Alas Kandung-based science learning tools to optimize students’ critical thinking skills

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ABSTRACT

Critical Thinking Skills (CTS) are the crucial skills required by nowadays generation in dealing with the 21st Century challenges. Yet, the researches focused on higher order thinking skills are still limited. This study aimed to analyze the effect of Alas Kandung-based science learning tools on students’ CTS. The research design was pretest and post-test with non-equivalent control group. The treatment given in experimental class was the implementation of Alas Kandung-based science learning tools, while the control class was taught using common method used by the teachers. The results of this study indicated that the students’ CTS in experimental class was significantly higher than the control class \([F(1,47) = 11.672, p = 0.001]\). In conclusion, the Alas Kandung-based science learning tools is effective in improving students’ CTS.

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INTRODUCTION

Environmental-based learning is able to train the learners’ thinking process, one of them is the skills to think critically (Arti & Ikhsan, 2020; Irwan, Dewi, Suryadarma, Wilujeng, & Wahyuningsih, 2017). Learning that based on a student’s environment as a learning resource can help achieve the completeness of competence and to help gain experience and knowledge by practicing intellectual skills (Arti & Ikhsan, 2020; Dwianto, Wilujeng, Prasetyo, & Suryadarma, 2017; Sasmitatias & Kuswanto, 2018). The 21st century requires the quality of Human Resources (HR) and the 21st era skills challenges, according to Reeve (2016) and Qin, J., Liu & Grosvenor (2016) including life and work skills, skills in technology, information communication media, critical thinking skills and creativity. These skills can be trained and elevated through formal and informal learning. The ability development of students in the process of learning science takes precedence in this era rather than relying on the provision of products such as materials, things and concepts (Facione, 2020).

Students’ critical thinking skills in Indonesia still need to be improved. The results of the Program for International Student Assessment (PISA) tests in 2018 showed that the average PISA score of Indonesian students was 396 on science, so that Indonesia was ranked 72 out of 77 countries (OECD, 2019). The results of pilot studies of critical thinking skills pattern on chapter interaction of living things with the environment in MTs PSM Tanen Rejoatangan (Indonesia) were still low. The 75% of students were placed in the “very less” category.
Students’ problem solving abilities that facilitate the learning process of science concepts. Inquiry learning, able to improve the thinking process of students.

Natural objects that exist around students have the potential as a source of learning that plays a role in elevating critical thinking skills. Involving nature in the learning process can be found by students to more easily associate with their environment.

One meaningful learning model that can be applied to junior high school students (SMP / MTs) is inquiry learning model. Inquiry can be taught through formal education in schools, one of the type of inquiry model learning is in science learning. Science learning is currently focused on exploration activities to activate students. In conducting exploration, students can utilize Alas Kandung as a learning resource. Otherwise, the advantages are located near the school (MTs PSM Tanen Rejotangan) and ecosystem in Alas Kandung also support the basic competencies about the interaction between living things and the environment.

The process of analyzing and evaluating that is doing in Alas Kandung, able to improve the meaningfulness of learning so that training the critical thinking skills of students. Students as learners learn to organize and build opinions, formulate problems, develop hypotheses, and find evidence. The process spurs and facilitates students’ problem solving abilities that facilitate the learning process of science concepts.

In the future, this research could be as a reference for further study to make source of learning related to the environment topic.
METHOD

The purpose of this study was to examine the effectiveness of Alas Kandung-based science learning tools to optimize students’ critical thinking skills. Effectiveness test of developed product was conducted using Pretest and Post-test Nonequivalent Control Group Design with control and experiment classes (Mckenney & Reeves, 2014). Population in this study was all of students in VII class of MTs PSM Tanen Rejotangan Tulungagung, Indonesia in second semester of academic year 2019/2020. The research samples were selected by purposive random sampling. Random sampling technique was chosen because the population was homogeneous and each member of the population had the same opportunity to be selected as objects of this study. Simple random sampling could be done by lottery method. One selected class was used as a control class and one other class was positioned as experimental class. The control class consisted of 24 students while the experimental class consisted of 26 students. The control class was treated by teaching and learning process using conventional method (lecture method) and textbooks as usual. Whereas the experimental class was treated by implementing a guided inquiry learning tools with Alas Kandung as learning resources to improve critical thinking skills that had previously been developed and each class has 5 meetings.

