qualitative and quantitative research methods. The design used is sequentially explanatory. The research methodology is also applied in [10] and [11].

This study used an experimental research design that compiled two classes, namely the control and experimental classes, which were selected by purposive random sampling and tested by pre-test and post-test using the design in [12] which is shown in table 1 below.

| Grup     | Pre-test | Treatment | Post-test |
|----------|----------|-----------|-----------|
| Experiment | O        | X         | O         |
| Control   | O        | C         | O         |

Information:
X : Treatment given (Independent Variable)
C : Control of treatment
O : Pretest / Post-test (Dependent Variables observed)

This research was carried out using a design that chose one class as the experimental class and one class as the control class. The pretest was carried out in the control and experimental classes to determine the students' initial abilities. At the time of the research, the control class is given conventional learning and the experimental class is given the division of student team learning achievement. Post-test is carried out after learning to assess learning outcomes and their effect on students' critical thinking ability.
2.1 Population
This research was done to MTs. Irsyadun Nasyi'in Kasiyan Timur Puger, with research subjects, namely students of class VIII who have not studied algebraic factorization studies. The first class is a control class consisting of 32 students and the second class is an experimental class consisting of 32 students. The sampling technique uses random sampling in selecting two classes which are carried out randomly.

2.2 Instrument
In this paper, the instruments used are tests, observations, and interviews. The research was carried out using the procedure which is illustrated in Figure 1 below:

![Figure 1. The Model of Mixed Method.](image)

In this study, students' thinking abilities were assessed based on indicators that have been converted into assessment instruments. The quantitative method is used to analysis students' abilities after the application of the cooperative learning model type of student teams achievement division. Qualitative methods were used to analysis data from observations and interviews with selected students. In this study, the two variables studied were the implementation of learning with a cooperative learning model of the type of Student Team Division of achievement which was included in the independent variables and students' critical thinking abilities.

The research hypothesis was formulated and tested using an independent sample t-test with a significance level of 5%.

- **$H_0$** = Critical thinking ability of students using student teams achievement divisions is lower than or equal to critical thinking ability of students not using student teams achievement divisions.
- **$H_1$** = Critical thinking ability of students using student teams achievement divisions is higher than to critical thinking ability of students not using student teams achievement divisions.

Information:
- If the p value <0.05 then $H_0$ is rejected and $H_1$ is accepted
If the p value ≥ 0.05 then $H_0$ is accepted and $H_1$ is rejected

3. Research Finding
The research was conducted in two classes, namely the experimental class consisting of 32 students and the control class consisting of 32 students using quantitative methods to determine students' critical thinking skills. Validity and reliability tests were carried out prior to the study. Then, the experimental class and the control class were given a preliminary test to determine their initial critical thinking ability. The implementation of the learning process in the experimental class using the cooperative learning model of the student teams division type after the implementation of the pre-test in the experimental class and the control class, the achievement of the division and the control class with conventional learning, the data analysis obtained during the study was analyzed using SPSS and excel applications.

3.1 Instrument Validation
Assessment instruments pre-test and post-test through a process of validation and reliability that was carried out before the study. The results of validity and reliability are shown in the following table 2.

| Table 2. The test result of the validity instrument Correlations |
|---------------------------------------------------------------|
|                  NO_1                  | NO_2 | NO_3 | NO_4 | Total          |
| Pearson Correlation | 1    | .087 | .202 | .224 | .482**         |
| Sig. (2-tailed)     | .657 | .208 | .218 | .005         |
| N                   | 32   | 32   | 32   | 32           |
| Pearson Correlation | .087 | 1    | .254 | .403* | .657**         |
| Sig. (2-tailed)     | .657 | .160 | .022 | .000         |
| N                   | 32   | 32   | 32   | 32           |
| Pearson Correlation | .202 | .254 | 1    | .430* | .736**         |
| Sig. (2-tailed)     | .268 | .160 | .014 | .000         |
| N                   | 32   | 32   | 32   | 32           |
| Pearson Correlation | .224 | .403* | .430‘ | 1   | .795**         |
| Sig. (2-tailed)     | .218 | .022 | .014 | .000         |
| N                   | 32   | 32   | 32   | 32           |
| Pearson Correlation | .482** | .557** | .736** | .795** | 1        |
| Sig. (2-tailed)     | .005 | .000 | .000 | .000         |
| N                   | 32   | 32   | 32   | 32           |

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Look at Table 2, it appears that the value of $r_{count}$ are:
1. item 1 was 0.482
2. item 2 was 0.657
3. item 3 was 0.736
4. item 4 was 0.795
All items generated $r_{count} > r_{table}$ with $N = 32$, so all items were valid.

| Table 3. The test result of the realibility question |
|-----------------------------------------------------|
| Reliability Statistics                              |
| Cronbach's Alpha | N of items |
| .606            | 4          |
Table 3 shows that the reliability value is 0.606 and, $r_{table}$ is based on the sig level. 5% with $dk = N - 1 = 31$, $r_{table} = 0.606$. Therefore, $r_{count} > r_{table}$. This concludes that the instrument item is reliable.

