Effectiveness of guided inquiry based on blended learning in physics instruction to improve critical thinking skills of the senior high school student

Arif Rahmat Zain\(^1\) and Jumadi\(^1\)

\(^1\)Departement of Physics Education Postgraduate Program, Yogyakarta State University, Indonesian

Abstract. This research is aimed to determine the effectiveness of guided inquiry based on blended learning to improve critical thinking skills of students on optics subject matter. This research was conducted in SMAN 1 Bolo in Bima, NTB. The samples include 70 students of 11th class of senior high school who selected by cluster sampling technique. The research method used quasi-experimental with pretest-posttest control group design. The data of students critical thinking obtained by test and be analyzed by analysis of variance. The result of data analysis showed that p-value score < 0.05. This result indicates that the guided inquiry in physics instruction effective to improve student critical thinking on optics subject matter.

1. Introduction

The trend of change in the current information age, demands the development of students to develop in such a way as to be able to think critically [1]. Teaching for critical thinking is an important goal of modern education, as it equips students with the necessary competence to think about social problems in a rapidly changing world [2]. Teaching critical thinking effectively in the classroom is very important for students. Learning to think critically makes students develop other skills, such as higher concentration levels, deeper analytical skills, and better mind-processing, concentration training and focusing problems [3].

Critical thinking proves to prepare learners to think in various sciences, to self-fulfillment of the intellectual and to develop learners as potential individuals, thereby the ability to think critically to be developed in learning [4]. the ability to think critically can help to improve the affective, cognitive, and psychomotor aspects of students [5].

The improvement of critical thinking ability which is measured in this research covers 6 aspects; focus on questions, analyze arguments, decide actions, observe, induce data, and follow-up explanations [6] [7] [8]. Aspects and indicators of critical thinking skills can be seen in table 1.

| Table 1. Indicators of critical thinking skills |
|------------------------------------------------|
| **Aspect** | **Indicator** |
| Focus on the question | 1. Identify or create questions  
2. Identify possible answers |
| Analyze arguments | 1. Provide an argument against the given problem  
2. Make a hypothesis based on the problem presented |
Indonesian is among the lowest in comparison with other countries in terms of learning achievements that include affective, cognitive, and psychomotor aspects [9]. Student achievement is low because lessons taught in schools are less demanding learners to develop their critical thinking skills. Therefore, an effective learning model is needed to improve the critical thinking ability of learners. One of the learning models that can improve critical thinking skills is the implementation of guided inquiry learning in guided [10] [11] [12]. The main purpose of the inquiry model is to develop thinking skills, especially critical thinking, and to develop intellectual skills and to solve problems [13]. Inquiry learning (inquiry) is one of the basic requirements for developing students' scientific thinking skills [14].

The guided inquiry has been widely implemented in various ways. The face-to-face manner is the most widely used method of teachers in implementing guided inquiry models. However, with the development of the times, it is necessary to modify the guided inquiry model to adapt to the era of digitalization in the 21st century. One of the recommended ways is to combine online and face-to-face learning or blended learning [15]. The syntax inquiry guided to be studied namely: orientation, exploration, data collection (practicum), hypothesis testing, and communicating [16] [17] [18]. Below is a guided inquiry syntax based on blended learning.

| GUIDED INQUIRY SYNTAX | ACTIVITY | APPLICATION |
|-----------------------|----------|-------------|
| Phase 1 Orientation   | Students develop and examine questions assisted by the teacher. | Online |
| Phase 2 Exploration   | Students check and analyze information about experimental procedures. | Online |
| Phase 3 Data collection | Students conducted experiments and recorded data based on guidance from teachers. | Face to face |
| Phase 4 Test the hypothesis | Students make inferences after the stage of discussing the data that has been obtained in experiments with the group. | Face to face |
| Phase 5 Communicates  | After the group representatives present their experimental results and other groups will ask and respond. The teacher commented on the discussion. | Face to face |

Blended learning-based learning is the best learning strategy for teaching and learning [19] [20], and it can be used in physics learning, especially in overcoming the lack of time required teachers in learning to complete a round syntax (Steps guided Inquiry implementation). E-learning used in this research is using application whatsapps in smartphone.

2. Method
This research was conducted in SMA Negeri 1 Bolo, Kabupaten Bima, West Nusa Tenggara. The time of the study was conducted in the second semester of the academic year 2017/2018. The critical thinking
skills in this study was assessed using multiple choice questions. The population in this research is the students of class XI IPA which amounts to 70 people divided into 2 classes. Sampling is taken by cluster sampling. The sample consists of experimental class by using guided inquiry model based on blended learning and control class using only guided inquiry model only. The design of this research is pretest-posttest control group design shown in table 3.