The research instrument consisted of 7 essay questions adapted from each aspect of Facione theory about critical thinking skills, namely: (1) interpretation, (2) analysis, (3) evaluation, (4) explanation, (5) conclusion, and (6) self-reinforcement (Facione, 2020). The score categories of students’ critical thinking skills showed in Table 1. The instruments used in this study were tested for validity and reliability by 31 students.

| Score Range      | Category     |
|------------------|--------------|
| 81.25 – 100.00   | Very high    |
| 62.50 – 81.25    | High         |
| 43.75 – 62.50    | Medium       |
| 25.00 – 43.75    | Low          |
| < 25.00          | Very low     |

The data analysis used ANCOVA with the pretest score as the covariate. This analysis using a significance level 0.05 and preceded a prerequisite test, i.e. Shapiro-Wilk normality test and Levene’s homogeneity test. The statistical analysis program used SPSS 22 for windows. N-gain was used to determine the effectiveness of the product developed to improve the ability to think critically after the guided inquiry learning process with learning resources applied. The n-gain category is shown in Table 2.

| Normalized N-Gain <g> | Category     |
|-----------------------|--------------|
| <g> ≤ 0.25            | Low          |
| 0.25 ≤ <g> < 0.45     | Medium-low   |
| 0.45 ≤ <g> < 0.65     | Medium-high  |
| <g> ≥ 0.65            | High         |

RESULTS AND DISCUSSION

First Stage: Define

The results of the analysis showed that the level of students’ critical thinking skills had varied in 2 categories mostly, which were: low (L) and very low (VL) as shown in Figure 1.

Based on Figure 1, it is known that 75% of students have held very low (VL) category of critical thinking skills and 25% of students have held low category (L) of critical thinking skills. Consequently, in more detail, four out of the six indicators of critical thinking that were also very low (VL) category (<25.00). There are four indicators included: (1) interpretation, (2) analysis, (3) evaluation, and (4) self-reinforcement. Meanwhile, others indicators were categorized in low (L) category under the score 25.00 - 43.75, namely: (1) conclusion and (2) explanation. These results indicated that the learning process carried out so far had not been able to improve students’ critical thinking skills. Thus, significant efforts are needed to be able to help improve critical thinking skills. Students’ critical thinking skills needs to be improved because it is very fundamental in managing learning skills and empowering students to contribute actively and creatively in life. Students who have good and elevated critical thinking skills are easier to solve problems in their lives. The critical thinking skills is able to explain the causal relationships of events that occur around them (Metcalf et al., 2018). At this stage, an analysis concept of interaction between living things and the environment is carried out on the science basic competencies of junior high school toward Alas Kandung ecosystem.
Second Stage: Design
The results of the analysis at the preliminary study stage (define) were used as a reference in designing learning tools. The reference created the learning tools to develop and have characteristics. There were 6 main characteristics, namely: (1) improving critical thinking skills, (2) concrete problem-based, (3) containing environmental content as a learning resource, (4) student-centered, (5) guided inquiry learning, and (6) using assessment authentic. Besides, adjusting to the results of the preliminary study was done and the six characteristics were also adjusted to the 2013 curriculum so the products (learning tools) could be more easily implemented at the level of junior high schools (SMP / MTs) in Indonesia. Students were conditioned to be able to interact with learning materials actively and carry out various learning activities and get feedback about what they are learning (Makar, Ali, & Fry, 2018). Design phase produced the first draft of product.

Third Stage: Develop
The results of content validity
This stage was used to determine the feasibility of products that have been developed. The learning tools prototype testing phase was carried out by involving several expert as validator (language, media, material, and learning expert validator, and educational practitioners). The results of the validation of the learning kit indicated that the guided inquiry-based product with the Alas Kandung as the learning resources was suitable for use in learning with several revisions shown in Table 3. This stage produces the second draft of product.

Table 3. Validation results of learning tools prototype
| Validator                  | Percentage (%) | Category |
|----------------------------|----------------|----------|
| Language                   | 92.85          | Very valid |
| Media                      | 96.66          | Very valid |
| Material                   | 96.87          | Very valid |
| Learning                   | 78.00          | Valid    |
| Educational practitioners  | 98.86          | Very valid |
| Mean of all aspects        | 92.64          | Very valid |

The results on limited testing trial
Science teachers as practitioners and respective users of learning tools developed in this study had responded to products through questionnaires that had been given after usage. Table 4 shows the response of the science teacher to the learning tools that had been designed in the previous stage.

Table 4. Results analysis of teachers questionnaires
| Aspect                    | Percentage (%) | Category |
|---------------------------|----------------|----------|
| Interface                 | 91.66          | Very valid |
| Content                   | 91.66          | Very valid |
| Language                  | 91.66          | Very valid |
| Media                     | 100.00         | Very valid |
| Learning resource         | 100.00         | Very valid |
| Mean of all aspects       | 95.00          | Very valid |
Student responses could be seen from the implementation of learning using learning tools that have been developed. The results of the students’ learning outcomes are shown in Table 5. This stage produces the third draft of product that will later be considered to revision after using.