### 3.2 Result

The study was conducted in a control class consisting of 32 students to determine the level of critical thinking. The pre-test was used to test 32 subjects (Chart 1), the results in the control class were found to be 21% in the non-critical category at the level of critical thinking ability, 30% of students were in the quite critical category at the critical thinking ability level, 25% of students in the critical category at the critical thinking ability level and 24% in the very critical category at the critical thinking ability level.

**Chart 1. The Distribution of Pre-test of student Critical Thinking Ability in the Control Class**

![Chart 1](image)

The research was also conducted in an experimental class consisting of 32 students to see the level of students’ critical thinking skills. The pre-test was used to test 32 subjects (Chart 2). In the experimental class, the results obtained are 25% in the non-critical category at the level of critical thinking ability, 33% in the sufficiently critical category at the critical thinking ability level, 23% in the critical category at the level of critical thinking skills and 19% of students in the very critical category at the critical thinking ability level.

**Chart 2. The distribution of Pre-test of student Critical Thinking Ability in the experiment class.**

![Chart 2](image)
Quantitative statistics are used in the analysis of variance data to determine differences in initial abilities before learning. The pretest data were analyzed using the SPSS application. The homogeneity test was conducted to determine whether the variance of the analyzed sample data was homogeneous or not. Based on table 4, the homogeneity test is obtained sig. 0.938. This is sig. if it is greater than 0.05 (based on mean = 0.938 > 0.05), so that the data variance is homogeneous in the pre-test control class and the experimental class.

Table 4. Test of Homogeneity

| Value  | Levene Statistic | Df1 | Df2 | Sig. |
|--------|------------------|-----|-----|------|
|        | 0.006            | 1   | 62  | 0.938|

Analysis Normality test is conducted to determine whether the data is normally distributed or not. Table 5 shows that the sig. in the experimental class 0.200 ≥ 0.05, and in the control class 0.078 ≥ 0.05. This means that the data from the two classes are normally distributed. The results of the data analysis of the pre-test implementation showed that the data variance was homogeneous and normally distributed. The independent test is significant if the value is sig. more than 0.05. Sig value. (2-tailed) based on mean = 0.262 > 0.05. Ho was accepted, the pretest mean score of the control class and the experimental class had no difference.

Table 5. Tests of Normality

| Kolmogorov-Smirnov* | Shapiro-Wilk |
|---------------------|--------------|
| Statistic           | df | Sig. |      | Statistic | df | Sig. |
| Control             | .147| 32  | .078 | .958      | 32 | .240 |
| Experiment          | .119| 32  | .200*| .939      | 32 | .068 |

a. Lilliefors Significance Correction

Table 6. Independent Samples Test

| Levene's Test for Equality of Variances | t-test for Equality of Means |
|----------------------------------------|-----------------------------|
| F | Sig. | T | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
|---|------|---|----|-----------------|-----------------|----------------------|------------------------------------------|
|  |      |   |    |                 |                 |                      |                           |
| Value | Equal variances assumed | .006 | .938 | -1.132 | 62 | .262 | -.906 | .800 | -2.506 | .694 |
Implementation of learning with conventional learning, then carry out a post-test at the end of the lesson. The study was conducted in a control class consisting of 32 students to determine the level of critical thinking after the learning process. The pre-test was used to test 32 subjects (Chart 3), in the control class it was found that 20% were in the uncritical category at the critical thinking ability level, 30% in the quite critical category at the critical thinking ability level, 27% are in the critical category at the critical thinking level, critical thinking ability and 23% of students are at the very critical critical thinking ability level.

**Chart 3. The distribution of Post-test of student Critical Thinking Ability in the Control class**

![Graph showing the distribution of critical thinking ability in the control class]

The research implementation was also continued in the experimental class with the implementation of learning using the cooperative learning model of the student team achievement division, then performed a post-test. The study was conducted on 32 students in the experimental class to determine the level of critical thinking after learning. Pre-test was used to test the level of critical thinking ability of 32 subjects (Chart 4), in the experimental class it was found that 10% were in the uncritical category at the critical thinking ability level, 18% in the quite critical category at the critical thinking ability level, 31% of students in the critical category at the critical thinking ability level and 41% of the students in the very critical category at the critical thinking ability level.

