Effect of Collaborative Inquiry on the Understanding of the Concept and Ability of Critical Thinking

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ABSTRACT
The need for human resources in the 21st century is emphasized on communication skills, collaboration, critical and creative thinking, this study aims to determine whether there is an influence of collaborative inquiry learning on understanding the concepts and critical thinking skills of students on thermodynamic in SMA N 1 Tanjungtiram North Sumatra. This type of research is quasi-experimental. Sampling was done by cluster random sampling by taking two classes from six classes, namely class XI IPA-3 as an experimental class with class XI IPA-1 as a control class, each with 30 students. The instruments used were 11 concept comprehension tests and 5 critical thinking skills tests in the form of validated essay tests. Research data were tested using two-way ANOVA. The results showed that there was a significant influence of the collaborative inquiry learning model on the understanding of students' concepts with a value of $F = 9.569 > F_{crit} = 3.881$ and there was a significant effect of the collaborative inquiry learning model on students' critical thinking skills with a value of $F = 120.184 > F_{crit} = 2.643$ when compared to conventional learning (direct instructions learning).

Keywords: Collaborative Inquiry, Understanding of Concept, Critical Thinking

1. INTRODUCTION
Education is one of the efforts made to improve the quality of human resources. The 21st century is a century known as the century of openness in science and technology that the role of humans has begun to be replaced by technology [1-2]. These demands have an impact on changes in competencies that are expected in human resources, namely, communication, collaboration, critical thinking, and creativity. [3-4).

Some of the obstacles encountered in the world of education include difficulty solving problems [4], which is caused by students not being encouraged to think creatively and also to critical thinking [5-10], and also the ability of students to understand concepts, especially for thermodynamic material which still very low, as many as 27.66% of the total students studied by [11]. Other than that, students are only directed to the child's ability to memorize information [12].

To overcome this problem, several solutions are offered by applying several learning models such as the guided inquiry [13-14] and inquiry training model [15-16], which are very effective in overcoming students' critical thinking skills but have not shown the conceptual ability of these students, both critical thinking skills and conceptual skills are directly proportional to each other [17] with a correlation coefficient of 0.651 [18].

As for the collaborative inquiry learning model, it has been carried out by [19-20]. This learning model makes students and educators interested in dealing with problems so that students can indirectly have the potential to improve students' conceptual skills as well as students' critical thinking abilities.

In addition, based on the results of an interview conducted with Mrs. Halimah, a Physics teacher at SMA N 1 Tanjungtiram. Mrs. Halimah, also stated that students are less active and difficult to critical thinking when learning is taking place and some of the results of her monthly evaluation show that only a few students understand the concepts on material such as law I of thermodynamics, law II of thermodynamics 6% and 9.5% respectively. We will study the effect of the collaborative inquiry model to see critical thinking skills as well as students' conceptual understanding abilities.
2. METHOD

2.1. Research Samples and Variables

Sampling in this study using cluster random sampling technique with IX IPA-3 totaling 30 students for the experimental class and XI IPA-1 totaling 30 students for the control class.

There are two variables in this research, namely:
1. Independent Variables: Collaborative Inquiry Learning Model and Direct Learning Model.
2. Dependent Variables: Students’ Critical Thinking Ability
3. Moderator Variables: Students’ Understanding of the Concept.

2.2. Research Samples and Variables

This research is quasi-experimental research, which is a research that is intended to determine whether there is a result of something imposed on students, namely students. The research design of the study with the design: two group pretest-posttest design. (Table. 1), The research design for two-way ANOVA (2 x 2 factorial design) is in the Table. 2.

Table 1. Pretest-posttest design

| Sample       | Pretest | Treatment | Posttest |
|--------------|---------|-----------|----------|
| Eksperiment Class | T11     | X1        | T21      |
| Control Class   | T12     | X2        | T22      |

where T11 is the pretest of the experimental class, T12 is the pretest of the control class, T21 is the posttest of the experimental class, T22 is the posttest of the control class, X1 is learning to apply the learning model of Collaborative Inquiry learning model, and X2 is learning to apply conventional learning models.