Table 5. The implementation of limited testing trial

| Implementation                  | Percentage (%) |
|---------------------------------|----------------|
| First meeting                   | 81.28          |
| First meeting (recurrence)      | 93.78          |
| Second meeting                  | 89.37          |
| Third meeting                   | 91.33          |

The results on operational testing

The response of students at this stage could also be seen from the implementation of learning using learning tools that have been developed. The results of the students’ learning outcomes are shown in Table 6.

Table 6. The implementation of operational testing

| Implementation | Percentage (%) |
|----------------|----------------|
| First meeting  | 93.70          |
| Second meeting | 99.50          |
| Third meeting  | 99.50          |

This stage had led to the results of fourth draft of product or a guided inquiry learning tools with a learning resource that was properly suitable for implementation in classroom learning and its effectiveness was measured.

Fourth Stage: Disseminate

The effectiveness of science learning tools based on guided inquiry learning with the Alas Kandung as learning resources was determined in disseminate stage. It was analyzed and stride under the effectiveness analysis indicators. Moreover, the results of the preliminary test using the normality and homogeneity tests in the experimental class and the control class indicate that the data are spread normally and homogeneously. Based on Table 7, it can be concluded that the normality test using the Shapiro-Wilk test showed that the pretest and posttest were normally distribute ($\alpha > 0.05$), while the Levene’s homogeneity test in all classes showed homogeneous pretest and posttest because of the significance level ($\alpha > 0.05$).

Table 7. Recapitulation of the results of the normality and homogeneity test

| Class    | Test   | Type of test       | Sig. pretest | Sig. posttest |
|----------|--------|--------------------|--------------|---------------|
| Exp.     | Norm.  | Shapiro-Wilk test  | 0.288        | 0.141         |
| Ctrl.    | Norm.  | Shapiro-Wilk test  | 0.442        | 0.696         |
| All Class| Homogeneity | Levene’s test     | Sig. 0.962   | Sig. posttest 0.886 |

The next test conducted is the ANCOVA to determine the difference in post-test values in the experimental class and the control class. Based on Table 8, there is a significant difference between the post-test value between the experimental class and the control class ($\alpha < 0.05$). Other research done by Nisa et al., (2018) revealed that static fluid learning with guided inquiry model is effective in improving critical thinking skills. Irwan et al., (2019) also found that learning with guided inquiry syntax on ecosystem material is properly linked to critical thinking indicators and it is suitable for use in the learning process. Findings from Nopiya and Fitri (2020) research showed that guided inquiry is able to improve students’ interpersonal intelligence. The learning that was carried out did indeed include the component of the scientific method that was able to support the ability to think but had not utilized the natural phenomena that was often encountered by the students in his/her neighborhood. The learning process that utilizes nature around students will present concrete problems and real experiences for students to build sharp thinking and applicable scientific insights. (Muharom Albantani & Madkur, 2018). Science learning integrated with the local potential of wood carving and pottery was able to influence the critical thinking skills of junior high school students in VIII class (Dewi et al., 2017). The research and development carried out is aimed at improving students’ critical thinking skills through meaningful learning by utilizing the natural environment around students as learning resources. Alas Kandung was chosen because of its location that has accessible contact and close to students, easy to reach, and not yet used by other researchers as a source of formal knowledge. Moreover, improving critical thinking skills in the learning process helps students improve their learning outcomes in the classroom (Pratono, Sumarti, & Wijayati, 2018). Integrating place-based education in biology learning through inquiry can improve the students’ cognitive ability in so many different level (Ashari, Pujiank, Ibrohim, Suwono, & Lukiati, 2018).
The effectiveness of students’ improvement of the critical thinking skills score of the experimental group was confirmed not to be lower than the control group. It happened because students became more accustomed to working critically and without difficulty to probing and solving the problems given with stages: formulating problems; expressing an opinion; compiling new knowledge; and deciding on an action based on the problems given. The perspectives in detail from each indicator of critical thinking according to Facione (2020) due to the N-gain scores of the two groups are shown in Table 10.

| Indicator         | N-gain | Category | N-gain | Category |
|-------------------|--------|----------|--------|----------|
| Interpretation    | 0.49   | Medium-high | 0.10   | Low      |
| Analysis          | 0.53   | Medium-high | 0.25   | Medium-low |
| Evaluation        | 0.52   | Medium-high | 0.29   | Medium-low |
| Conclusion        | 0.52   | Medium-high | 0.23   | Low      |
| Explanation       | 0.44   | Medium-low  | 0.19   | Low      |
| Self-regulation   | 0.43   | Medium-low  | 0.22   | Low      |

The experimental group had the upper medium dominant N-gain score, while the control group was dominated by the low N-gain score. From Table 8 to Table 10, we could interpret that the level of students’ improvement of mean value before and after treatment in two groups of students was different. Thus it can be said that learning interaction of living beings and the environment utilizing the Alas Kandung as learning resources through guided inquiry has a medium increasing effect on critical thinking skills of students of the experimental group.

