Ethno-Biology Learning Model Based on Design Thinking to Improve Students' Critical Thinking Skills

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Abstract: This study aims to investigate the effect of an ethnobiology learning model based on design thinking on students' critical thinking skills. The research is a type of quasi-experimental research with a randomized control group pretest-posttest design. The population of this study came from SMA Negeri 12 Kerinci. The research sample came from two classes, namely class XI MIPA (experimental class) and class MIPA 3 (control class) totaling 42 students. The experimental class group used the ethnobiology learning model while the control class group used the conventional learning model. The sampling technique is random sampling. The research instrument was an objective test. Data analysis was quantitative statistical analysis with the help of SPSS version 26. The results of this study showed that the average value of posttest and N-gain critical thinking skills of classes that obtained ethnobiology learning based on design thinking was better than classes that used conventional learning. The t-test results show that the ethnobiology learning model based on design thinking has an effect on critical thinking skills sig. < 0.05 (0.00 < 0.05). Students’ thinking skills in the experimental class obtained an average score of 82.30 with an N-value of 0.72.

Keywords: Ethno-Biology; Ethnosains; Critical thinking; Design thinking; Learning

Introduction

Critical thinking is a very important skill for a student in facing Revolution 4.0 (Amin et al., 2020; Rijal et al., 2021). Critical thinking skills are a student's ability to analyze a problem systematically (Samaras et al., 2022; Redhana, 2013). Critical thinking skills have a very important role for students in solving problems in learning (Zanden et al., 2020; Kanmaz, 2022; Hazaymeh & Alomery, 2021). In addition, critical thinking skills are important for students in developing their cognitive potential (Herzon et al., 2018). Critical thinking skills are needed for students to think scientifically in solving problems in science learning, especially in biology (Syawaludin et al., 2019; Al-shaye, 2021).

Biology as part of Natural Sciences (IPA) has not been able to develop students' critical thinking skills. Many problems in science are considered to be a difficult and boring subjects for students (Yaki, 2022). This causes students to be less stimulated to think critically. According to the 2018 Program For International Students (PISA) study, Indonesian students' science literacy score of 382 ranked 64 out of 65 countries (Razak et al., 2021; Hamdani et al., 2022; Marudut, 2020; Elfira et al., 2023; Suharyat et al., 2023). This shows that the ability of students to think critically in Indonesia is still relatively low (Yustiana et al., 2022). Furthermore, in the learning process students are less actively involved, learning is only memorizing, the teaching and learning process is still centered on the teacher (centered teacher) (Fitriani, 2020), the teaching materials used by the teacher are less interesting and the learning model is not appropriate (Sutiani et al., 2021).

The ethno-biology learning model based on design thinking is able to make students more active. Ethno-biology learning is a learning model that reconstructs local wisdom into biology (Santoros et al., 2018; Ludwig & Charbel, 2023). The ethno-biology

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model can create a more interesting learning atmosphere by combining local wisdom with science (Ardianti & Raida, 2022). Ethno-biology model based on design thinking makes it easier to think critically and understand the lesson more easily (Nuralita, 2020; Padhy et al., 2015; Hikmawati et al., 2020). Ethnobiology learning based on design thinking helps students to improve learning outcomes, critical and creative thinking (Damayanti et al., 2017; Dewi et al., 2021).

Previous research by Sudarmin et al. (2018) ethnoscience learning can influence students' cultural awareness. Design thinking-based learning model helps students in problem solving and critical thinking in elementary school students (Brown, 2020; Welsh & Dehler, 2019). Research by Pande et al. (2020) Design thinking-based learning is able to develop thinking with the principle of constructivism in students. Zidny & Eilks (2022) ethnoscience learning model helps students to connect culture with subject matter at school. The ethnobiology learning model based on design thinking is very good for developing students' critical thinking in biology learning. Research on the application of ethnoscience learning models in biology improves critical thinking skills (Temuningsih et al., 2017). Based on these problems, this study aims to investigate the effect of ethnobiology learning model based on design thinking on students' critical thinking skills.

Method

This research is a type of quasi-experimental research with randomized control group pretest-posttest design (Table 1). The research was conducted at SMA Negeri 2 Kerinci using ethnobiology learning based on design thinking in the experimental class and conventional learning in the control class according to the chosen model. The independent variable is the ethnobiology learning model based on design thinking. The dependent variable is critical thinking skills. The population in this study came from all students of class XI IPA SMA Negeri 12 Kerinci consisting of 4 classes. The research sample came from class XI MIPA 1 as an experimental class and class XI MIPA 3 as a control class totaling 42 people. The sample technique is random sampling.

The data collection technique is a test. The instrument used is a critical thinking test consisting of 20 multiple choice questions that have been tested for validity and reliability. This test serves to determine students' critical thinking skills in learning biology. Data analysis is quantitative descriptive analysis by conducting T-test and N-gain test with the help of SPSS version 26 application with hypothesis test criteria H0 is rejected and H1 is accepted if the sig value. < 0.05. The N-gain criteria can be seen in Table 2.