Table 3. Experimental design

| Experiment | O₁ | X   | O₂ |
|------------|----|-----|----|
| Control    | O₁ | Y   | O₂ |

Description: O₁: pretest, O₂: post-test, X: guided inquiry model based on blended learning, Y: learning using only guided inquiry model.

The pretest is given at the beginning of experimental classroom and control class learning. After the initial test, the experimental class students were given guided inquiry lessons based on blended learning while the control class students were given guided inquiry learning only. At the end of the lesson, students are given a posttest with the equivalent of the pretest.

3. Result

After 3 weeks of treatment, the students were given a post-test to determine the improvement of critical thinking skills in the experimental class and control class, which was then compared with the pretest results. The results of pre-test and post-test can be seen in table 4.

Table 4. Description Analysis of pre-test and post-test data

| Aspects of Critical Thinking Ability | Experiment Class | Control Class |
|-------------------------------------|-----------------|--------------|
|                                     | Pre test | Post test | Pre test | Post Test |
| Focus on the question               | 60   | 85       | 53    | 80      |
| Analyze arguments                   | 53   | 75       | 60    | 71      |
| Decide action                       | 60   | 87       | 46    | 73      |
| Observing                           | 60   | 80       | 40    | 68      |
| Induces data                        | 53   | 70       | 47    | 66      |
| Advanced Explanation                | 53   | 73       | 54    | 70      |
| **Maximum Score**                   | **67**| **93**   | **60**| **87**  |
| **Minimum Score**                   | **33**| **60**   | **33**| **53**  |
| Standart. Dev                       | 4    | 7        | 4     | 8       |
| Score Average                       | 50   | 77       | 49    | 70      |

Based on table 4, the pretest results of both classes are not much different ie 50 and 49, this shows the initial ability of learners are at the same level. After a different treatment, the experimental class used guided inquiry model based on blended learning and control class using guided inquiry model only, and posttest result showed that the experiment class students were much higher than the control class. To know the difference between of critical thinking skills improvement on the students is using Independent Sample t-test, firstly tested normality and homogeneity using pretest data. Normality test to determine whether the ability of learners to normal distribution and homogeneity test to determine whether the ability of learners have the same variance. Normality test results can be seen in table 5.
Table 5. Normality test

| Class  | shapiro-wilk | Df | Sig. |
|--------|-------------|----|------|
| Experiment | 35       | 0.138 |
| Control   | 35       | 0.090 |

Based on normality test result in experiment class with significance 0.138 > 0.05 and control class 0.090 > 0.05. This means that the critical thinking skills of learners in experiment and control classes are normally distributed. Furthermore, the homogeneity test and the results can be seen in table 6 below.

Table 6. Homogeneity Test

| Levene Statistic | df2 | sig. |
|-----------------|-----|------|
| 0.001           | 68  | 0.976 |

Based on homogeneity test results with the significance of 0.976 > 0.05 means that critical thinking ability of learners in experiment class and control class have the same variance. After the data is confirmed to be normal and homogenous, Independent Sample t-test is conducted to determine whether guided inquiry learning based on blended learning can improve the critical thinking skills of learners, the result can be seen in table 7.

Table 7. Anova Test

| Variable          | t  | Sig. | Information |
|-------------------|----|------|-------------|
| Critical thinking skills | 3.119 | 0.036 | significant |

Result Independent Sample t-test using 0.05 significance level show that there is difference between of critical thinking skills in experiment class and control class, results showed that the significance level of 0.036 < 0.05, this indicates that there is influence from the learning of physics by using guided inquiry model based on blended learning in improving critical thinking skills of high school students on optics subject matter.

4. Discussion

Learning through inquiry is one of the basic requirements to develop students scientific thinking skills [21]. One of the learning models that can improve critical thinking skills is the implementation of guided inquiry [10] [11] [12]. Syntax guided inquiry relationship with indicators of critical thinking skills can be seen in figure 1.
Figure 1. The relationship between the syntax of guided inquiry with indicators of critical thinking skills

The main purpose of the guided inquiry model is to develop thinking skills, especially critical thinking, and to develop intellectual skills and to solve problems [13]. Guided inquiry learning is one of the basic conditions for developing students' scientific thinking skills [14]. One of the best ways to understand science in school is through a classroom visit where a scientific inquiry is practiced [22]. Students will collaborate to create new knowledge while studying simultaneously how to think critically through investigation, reflection, exploration, experimentation [23].

5. Conclusion
We have described the pretest and postest score of experimental and control class, although the pretest results of both classes are contiguous, the different condition can be found in the postest result that showed score the experiment class students were much higher than the control class. Based on the results of research it can be concluded that physics learning by using guided inquiry model based on blended learning is more effective to improve critical thinking skills of high school student on optics subject matter when compared to physics learning using guided inquiry only. We hope this research can be as information to teachers especially to teach materials related to the investigation.

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