Meta-Analysis: The Effect of Ethnoscience-Based Project Based Learning Model on Students' Critical Thinking Skills

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Abstract: This study aims to determine the effect size of ethnoscience-the based project-based learning model on students' critical thinking skills. This type of research is a meta-analysis. Data sources come from 20 national and international journals published from 2015-2023. The search for data sources comes from the google scholar journal database, Eric, ScienceDirect, and ProQuest. The process of selecting data sources using the PRISMA method. Data collection techniques through direct observation and documentation through journal databases. The data analysis technique in this meta-analysis is quantitative statistical analysis with the help of the Comprehensive Meta-Analysis (CMA) version 3.0 application. The results showed an average effect size of 0.827 with high criteria and a standard error of 0.088. This finding shows that the ethnoscience-based Project Based Learning (PjBL) model has a positive effect on students' critical thinking skills.

Keywords: Critical thinking; Ethnoscience; Meta-analysis; Project based learning model

Introduction

Critical thinking is an ability that students must have in facing the 21st century (Elfira et al., 2023; Oktarina et al., 2021; Ichsan et al., 2023; Bagus et al., 2022). Critical thinking is very important for students in solving a problem (Nurtamam et al., 2023; Zulkifli et al., 2022; Rahman et al., 2023; Amin et al., 2020). According to Mustofa & Hidayah (2020), Critical thinking skills help students to foster logical, systematic, and scientific reasoning in learning. In addition, critical thinking skills encourage students to think in detail in finding a solution (Haryati et al., 2022; Dakabesi et al., 2019). Thinking skills encourage students to provide odoriferous ideas in solving a problem (Yousef, 2021).

Indonesian students' critical thinking skills are still low (Kurniahtunnisa et al., 2016; Suryono et al., 2023; Rijal et al., 2021). This is supported by the results of the 2018 PISA survey of critical thinking skills of Indonesian students obtained a score of 396 ranked 71 out of 78 members (Zulyusri et al., 2023; Putra et al., 2023; Yustiana et al., 2022; Cahyono et al., 2021). Furthermore, the results of the United Nations Development Program (UNDP) conducted by the Human Development Index (HDI) in 2019, the critical thinking skills of Indonesian students obtained a score of 71.98, ranked 130 out of 199 countries (Sudirman et al., 2021). Based on the Trends in International Mathematics and Science Study (TIMSS) survey in 2015, students' thinking skills in science learning amounted to 402 which is lower than the international average score of 500 (Ayuningrum et al., 2015; Rahman & Ristiana, 2020; Rahman et al., 2023).

Yahdi et al. (2020) stated that the low critical thinking skills of students were influenced by the teacher-centered learning process, uninteresting learning models and methods, and learning evaluations
that did not lead to critical thinking skills. Learning activities only train students in understanding concepts so that they do not lead students to think critically (Rusmansyah et al., 2019; Arsih et al., 2021; Supriyadi et al., 2023; Suharyat et al., 2022; Rahman et al., 2018). Research results by Ejin (2017) explained that only 50% of students have critical thinking skills in learning. Therefore, there is a need for learning methods and models that can encourage students' critical thinking skills.

Project Based Learning (PjBL) is one of the learning models that can train students to think critically (Mursid et al., 2022; Listiqowati et al., 2022; Chua & Islam, 2021; Issa et al., 2021; Sönmez et al., 2019). Project Based Learning is a learning model that leads students to create a project in learning activities (Niswara et al., 2019; Chua, 2014; Maros et al., 2021). Research results by Janah & Widodo (2013) Project-based learning model can improve science process skills and student learning outcomes. The Project Based Learning model helps students be more active and creative in learning (Santyasa et al., 2021; Ichsan et al., 2022; Suharyat et al., 2022). Further research results by Syawaludin et al. (2022) The Project Based Learning model has a significant effect on students' cooperation skills in learning. Furthermore, ethnoscience-based Project Based Learning trains students to be more creative in applying learning materials with local wisdom (Sudarmin et al., 2020; Sudarmin et al., 2019). Ethnoscience is a process of applying traditional science with modern science (Sumarni et al., 2022). Ethnoscience-based learning fosters environmental awareness in students (Nisa et al., 2015; Rahman et al., 2023).