Table 2. Two-way ANOVA Research Design (2 x 2 factorial design)

| Understanding of the Concept (B) | Ability of Critical Thinking | Average |
|----------------------------------|-----------------------------|---------|
| Above average (B1)              | \( \mu A_1 B_1 \)            | \( \mu A_2 B_1 \) |
| Bottom average (B2)             | \( \mu A_2 B_2 \)            | \( \mu A_2 B_2 \) |
| Average                         | \( \mu_k \)                  | \( \mu_e \) |

where

\( \mu A_1 B_1 = \) The average understanding of the concept is above average using the direct instruction model

\( \mu A_2 B_1 = \) The average understanding of the concept is above average using the collaborative inquiry model

\( \mu A_2 B_2 = \) The average understanding of the concept is below average using the direct instruction model

\( \mu A_2 B_2 = \) The average understanding of the concept is below average using the collaborative inquiry model

\( \mu_k = \) The average critical thinking ability of students using the direct instruction model

\( \mu_e = \) The average critical thinking ability of students using the collaborative inquiry model

\( \mu_R = \) The average critical thinking ability of students in understanding the concept was above average.

\( \mu_T = \) The average critical thinking ability of students in understanding the concept was bottom average.

2.2. Collaborative Inquiry Model

Table 3. Collaborative inquiry model phase

| Phase                      | Behavior of Teachers and Students                                                                 |
|---------------------------|---------------------------------------------------------------------------------------------------|
| problem framing           | During this stage, the team defines a shared vision, develops investigations into the relationship between professional practice and student learning outcomes, and formulates a theory of action. |
| collecting evidence       | In the second stage, the collaborative investigation team determines the types of data to be collected, how to collect the data, and where to collect it. |
| analyzing evidence        | Students explore ideas that attract the learning team to make data meanings by identifying patterns and themes and formulating conclusions. |
| celebrating and sharing   | During this final stage, the team came together to present and share their new insights.            |

Collaborative Inquiry is a process where students come together to check their learning practices systematically and carefully using research techniques. There are four phases of Collaborative Inquiry [21] which can be seen in Table 3.

3. RESULT AND DISCUSSION

3.1. Distribution of Pretest and Posttest Data

The control class and the experimental class were tested for their initial ability (pretest), the distribution of the two classes is shown in Fig. 1 (a) and 1 (c), for understanding students 'concepts and figures 1 (b) and 1 (d) for students' critical thinking skills. Judging from the distribution of data and testing for normality and
homogeneity, the two classes have relatively the same abilities (homogeneous) and are normally distributed.

After each class was treated differently, for the experimental class applying the collaborative inquiry learning model and applying the direct instruction model for the control class, it was retested by looking at the students' final ability (posttest). Fig. 2 (a) and 2 (c) for the distribution of post-test scores for the control class and distribution of post-test scores for the experimental class (Fig. 2 (c) and 2 (d). The recapitulation of the distribution of pretest and posttest data is shown in Table 4.

After the two data obtained, both the experimental class and the control class for concept understanding and critical thinking skills, then performed hypothesis testing using two-way ANOVA as in Table 5.

### Table 4. Distribution of Pretest and Posttest scores

| Class                              | Pretest | Posttest |
|------------------------------------|---------|----------|
|                                    | Average | Standard Deviation | Average | Standard Deviation |
| Understanding of the concept control | 33.03   | 42.29     | 63.33 | 167.68 |
| Understanding of the concept experiment | 34.16   | 39.00     | 67.04 | 138.48 |
| Critical thinking control          | 38      | 100.17    | 60.91 | 142.88 |
| Critical thinking experiment       | 45.5    | 193.27    | 66.41 | 174.86 |

