The Effect of Flipped Classroom Size on Students' Critical Thinking Abilities

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Abstract

The purpose of this research is to determine the effect of flipped classroom size on students' critical thinking abilities. This type of research is meta-analysis. The data source comes from an analysis of 12 national and international journals published in 2018-2023. Data source search process via Google Scholar; ERIC, ScienceDirect, Wiley; ProQuest, DOAJ and EBSCO. Data selection using the PRISMA method consists of identification, screening, eligibility and inclusion. These findings conclude that the flipped classroom has a positive influence on students' critical thinking skills with a summary effect size value ($r_{RE}$ = 0.799). The flipped classroom has a moderate influence on students' critical thinking abilities at school.

Keywords: Flipped Classroom; critical thinking; Effect Size; Meta-analysis
Introduction

Critical thinking is an ability that students have to deal with 21st century developments (Rusilowati, 2020; Elfira et al., 2023; Putra et al., 2023; Hebebci & Usta, 2022). According to Zhou (2018), critical thinking is a student's ability to analyze information holistically and systematically. The ability to think critically is very important for students in analyzing and concluding a material (Mutakinat & Anwari, 2018; Rijal et al., 2021; Suryono et al., 2023; Suharyat et al., 2022). Students who have the ability to think critically can provide accurate conclusions of material and concepts in learning (Hidayati et al., 2022), in solving a problem (Wahyuni, 2021). In addition, critical thinking skills can encourage students to be active in learning activities (Ariani, 2020; Noverli & Cahya, 2021).

However, the problems that occur in schools students have low critical thinking skills (Kurniahtunnisa et al., 2016; Asokawati & Hamidah, 2023). This is because learning activities do not lead students to think critically in learning (Zulyusri et al., 2023; Cahyono et al., 2021). The results of the Trends in International Mathematics and Science Study (TIMSS) research in 2015 stated that the critical thinking ability of Indonesian students in the fields of science and mathematics obtained a score of 396 far compared to the average international score of 500 (Sofianora et al., 2023; Utomo et al., 2023). In addition, the learning process is teacher-centered so that students find it difficult to understand the material (Al-fikry & Syukri, 2018; Pebriyani, 2020). Teachers choose inappropriate learning models to encourage students to think critically (Nurtamam et al., 2023; Luciana et al., 2023; Fitriani et al., 2020).

Flipped Classroom is a learning model that can improve students' critical thinking skills in learning (Andrini et al., 2019; Putri et al., 2021; Listiqowati, 2022). Flipped classroom is a creative learning model that helps students learn outside and inside the classroom (Ario & Asra, 2018; Widodo, 2022). Flipped classrooms can help students learn creatively and independently through videos provided by teachers (Juniantari et al., 2018; Astawa et al., 2022). Flipped classroom students can be more active and easier to understand the subject matter (Rapi et al., 2022). In addition, student flipped classrooms can help student learning activities online (Gomez, 2018; Shahani et al., 2022).

Previous research on flipped classrooms provides a significant influence on students' critical thinking skills (Afzali & Izadpanah, 20, 22; Widyasari et al., 2021; Nurfadillah et al., 2020; Rahmatan et al., 2022). In addition, flipped classroom can help students to improve student learning outcomes and motivation (Sahara et al., 2020; Darmawan et al., 2020). There is a lot of research on flipped classrooms, there is still little research on the effect of flipped classroom size. Based on these problems, this study aims to determine the effect of size flipped classroom on students' critical thinking skills.

Methods

This study is a meta-analysis study. Meta-analysis is a type of research that collects and analyzes previous studies that can be analyzed quantitatively (Öztop, 2023; Hidayah et al., 2023; Taşdemir, 2022; Suharyat et al., 2022; Santosa et al., 2021; Oktarina et al., 2021). The meta-analysis aims to determine the effect of flipped classroom on students' critical thinking skills.

Inclusion Criteria
Meta-analysis research has criteria that are publication published in 2020-2023; research must be experimental or quasi-experimental; data comes from national and international journals indexed by SINTA, Web of science and Scopus; The data has an average value, standard deviation (SD) and t value and the journal must be in Indonesian and English (science and mathematics).

**Literature Search**

Literature search through Google Scholar; ERIC, ScienceDirect, Wiley; ProQuest, DOAJ and EBSCO. The keyword is flipped classroom; critical picturing; and the effect of flipped classroom on students' critical thinking skills. Selection of data sources through the PRISMA method consists of identification, screening, Eligibility and Included.

**Statistical Analysis**

The statistical analysis in this meta-analysis is 1) calculating the effect size value of each primary study; 2) Test heterogeneity and determine estimation models; 3) checking publication bias; and calculate the p-value to test the hypothesis (Borenstein et al., 2009). The effect size criteria in the study are guided by the criteria Cohen et al., (2007) can be seen in Table 1. Data analysis in this study with the help of JSAP 0.8.4.

**Result and Discussion**

Based on the process of searching data source through Google Scholar; ERIC, ScienceDirect, Wiley; ProQuest, DOAJ and EBSCO obtained 12 articles that met the inclusion criteria to be meta-analyzed data. The results of the analysis of 12 data articles for the meta-analysis can be seen in Table 2.