Research by Ardianti et al. (2022), Ethnosai-based Project Based Learning trains students' concept understanding skills in learning. Wulandari et al. (2020) stated that the Project Based Learning (PjBL) model has a positive impact on students' collaborative character abilities in learning activities. Research results Muzana et al. (2021) Project Based Learning model can improve students' problem solving skills in science learning. Research results by Ramandanti et al. (2020) stated that the ethnoscience-based Project Based Learning model can train students' understanding of learning concepts. Sholahuddin et al. (2021) The ethnoscience-based Project Based Learning model can increase students' science literacy in learning so as to encourage students to think critically. But in fact, many studies on Project Based Learning models are still few that analyze the size effect of ethnoscience-based Project Based Learning models. Based on these problems, this study aims to determine the size effect of the ethnoscience-based project-based learning model on students' critical thinking skills.

Method

Research Design

This research is a meta-analysis study. Meta-analysis is a type of research that analyzes previous studies that can be analyzed statistically (Öztürk et al., 2022; Putra et al., 2023; Diah et al., 2022; Santosa et al., 2021). This meta-analysis research is used to determine the effect of the ethnoscience-based Project Based Learning (PjBL) model on students' critical thinking skills.

Eligibility Criteria

Determination of eligibility criteria aims to obtain accurate research results (Demir & Kaya, 2022). The data criteria for conducting this meta-analysis are: data from journals or proceedings published in 2015-2023, The type of research must be experimental or quasi-experimental, Has a relationship with the research variable, namely the ethnoscience-based Project Based Learning Model on critical thinking skills. Journals or proceedings indexed by SINTA, DOAJ, Copernicus International, or Scopus and 5) journals or proceedings have a value (r) and (t).

Data Coding

In meta-analysis, data coding serves to facilitate data collection and data analysis (Utomo & Aliman, 2021; Ridwan, 2022). Data coding in this meta-analysis research considers the year of publication, country of origin, journal type, research sample, effect size (ES). The effect size criteria can be seen in Table 1.

Data Analysis

The data analysis technique in this study was carried out by analyzing the data according to the characteristics of the research sample, coding the data; 3) changing the T and F values to the r correlation value with the formula; 4) calculating the heterogeneity test value; 5) calculating the effect size (ES) value; 6) making funnel flot; 7) conducting hypothesis testing and 8) calculating publication bias (Cohen et al., 2007; Aybirdi, 2023; Mutohharai et al., 2021). Data analysis was done with the help of JSAP 0.8.4.0 application.

Table 1. Effect Size Value Criteria (Suparman et al., 2021; Supriyadi et al., 2023; Rahman et al., 2023)

<table>
<thead>
<tr>
<th>Effect size</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 ≤ ES ≤ 0.20</td>
<td>Ignored</td>
</tr>
<tr>
<td>0.20 ≤ ES ≤ 0.50</td>
<td>Low</td>
</tr>
<tr>
<td>0.50 ≤ ES ≤ 0.80</td>
<td>Medium</td>
</tr>
<tr>
<td>0.80 ≤ ES ≤ 1.30</td>
<td>High</td>
</tr>
<tr>
<td>1.30 ≤ ES</td>
<td>Very High</td>
</tr>
</tbody>
</table>
Result and Discussion

Result

From the results of the meta-analysis of 145 journals or proceedings related to the effect of ethnoscience-based project-based learning models on students’ critical thinking skills, only 19 journals or proceedings met the inclusion criteria. Furthermore, journals or proceedings that have met the inclusion criteria become the source of data in this study which is calculated the effect size value which can be seen in Table 2.