The obtained improvement of the students’ critical thinking skills score utilizing Alas Kandung as learning resources through guided inquiry with an increased level of medium categories above was supported with the findings of Pratono et al. (2018) and Wenning (2011). The findings showed that students were able to grow their skills and build their own knowledge so that their critical thinking skills had also developed. Guided inquiry learning model was able to train active learners independently and collaborate in solving and probing problems provided by the facilitator through investigations (Tindangen, 2018; Uswatun & Widyanto, 2018; Zhang, 2019) It was not only increasing the ability of students to understand the material, but it can also improve the process skills and scientific work (Hunapi et al., 2019; Khasanah & Widoretn, 2017; Mutakinati et al., 2018; Putra et al., 2016). Stages in the investigation of learning models from stage to stage to formulate the problem until the conclusion were proven to guide students in making the concept of accommodation and assimilation as Piaget theory (Slavin, 1994).

Learning by inquiry methods can utilize alternative learning resources such as the environment around students. Nature as a provider of needs from all aspects of life is an effective media to stimulate thinking skills and develop one’s knowledge because by utilizing nature, students will be motivated to discover new things, which will then become an assimilation of knowledge (Arti & Ikhsan, 2020; Muharom Albantani & Madkur, 2018; Rogers, 1995).

Table 8. ANCOVA test result

| Source             | Sum of Squares | df  | Mean Square | F     | Sig. |
|--------------------|----------------|-----|-------------|-------|------|
| Corrected Model    | 3620.934a      | 2   | 1810.467    | 5.892 | .005 |
| Intercept          | 13126.089      | 1   | 13126.089   | 42.720| .000 |
| Pretest            | .410           | 1   | .410        | .001  | .971 |
| Group              | 3586.206       | 47  | 307.255     | 11.672| .001 |
| Error              | 14441.002      | 47  |             |       |      |
| Total              | 182968.735     | 50  |             |       |      |
| Corrected Total    | 18061.936      | 49  |             |       |      |

a. R Squared = .200 (Adjusted R Squared = .166)

Table 9. N-gain students' critical thinking skills score of pretest and post-test

| Groups | N-gain |
|--------|--------|
| Exp.   | 0.47   |
| Ctrl.  | 0.19   |

Medium-high

Table 10. N-gain score on each indicator to students' critical thinking skills

| Indicator         | Experimental | Category | Control | Category |
|-------------------|--------------|----------|---------|----------|
| Interpretation    | 0.49         | Medium-high | 0.10    | Low      |
| Analysis          | 0.53         | Medium-high | 0.25    | Medium-low |
| Evaluation        | 0.52         | Medium-high | 0.29    | Medium-low |
| Conclusion        | 0.52         | Medium-high | 0.23    | Low      |
| Explanation       | 0.44         | Medium-low  | 0.19    | Low      |
| Self-regulation   | 0.43         | Medium-low  | 0.22    | Low      |
According to Ardan (2016) social interaction obtained in groups and between groups during the learning process with guided inquiry model can increase the potential of students to collaborate (Ardan, 2016). Collaboration is also one of the skills that must be possessed in this era. Students who were actively involved independently or collaborate in inquiry-based learning were easier to have information in long-term memory, so mastery of the concepts increased well and elevated properly (Irwan et al., 2019; Slavin, 1994). Learning outcomes through inquiry models can improve understanding of science, increase learning objectives and trigger the use of critical thinking skills (Prasetyowati & Suyatno, 2016; Sulistijo et al., 2017), improve predictive skills, and elevate mastery of concepts. Nevertheless, there was a significant correlation between critical thinking skills and students’ mastery concepts (Prasetyowati & Suyatno, 2016). Pursitasari et al. (2020) and Ramdiah et al. (2019) also agreed that guided inquiry-based learning by utilizing the environment around students effectively made students critical thinkers, which this ability is a provision for real life in the future and near globalization.

The implications of this research and development can be used as a theoretical basis and fundamental in subsequent studies related to learning science. Also, these finding can lead to the implemented teaching and learning process by science teachers in learning the material interaction of living things and the environment within natural learning resources. This learning tools can also be used as an example for science teachers to develop learning tools based on guided inquiry based on other material.

CONCLUSION

The treatment given to students was science learning process with the combination of developed science learning tools and Alas Kandung as learning resources. Students in the two groups were given the same test (pretest and post-test). The results of this study indicated that there is a significant difference between the post-test scores of students' critical thinking skills in each group with significance value = 0.001. Furthermore, the average n-gain critical thinking of the experimental group students was higher. The conclusion of this research was developed science learning tools with Alas Kandung as learning resources through guided inquiry was effectively enhancing and improving students’ thinking pattern as critical thinking learners.

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