Table 1. Randomized Control Group Pretest-Posttest Design (Lufri & Ardi, 2017)

<table>
<thead>
<tr>
<th>Class</th>
<th>Pretest</th>
<th>Treatment</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>T1</td>
<td>X</td>
<td>T2</td>
</tr>
<tr>
<td>Control</td>
<td>T1</td>
<td></td>
<td>T2</td>
</tr>
</tbody>
</table>

Description:
- T1 : Pretest for Experimental class
- T2 : Pretest for control class
- X : Ethnobiology Learning Model based on design thinking
- T2 : Posttest for experimental class
- T2 : Posttest for control class

Table 2. N-gain Criteria of Ethno-Biological Learning Model (Hake, 1998)

<table>
<thead>
<tr>
<th>Coefficient Value</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.70 &gt; N-gain</td>
<td>High</td>
</tr>
<tr>
<td>0.30 ≤ N-gain &lt; 0.70</td>
<td>Medium</td>
</tr>
<tr>
<td>N-gain &lt; 0.30</td>
<td>Low</td>
</tr>
</tbody>
</table>

Result and Discussion

The results of the research on the application of ethnobiology learning model based on design thinking to improve students' critical thinking skills in SMA Negeri 2 Kerinci students can be seen in Table 3.

Table 3. Students' Critical Thinking Ability Score on Pretest and Posttest of Experimental and Control Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>N-gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>21</td>
<td>45.17</td>
<td>7.12</td>
<td>0.72 (High)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posttest</td>
<td>82.40</td>
<td>8.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>21</td>
<td>31.20</td>
<td>6.32</td>
<td>0.56 (Medium)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posttest</td>
<td>70.60</td>
<td>7.10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on Table 3 Shows the pretest value of students in the experimental class of 45.17 while the posttest value of experimental class students is 82.40. The pretest value of control class students was 31.20 while the posttest value of control class students was 70.65. This explains that the value of critical thinking skills of experimental class students who use ethnoscience learning based on design thinking is higher than control class students who use conventional learning. Ethnoscience learning based on design thinking encourages students to improve cognitive abilities and critical thinking in students (Muhamad et al., 2018; Setiawan et al., 2017). Thinking skills are very important for students in solving problems in everyday life (Shaw et al., 2019; Ma et al., 2021; Oktarina et al., 2021; Razak et al., 2021). Therefore, the design thinking-
based ethno-biology learning model provides opportunities for students to think critically to implement ethnoscience-based biology learning (Agustin et al., 2018; Sumarni et al., 2022). Ethno-biology learning model based on design thinking students are more innovative and creative in learning to find new ideas. So this ethno-biology learning model makes it easier for students to understand the subject matter directly with nature (Nuroso et al., 2018; Tresnawati et al., 2020; Vandebroek et al., 2020).

The application of ethno-biology-based learning models is more effective in fostering students’ critical thinking skills. When compared to other conventional learning, the ethnobiology learning model allows students to interact with their local wisdom. This can encourage students’ critical thinking skills in learning (Dewi et al., 2021; Arfianawati et al., 2016). Furthermore, Figure 1 explains that there is a significant increase in the value of critical thinking skills of experimental class students compared to the value of critical thinking skills of the control class. According to Atchia (2021) design thinking-based learning can improve student learning outcomes and students are able to develop their ideas.

The results in Table 3. Shows that students’ critical thinking skills in the experimental class increased 0.72 with a high category and in the control class increased 0.56 with a moderate category. Rini et al. (2021) Design thinking-based learning improves students’ critical thinking skills in science learning. The ethno-biology learning model based on design thinking in the student learning process is carried out by linking learning materials with local wisdom related to biology (Padhy et al., 2017; Fasasi, 2017). According to Yuliana et al. (2021) ethnoscience learning model based on design thinking fosters students' critical thinking skills and science literacy in learning. This helps students in fostering critical thinking skills because students interact directly with nature. Students who gain knowledge directly with their environment are able to develop their critical thinking skills (Risdianto et al., 2020; Izalia & Wisnuadi, 2020).

Students’ critical thinking skills in ethno-biology learning based on design thinking pay attention to the indicators of critical thinking skills. Ennis (1985) found indicators of critical thinking skills, namely the ability to provide simple explanations (elementary classification), build students’ basic skills (Basic support), provide inference, the ability to make further explanations (Advances classification), and provide strategies and tactics. The value of critical thinking skills of experimental and control classes seen in each indicator can be seen in Table 4-5.