### Table 5. Hypothesis testing research with two-way ANOVA

| Source of Variation | SS      | df | MS       | F         | P-Value  | F-crit |
|---------------------|---------|----|----------|-----------|----------|--------|
| Sample              | 1194    | 1  | 1194.4   | 9.569     | 0.00222  | 3.88   |
|                     | .631    | 1  | 1194.6   | 87369     | 1        | 1853   |
|                     | 831     | 1  | 31831    |           |          |        |
| Columns             | 4580    | 3  | 15002    | 120.1     | 5.49E-47 | 2.64   |
|                     | 888     | 3  | 96297    | 84692     | 47       | 3511   |
|                     | 891     | 3  |           |           |          |        |
| Interaction         | 328     | 3  | 109.64   | 9.878     | 0.45298  | 2.64   |
|                     | 9358    | 3  | 52741    | 33874     | 5        | 3511   |
|                     | 9224    | 3  |           |           |          |        |
| Within              | 2896    | 23 | 124.83   | 25607     |          |        |
|                     | 1.15    | 23 | 33874    | 5         |          |        |
|                     | 408     | 23 |           |           |          |        |
|                     | 065     | 23 |           |           |          |        |
| Total               | 7548    | 9  |           |           |          |        |

3.2. The Effect of Collaborative Inquiry Learning Model and Direct Instruction on Concept Understanding

Based on Table 4, it can be seen that the pretest and posttest scores of students from each class, as for the control class in understanding the concept, they get an average pretest score of 33.03 and an average post-test score of 63.33 and for the experimental class, the average pretest score 34.16 and 67.05 for the mean score of the class posttest. It can be seen that the increase in the value for the control class only reaches 30.30, while for the experimental class, it reaches a more significant growth, namely an increase in score of 33.89. This is in line with research conducted by [10,16], showing that the rise in the mean score of the pretest and posttest in the experimental class is higher when compared to the control class.

The above opinion is also supported by performing statistical analysis of two ways ANOVA (Table 5), the value of $F = 120.1846$, while for the value of $F_{crit} = 2.6435$. From these results, the $F > F_{crit}$ statistical testing concluded that there was a significant difference in students' ability in understanding students' concepts between the collaborative inquiry learning model carried out in the experimental class and the conventional learning model carried out in the control class.

![Fig. 1](image-url)
Fig. 2. The distribution of posttest data for each class (a) understanding the concept of the control class, (b) understanding the concept of the experimental class, (c) the critical thinking ability of the control class, (d) the critical thinking ability of the experimental class.

3.3. The Effect of Collaborative Inquiry and Direct Instruction Model on Critical Thinking Ability

The increase in the pretest and posttest scores can be seen in table 4, as for the control class in critical thinking skills got an average score of 38.00 and 60.91 for the pretest and posttest scores, respectively, which the critical thinking ability score got an average score. 45.50 for the pretest score and 66.41 for the posttest score, it appears that the post-test mean score for the experimental class gets higher scores when compared to the post-test score for the control class. This is in line with research conducted by [22-23]. They said that learning with the collaborative inquiry model can increase critical thinking skills and creativity by facilitating students and directing students to summarize the findings of existing problems by searching and solve the problems faced so that the results of students' innovative thinking are more creative and more developed.

The above is also supported by statistical analysis using two-ways ANOVA (Table 5), the value of \( F = 9.5698 \) is obtained, while for the value of Fcrit = 3.8828. From these results, the \( F > F_{\text{crit}} \) test concluded that there was a significant difference in students' critical thinking abilities between the collaborative inquiry learning model carried out in the experimental class and the conventional learning model carried out in the control class.

4. CONCLUSION

There is a significant effect of the collaborative inquiry learning model on concept understanding and also on students' critical thinking skills. What is shown by \( F > F_{\text{crit}} \) that 9.5698 > 3.8818 is for understanding concepts and 120.1846 > 2.6435 for students’ critical thinking skills.

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