**Chart 4. The distribution of Post-test of student Critical Thinking Ability in the experiment class**

![Graph showing the distribution of critical thinking ability in the experimental class]
Quantitative statistics are used in the analysis of various data to determine differences in learning outcomes with the cooperative learning model of the student team type learning achievement division. Post-test learning outcomes data were analyzed using the SPSS application. The homogeneity test was conducted to determine whether the variance of the analyzed sample data was homogeneous or not. Table 7 shows the results of the homogeneity test, namely sig. 0.727 (based on mean = 0.727 > 0.05), so that the data variance was the post-test control class and the experimental class was homogeneous.

Table 7 Test of Homogeneity of Variances

| Value | Levene Statistic | df1 | df2 | Sig. |
|-------|-----------------|-----|-----|------|
|       | .123            | 1   | 62  | .727 |

Analysis of the normality test was carried out after the homogeneity test. This test is done to find out whether the data distribution is normally distributed or not. The data distribution is said to be significant if the value is greater than or equal to 0.05. Table 8 shows that the significance value of the experimental class is 0.097 ≥ 0.05 and the control class is 0.066 ≥ 0.05. This means that the data from the two classes are normally distributed.

Table 8. Tests of Normality

| Statistic | Kolmogorov-Smirnov* | Shapiro-Wilk | Kolmogorov-Smirnov* | Shapiro-Wilk |
|-----------|---------------------|--------------|---------------------|--------------|
|           | Sig.                | df           | Sig.                | df           | Sig.    |
| Control   | .150                | 32           | .066                | 32           | .066    |
| Experiment| .143                | 32           | .097                | 32           | .245    |

a. Lilliefors Significance Correction

The results of the post-test data analysis in the control class and experimental classes show that both classes have data that is normally distributed. Independent t test was carried out and It has been found that the results based on table 9 show Sig. (2-tailed) based on mean = 0.011 <0.05 $H_0$ is rejected, then the pretest mean of the control class and the experimental class has a difference in value.

Table 9. Independent Samples t-test

| Levene's Test for Equality of Variances | t-test for Equality of Means |
|----------------------------------------|-----------------------------|
| F                                      | t                      |
| Sig.                                   | df (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
| Value assumed                           | Equal variances assumed   |
| .123                                   | .727                   | -2.623          | 62  | .011 | -1.750 | .667 | -3.083 | .417 |

The independent test results based on table 9 obtained the variance with the sig value (2-tailed) 0.011<0.05. It can be concluded that the post-test results between the control class and the experimental class have a significant difference after the implementation of the cooperative learning tool type student teams achievement divisions in learning. The control class average was
20.28, while the experimental class had an average of 22.03 meaning that the average results of students' critical thinking abilities in the experimental class were higher than the average results of the control class students' critical thinking abilities and showed that learning using learning tools the cooperative learning in the type of student teams achievement divisions has a greater effect on students' critical thinking abilities significantly.

4. Discussion
Critical thinking in learning is very necessary because critical thinking is an asset for students to be able to develop knowledge widely. The ability to think is also the basis of a learning process. Critical thinking is the ability to think reflective that focuses on patterns of making decisions about what to believe and what to do. Based on previous research, cooperative learning type student team access division can affect learning. [6] have found that cooperative learning in the type of student teams achievement divisions has an effect on student academic achievement. [7] found that learning student teams achievement divisions had an effect on student learning outcomes. [9] found that learning student teams achievement divisions had an effect on Students’ Understanding of Electrochemical Cells.

The findings in the control class were found that 20% were in the less critical category in the critical thinking ability level, 30% were in the quite critical category in the critical thinking ability level, 27% were in the critical category in the critical thinking ability level and 23% students were at the very critical level. In the critical thinking ability level, the experimental class in the experimental class found that 10% were in the less critical category in the critical thinking ability level, 18% were in the critical enough category in the critical thinking ability level, 31% students were in the critical category in the ability level critical thinking and 41% of students are in the very critical category in the level of critical thinking ability.

The independent sample test showed that students' critical thinking skills at the pre-test stage were not different and in the implementation of the post-test data analysis showed a significant value ($p \leq 0.05$), which means that the post-test learning outcomes had different results.

5. Conclusion
The results of data analysis have been presented in the results and discussion, based on these results it can be seen that the application of the cooperative learning model type of student team achievement division has a significant effect on students' critical thinking ability in the experimental class. The results showed that the improvement of student learning outcomes and critical thinking ability was seen from the post-test. Students in the experimental class showed an increase in their critical thinking ability compared to students in the control class.

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