**Table 2. Analysis Results 12 Meta-analysis Data Articles**

<table>
<thead>
<tr>
<th>Writer</th>
<th>Index</th>
<th>Effect Size</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurfadillah et al., (2020)</td>
<td>Sinta</td>
<td>0.92</td>
<td>0.20</td>
</tr>
<tr>
<td>Suci et al., (2021)</td>
<td>Sinta</td>
<td>0.87</td>
<td>0.25</td>
</tr>
<tr>
<td>Inayah et al., (2021)</td>
<td>Sinta</td>
<td>1.02</td>
<td>0.34</td>
</tr>
<tr>
<td>Atikah et al., (2022)</td>
<td>Sinta</td>
<td>0.61</td>
<td>0.17</td>
</tr>
<tr>
<td>Al-zoubi, (2021)</td>
<td>Scopus</td>
<td>1.17</td>
<td>0.42</td>
</tr>
<tr>
<td>Listiqowati, (2022)</td>
<td>Scopus</td>
<td>0.86</td>
<td>0.20</td>
</tr>
<tr>
<td>Atwa et al., (2022)</td>
<td>Scopus</td>
<td>1.31</td>
<td>0.46</td>
</tr>
<tr>
<td>Etemadfar et al., (2020)</td>
<td>Scopus</td>
<td>0.88</td>
<td>0.21</td>
</tr>
<tr>
<td>Astawa et al., (2022)</td>
<td>SINTA &amp; Scopus</td>
<td>0.76</td>
<td>0.18</td>
</tr>
<tr>
<td>Widodo (2022)</td>
<td>Scopus</td>
<td>1.54</td>
<td>0.52</td>
</tr>
<tr>
<td>Sulisworo &amp;; Sari, (2019)</td>
<td>Wos</td>
<td>0.93</td>
<td>0.30</td>
</tr>
<tr>
<td>(Widyasari et al., 2021)</td>
<td>Sinta</td>
<td>0.47</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Table 2, shows the results of 12 articles indexed by SINTA, Scopus and Wos which were used as data in the meta-analysis obtained effect size values ranging from 0.47-1.54. According to Cohen et al., (2007) of the 12 effect sizes there is one small effect size criterion (8.3%), two medium effect size criteria (16.67%) and seven large effect size criteria (58.3%) and two very large effect size criteria (16.67%). Next, test the heterogeneity of the effect size and determine the estimation model.
Next, conduct a heterogeneity test of the 12 effect sizes analyzed. Test results of the overall heterogeneity of the study can be seen in Table 3.

### Table 3. Heterogeneity Test Results

<table>
<thead>
<tr>
<th></th>
<th>Q</th>
<th>Df</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omnibus test of Model Coefficients</td>
<td>104.860</td>
<td>1</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Test of Residual Heterogeneity</td>
<td>13.545</td>
<td>11</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

Table 3, explaining the results of the heterogeneity test of 12 effect sizes analyzed obtained a value of Q = 104.860 is greater than 13.545, so the overall effect size analyzed by ISIS is heterogeneously distributed. Next, check the publication bias to avoid the appearance of bias against the analyzed article. Checking publication bias can be known through Egger's funnel plot and test (Tamura & Wijaya, 2021; Yıldırım, 2022; Diah et al., 2022). The results of checking publication bias with funnel plots can be seen in figure 1.

![Funnel Plot Standard Error](image)

#### Figure 3. Funnel Plot Standard Error

Figure 3, explaining the analysis of effect size with funnel plot, does not yet know whether the shape of the funnel plot is symmetrical or asymmetric. Therefore, it is necessary to conduct Egger's test. Egger's test results are shown in Table 4.

### Table 4. Egger's Test Results

<table>
<thead>
<tr>
<th></th>
<th>Z</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sei</td>
<td>3.365</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Based on Table 4, explain the value of $z = 3.365$ with $p < 0.001$. This result can be concluded that the funnel plot is symmetrical. The results also make it clear that articles that are not analyzed are resistant to publication bias. Next, calculate the p-value through summary effect size or mean effect size to test the hypothesis. The test aims to determine the effect of flipped classroom on students' critical thinking skills. The results of the summary effect size analysis can be shown in Table 5.

### Table 5. Summary Effect Size

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Z</th>
<th>P</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.79</td>
<td>0.078</td>
<td>10.240</td>
<td>0</td>
<td>0.6</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Table 5, explaining the results of the summary effect size test obtained a CI value of 95% lower of 0.646 and upper of 0.952 and Z value of 10.240. The findings conclude that the flipped classroom model affects students' critical thinking skills. The effect of flipped classroom on critical thinking skills is medium category with a value ($r_{RE} = 0.799$; $SE = 0.078$). Therefore, flipped classrooms are very effective for teachers to encourage students' critical thinking skills.

This research is in line with Musdi et al., (2022) Flipped Classroom can improve students' critical thinking skills in learning activities. The results are supported by Ma's (2023) findings that flipped classroom has a positive influence on students' critical thinking skills. Flipped classroom students...
are able to learn online and independently in understanding the concepts of lessons given by the teacher (Yavuz & Ozdemir, 2021; Fatmiyati & Juandi, 2023), thus stimulating students' critical thinking skills. Flipped Classroom helps students learn more creatively and innovatively by utilizing technology.

Flipped classroom students can learn outside and inside the classroom about learning materials (Walidah et al., 2020; Arbaeen, 2021). Flipped classroom students learn more actively into student-centered learning (Suswandi, 2018). In addition, flipped classroom can develop problem-solving skills so that students can think critically in learning. Flipped classroom encourages students to have higher-order thinking skills in learning (Kurniasih & Nofiana, 2023). So, this flipped classroom really needs to be applied by teachers in schools in encouraging students' critical thinking skills in learning.

**Conclusion**

In this study, it can be concluded that flipped classroom has a positive influence on students' critical thinking skills with a summary effect size value ($r_{RE} = 0.799$). Flipped classroom has a moderate influence on students' critical thinking skills at school. Flipped classrooms help students learn more actively and independently in learning. Flipped classrooms help students' learning process become more interesting by utilizing technology.

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