Table 4. Students’ Critical Thinking Skills Based on Indicators in the Experiment Class

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Experiment Mean Pretest</th>
<th>N-gain</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary classification</td>
<td>45</td>
<td>0.76</td>
<td>High</td>
</tr>
<tr>
<td>Basic support inference</td>
<td>50</td>
<td>0.83</td>
<td>High</td>
</tr>
<tr>
<td>Advances classification</td>
<td>40</td>
<td>0.72</td>
<td>High</td>
</tr>
<tr>
<td>Strategies and Tactics</td>
<td>35</td>
<td>0.91</td>
<td>High</td>
</tr>
<tr>
<td>Average score</td>
<td>42</td>
<td>0.82</td>
<td>High</td>
</tr>
</tbody>
</table>

Table 5. Students’ Critical Thinking Skills Score Based on Indicators in the Control Class

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Control Mean Pretest</th>
<th>N-gain</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary classification</td>
<td>45</td>
<td>0.51</td>
<td>Medium</td>
</tr>
<tr>
<td>Basic support inference</td>
<td>30</td>
<td>0.67</td>
<td>Medium</td>
</tr>
<tr>
<td>Advances classification</td>
<td>40</td>
<td>0.79</td>
<td>High</td>
</tr>
<tr>
<td>Strategies and Tactics</td>
<td>30</td>
<td>0.79</td>
<td>High</td>
</tr>
<tr>
<td>Average score</td>
<td>37</td>
<td>0.68</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Tables 4 and 5, shows the average value of pretest and posttest critical thinking skills based on each indicator of experimental classes that use ethnobiology learning models based on design thinking better than control classes that use conventional learning. This can be seen from the average pretest of experimental and control classes. The experimental class had an average pretest score of 42 and a posttest score of 81 with an n-gain of 0.82 in the high category. The control class had an average pretest score of 37 and a posttest score of 72 with an n-gain of 0.68 in the medium category. Ethnobiological learning models improve critical thinking skills and understanding of student concepts in learning (Ardianti & Raida 2022; Untari et al., 2020). Not only that, the ethnobiology learning model encourages critical thinking skills in students Sudarmin (2018). The ethnonobiology learning model helps students be more active in learning activities and students are able to apply learning concepts to everyday life (Sudarmin et al., 2019; Zaenuri et al., 2017).

Figure 2, shows the n-gain value of critical thinking skills of the experimental class is higher than the control class. Based on the indicators of critical thinking ability from the results of the student critical thinking ability test, the average n-gain value of the experimental class is higher than the control class. This is due to one factor, namely the application of the design
thinking-based ethnobiology learning model carried out in the experimental class so that it can foster students' thinking skills in biology learning (Munirotus et al., 2020) stated that students who only receive knowledge from teachers without involving critical thinking skills will make teaching and learning activities less effective. The teaching and learning process with the ethnobiology learning model based on design thinking stimulates students' critical thinking skills in learning biology (Rahmawati & Subali, 2019; Sari & Wilujeng, 2023; Hidaayatullaah et al., 2021). Students who have critical thinking skills can solve problems that occur in learning activities (Djamas et al., 2018; Ramli et al., 2020). In addition, the application of the right model in the learning process will be able to encourage students to be more active and creative in learning (Festiyed et al., 2022; Santosa et al., 2021). This causes students' critical thinking skills in the experimental class to be higher than the control class.

To see the effect of ethnobiology learning model based on design thinking on critical thinking skills, hypothesis testing with T-test was conducted. The results of the hypothesis test of students' critical thinking skills can be seen in Table 6.

Table 6. Independent sample T-test Hypothesis Test Results

<table>
<thead>
<tr>
<th>Assumption</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal variances</td>
<td>3.023</td>
<td>42</td>
<td>0.000</td>
<td>H1 accepted</td>
</tr>
<tr>
<td>not assumed</td>
<td>3.120</td>
<td>43.199</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

Based on Table 6, shows the sig value. < 0.05 or 0.00 < 0.05, so H0 is rejected and H1 is accepted. This explains that the design thinking-based ethnobiology learning model has a significant effect on students' critical thinking skills in learning biology. Ethnoscienced learning supports the quality of student learning in fostering students' critical thinking skills (Ibe & Nwosu, 2017; Zidny & Eilks, 2022; Suastra & Pujani, 2021). In addition, the learning process that applies ethnobiology learning is more effective in helping students apply local wisdom in learning materials (Parmin et al., 2017; Kik et al., 2021). The learning process through the design thinking-based ethnobiological learning model helps students develop knowledge in understanding local wisdom. This has a positive impact on students in developing the potential to think critically in learning biology. In addition, learning with ethnoscience students care more about nature (Yulkifli et al., 2022).

Conclusion

Based on this research, it shows that the average value of posttest and N-gain critical thinking skills of classes that get ethnobiology learning based on design thinking is better than classes that use conventional learning. The t-test results show that the ethnobiology learning model based on design thinking has an effect on critical thinking skills sig. < 0.05 (0.00 < 0.05). Ethnobiology learning model based on design thinking is effective to be applied in learning biology. This learning model can stimulate students' critical thinking skills. not only that, design thinking-based ethnobiology learning fosters students' caring attitude towards the environment. So, through the design-based ethnobiology learning model becomes one of the effective learning models to improve student thinking and biology learning.

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Authors Contribution

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Conflicts of Interests

The authors declare no conflict of interest.

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decline precipitously in Papua New Guinea, the world’s most linguistically diverse nation. *PNAS* 2021, 118(2), 1–8. https://doi.org/10.1073/pnas.2100096118