<table>
<thead>
<tr>
<th>Journal Code</th>
<th>Years</th>
<th>Nation</th>
<th>N</th>
<th>ES</th>
<th>Criteria Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>2017</td>
<td>Indonesia</td>
<td>17</td>
<td>0.88</td>
<td>High</td>
</tr>
<tr>
<td>V2</td>
<td>2020</td>
<td>Indonesia</td>
<td>25</td>
<td>1.07</td>
<td>High</td>
</tr>
<tr>
<td>V3</td>
<td>2019</td>
<td>Indonesia</td>
<td>13</td>
<td>0.72</td>
<td>Medium</td>
</tr>
<tr>
<td>V4</td>
<td>2017</td>
<td>Indonesia</td>
<td>10</td>
<td>0.90</td>
<td>High</td>
</tr>
<tr>
<td>V5</td>
<td>2023</td>
<td>Indonesia</td>
<td>35</td>
<td>1.22</td>
<td>High</td>
</tr>
<tr>
<td>V6</td>
<td>2023</td>
<td>Indonesia</td>
<td>20</td>
<td>0.79</td>
<td>Medium</td>
</tr>
<tr>
<td>V7</td>
<td>2021</td>
<td>India</td>
<td>20</td>
<td>0.42</td>
<td>Low</td>
</tr>
<tr>
<td>V8</td>
<td>2020</td>
<td>Indonesia</td>
<td>16</td>
<td>0.81</td>
<td>High</td>
</tr>
<tr>
<td>V9</td>
<td>2023</td>
<td>Indonesia</td>
<td>30</td>
<td>1.40</td>
<td>Very High</td>
</tr>
<tr>
<td>V10</td>
<td>2021</td>
<td>Turki</td>
<td>50</td>
<td>0.65</td>
<td>Medium</td>
</tr>
<tr>
<td>V11</td>
<td>2022</td>
<td>Meksiko</td>
<td>18</td>
<td>0.30</td>
<td>Low</td>
</tr>
<tr>
<td>V12</td>
<td>2018</td>
<td>Pakistan</td>
<td>15</td>
<td>1.53</td>
<td>Very High</td>
</tr>
<tr>
<td>V13</td>
<td>2016</td>
<td>Indonesia</td>
<td>25</td>
<td>0.82</td>
<td>High</td>
</tr>
<tr>
<td>V14</td>
<td>2016</td>
<td>Indonesia</td>
<td>25</td>
<td>0.74</td>
<td>Medium</td>
</tr>
<tr>
<td>V15</td>
<td>2021</td>
<td>Indonesia</td>
<td>40</td>
<td>0.81</td>
<td>High</td>
</tr>
<tr>
<td>V16</td>
<td>2022</td>
<td>India</td>
<td>30</td>
<td>0.98</td>
<td>High</td>
</tr>
<tr>
<td>V17</td>
<td>2021</td>
<td>Indonesia</td>
<td>26</td>
<td>0.49</td>
<td>Low</td>
</tr>
<tr>
<td>V18</td>
<td>2023</td>
<td>Indonesia</td>
<td>34</td>
<td>0.51</td>
<td>Medium</td>
</tr>
<tr>
<td>V19</td>
<td>2021</td>
<td>Indonesia</td>
<td>64</td>
<td>0.69</td>
<td>Medium</td>
</tr>
<tr>
<td>Average Effect Size</td>
<td></td>
<td></td>
<td></td>
<td>0.827</td>
<td>High</td>
</tr>
</tbody>
</table>

Based on Table 2. Shows that 8 articles with high effect size criteria, 2 articles with very high effect size criteria, 6 journals with medium effect size criteria and 3 articles with small effect size criteria. Furthermore, the average effect size value is 0.827 with high criteria. These results explain that the ethnoscience-based Project Based Learning model has a positive effect on students’ critical thinking skills. The next step is to conduct a heterogeneity test which aims to determine the meta-analysis model used clearly in Table 3.

<table>
<thead>
<tr>
<th>Model</th>
<th>Hedge’s g</th>
<th>95% CI</th>
<th>Z-Value</th>
<th>P-Value</th>
<th>Q-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>0.615</td>
<td>[0.624; 0.730]</td>
<td>34.004</td>
<td>0.000</td>
<td>213.785</td>
<td>0.000</td>
</tr>
<tr>
<td>Random</td>
<td>0.783</td>
<td>[0.681; 0.869]</td>
<td>9.170</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on Table 3. Shows that the Q-value is 213.785 or p < 0.05, meaning that the effect of each study has a significant difference. The meta-analysis model used is the random effect model. This analysis shows that the application of the ethnoscience-based Project Based Learning model provides a high significant value compared to the conventional model.

Next, we calculated the publication bias of the studies used by using the Funnel Plot which can be seen in Figure 1.

Figure 1. Funnel plot standard error by Hedge’s g
Based on Figure 1 shows that the effect size is still scattered in the field of symmetrical lines in the middle of the funnel plot. The distribution is not completely symmetrical on the vertical line. Therefore, it is necessary to see the Fail save-N (FSN) value. The FSN value is meta-analyzed to determine publication bias. From the analysis with the CMA application, the FSN value is 434 then entered in the formula 434/(5.19-10) > 1 = 5.10 > 1. This result explains that the study is not susceptible to publication bias, so it is necessary to do the Trim and Fill test which can be seen in Table 4.

### Table 4. Results of Publication Bias Test with Trim and Fill

<table>
<thead>
<tr>
<th>Observed Value</th>
<th>Ommited studies</th>
<th>Point Estimate</th>
<th>Lower limit</th>
<th>Upper Limit</th>
<th>Q-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed Value</td>
<td>1</td>
<td>0.742</td>
<td>0.516</td>
<td>1.39</td>
<td>57.68</td>
</tr>
<tr>
<td>Adjusted Value</td>
<td></td>
<td>0.617</td>
<td>0.478</td>
<td>1.04</td>
<td>134.96</td>
</tr>
</tbody>
</table>

Based on Table 4. Shows the results of the Trim and Fill test with an observed value of 0.742 and an adjusted value of 0.617. Furthermore, there is 1 article that is omitted, namely V11. The heterogeneity value is normally distributed. The next step, conducting hypothesis testing to determine the effectiveness of the Ethnosience-based Project Based Learning model on critical thinking skills can be seen in Table 5.

### Table 5. Hypothesis Test Results Based on Random Effect Models

<table>
<thead>
<tr>
<th>Estimation model</th>
<th>n</th>
<th>Z</th>
<th>P</th>
<th>ES</th>
<th>Standard Error</th>
<th>95 % CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random effect model</td>
<td>19</td>
<td>7.595</td>
<td>0.00</td>
<td>0.827</td>
<td>0.088</td>
<td>[0.681; 0.869]</td>
</tr>
</tbody>
</table>

Based on Table 5. Shows that the Z value is 7.595 or p < 0.00. These results can be concluded that the application of ethnosience-based Project Based Learning model is more effective in improving students' critical thinking skills than conventional learning.

**Discussion**

The use of ethnosience-based Project Based Learning (PjBL) model has a positive influence on students' critical thinking skills compared to conventional learning models. This can be seen from the average value of the effect size (ES = 0.827) high criteria. Research results Hanum et al. (2023) ethnosience-based Project Based Learning model can encourage students' critical thinking skills in learning activities. The application of the ethnosience-based Project Based Learning (PjBL) model helps students more easily understand learning concepts (Ardianti & Raida, 2022; Rumasyah & Sofia, 2023; Rahman et al., 2018). Ethnosience-based learning can train students to apply learning materials with the local environment for learning resources (Sari & Wilujeng, 2023; Ilwandri et al., 2022; Elvianasti et al., 2022). Therefore, the ethnosience-based Project Based Learning model can improve students' critical thinking skills so that they can solve a problem in learning (Hikmawati et al., 2020; Irvan & Mushlihuddin, 2020).

This ethnosience-based learning encourages critical thinking and makes it easier for students to understand the subject matter (Sumarni, 2018). Critical thinking skills help students more easily remember and analyze a problem that occurs in their environment (Sudarmin et al., 2019; Que et al., 2022; Suharyat et al., 2022). Research results Yuliana et al. (2021) Ethnosience learning trains students to think critically and creatively in learning so as to create a more interesting learning atmosphere. Furthermore, the ethnosience-based Project Based Learning (PjBL) model helps students be more creative so as to stimulate their critical thinking skills in learning (Lazic, 2021; Rahmawati & Subali, 2019; Rofik et al., 2022; Safitri, 2021). Not only that, the ethnosience-based Project Based Learning model trains students to learn with nature (Wati et al., 2020).

Temeningsih et al. (2017) the ethnosience learning process helps students develop cognitive potential so that it can train students to think critically in learning. In learning activities students must be able to analyze a subject matter that they have learned. According to Dike et al. (2020) The application of ethnosience concepts in the learning process makes students more active and creative in learning. Therefore, students are more motivated in learning so that it is easier to encourage students to think critically in analyzing a problem in learning (Yusuf, 2023; Vidergor, 2022). So, the selection of the right learning model greatly influences students' thinking process skills (Sudjimat, 2021). The application of Project Based Learning (PjBL) model based on one of the more effective models to improve students' critical thinking skills. In addition, the ethnosience-based Project Based Learning model trains students to be more creative in learning (Kasi et al., 2020).

**Conclusion**

From the results of this study, it can be concluded that the average effect size value is 0.827 with high
criteria and a standard error of 0.088. This finding shows that the ethnoscience-based Project Based Learning (PjBL) model has a positive effect on students' critical thinking skills. The ethnoscience-based Project Based Learning model is more effective for improving critical thinking skills than conventional learning models. The ethnoscience-based Project Based Learning model is one solution to improve students' thinking skills in learning.

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Author Contributions
The first author Aried Aulia Rahman distributed in collecting research from journal databases. Authors Tomi Apri Santosa and Mohammad Edy Nur Amam distributed data selection based on inclusion criteria. Heru Widoyo and Abdul Rahman distributed in analyzing and interpreting the research data.

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Conflicts of Interest
The authors declare no conflict of interest.

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