EDUMASPUL
JURNAL PENDIDIKAN
Vol. 7 – No. 1, year (2023), page 1491-1501
| ISSN 2548-8201 (Print) | 2580-0469) (Online) |

Meta-analysis: The Effectiveness of Iot-Based Flipped Learning to Improve Students' Problem Solving Abilities

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Receive: 10/01/2023	Accepted: 10/02/2023	Published: 01/03/2023

Abstrak

Penelitian ini bertujuan untuk mengetahui efektivitas pembelajaran flipped berbasis IoT untuk meningkatkan kemampuan pemecahan masalah siswa. Jenis penelitian ini adalah penelitian meta-analisis. Sumber data dalam penelitian ini berasal dari 11 jurnal nasional dan internasional. Penelusuran sumber data melalui Google Scholar, ScienceDirect, Wiley dan Eric. Teknik pengumpulan data adalah observasi langsung melalui database online. Kriteria inklusi dala penelitian ini adalah 1) sumber data berupa jurnal nasional dan internasional terbit dari tahun 2019-2023; 2) Jenis penelitian eksperimen atau quasi-eksperimen; 3) Penelitian tentang pembelajaran flipped dan kemampuan pemecahan masalah siswa dan 4) Sumber data berupa jurnal atau prosiding terindeks SINTA, DOAJ dan Scopus. Analisis data adalah analisis deskriptif kuantitatif dengan bantuan aplikasi JASP. Hasil penelitian menunjukan bahwa nilai rata-rata effect size (ES = 0.839) kriteria tinggi. Temuan ini menunjukan bahwa model pembelajaran flipped berbasis IoT dapat meningkatkan kemampuan pemecahan masalah siswa. Model pembelajaran flipped learning membantu siswa lebih kreatif dan inovatif dalam belajar

Kata Kunci: Model Pembelajaran, Flipped, IoT, Pemecahan Masalah

Meta-analysis: The Effectiveness Of Iot-Based Flipped Learning To Improve Students' Problem Solving Abilities

Abstract

This study aims to determine the effectiveness of IoT-based flipped learning to improve students' problem-solving skills. This type of research is meta-analysis research. The data sources in this study came from 11 national and international journals. Data sources were searched through Google Scholar, ScienceDirect, Wiley, and Eric. The data collection technique is direct observation through online databases. The inclusion criteria in this study are 1) data sources in the form of national and international journals published from 2019-2023; 2) Experimental or quasi-experimental type of research; 3) Research on flipped learning

and solving skills. Research on flipped learning and student problem-solving skills and 4) Data sources in the form of journals or proceedings indexed by SINTA, DOAJ, and Scopus. Data analysis is quantitative descriptive analysis with the help of the JASP application. The results showed that the average effect size value (ES = 0.839) was high. This finding shows that the IoT-based flipped learning model can improve students' problem-solving skills. The flipped learning model helps students to be more creative and innovative in learning.

***Keywords**: Learning Model, Flipped, IoT, Problem Solving*

Introduction

Problem solving is a type of 21st century thinking skills that must be possessed by students (Sudarsono et al., 2022;Rahman et al., 2023; Ichsan et al., 2023; Putri et al., 2022). Problem solving is a complex ability that involves cognitive processes in gathering and selecting information to find solutions to solve a problem (Kodariyati & Astuti, 2016; Rahman et al., 2023; Supriyadi et al., 2023; Ummah & Yuliati, 202; Ridwan et al., 2021). Problem solving ability is very important for students to find ideas and information in learning (Nurfitriyanti, 2016). In addition, problem solving abilities include higher order thinking skills that students must have in solving a problem in everyday life (Destianingsih & Pasaribu, 2013; Surur et al., 2020;Hulaikah et al., 2020). Muslim (2017) students who have problem solving abilities will be more active in learning.

Furthermore, the problem solving ability of students in Indonesia is still low (Sumiantari et al., 2019; Setyaningsih & Rahman, 2022). This can be seen from the results of the Trends In International Mathematics And Science Study (TIMSS) stating that the level of problem solving abilities of Indonesian students is still in the low category. In addition, it is supported by the results of the 2018 PISA survey showing that the level of scientific literacy of Indonesian students in problem solving is low, only obtaining a score of 396, ranking 73 out of 78 participating countries (Aiman et al., 2020; Sofianora et al., 2023; Suryono et al., 2023; Oktarina et al., 2021;Zulyusri et al., 2023; Suharyat et al., 2022; Elfira et al., 2023). The low problem solving in students is influenced by many factors. Widiana (2020) states the low problem-solving ability of students is due to teacher-centered learning activities and students only memorize learning concepts so that they do not encourage students to solve a problem. Furthermore, the low interest and motivation of students in learning (Hasanah et al., 2019), as well as the application of inappropriate learning models and methods (Ichsan et al., 2022).

Flipped learning is a creative learning model that can help students' learning process be more active so that students don't get bored while learning (Walidah et al., 2020; He et al., 2019;Youhasan et al., 2021). Damayanti et al., (2020) states that the flipped learning model affects students' creative abilities in learning. Research result (Nurfadillah et al., 2020) states that the flipped learning model can improve students' critical thinking skills and problem solving in learning. Not only that, the flipped model affects students' cognitive abilities in learning so that it encourages problem solving abilities in students (Park et al., 2021; Rahman et al., 2023; Aybirdi, 2023; Nasser & Mulhim, 2021; Rusdi et al., 2016). Therefore, model flipped learning can improve problem solving skills in students (Khofifah et al., 2021; Arnata et al., 2020).

Previous research by Sinmas et al., (2019) states that the application of the flipped learning model can improve student achievement and interest in

learning. Research by (Adhitiya, 2015) states that the Flipped Classroom learning model helps students to be more creative and innovative in carrying out the learning process so as to encourage students' problem-solving abilities. But in reality, there are many studies with the influence of the flipped learning model in the field of education but still little illustrates the effectiveness of the IoT-based flipped classroom learning model on students' problem solving abilities. Research by Umam (2020) the flipped classroom learning model can encourage students' conceptual understanding skills. Based on the problems above, this study aims to determine the effectiveness of the IoT-based flipped classroom learning model in improving students' problem solving abilities.

Methods

This research is a type of meta-analysis research. Meta-analysis is a type of research that analyzes previous studies that can be analyzed statistically (Öztürk et al., 2022; Santosa et al., 2021; Razak et al., 2021; Ichsan et al., 2022). Sources of data in this study were 11 national and international journals. Searching for data sources through the Google Scholar database, ScienceDirect, Eric and Wiley. The method of selecting data sources through the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) method can be seen in Figure 1. The data collection technique is direct observation and documentation through the journal database.

The inclusion criteria in the study were 1) data sources in the form of national and international journals published from 2019-2023; 2) Types of experimental or quasi-experimental research; 3) Research on flipped learning and students' problem solving abilities and 4) Sources of data in the form of SINTA, DOAJ and Scopus indexed journals or proceedings. Data analysis in this research is descriptive statistical analysis with the help of the JSAP application. Data analysis in this study calculates the Effect Size (ES) value of each study and calculates the Standard Error (SE). The effect size criteria in this study can be seen in Table 1.

Table 1. Criteria for Effect Size Value

Effect Size	Kriteria *Effect Size*
-0.15 ≤ 0.15	Ignored
0.15 < ES ≤ 0.40	Small
0.40 < ES ≤ 0.75	Medium
0.75 < ES ≤ 1.10	Hight
1.10 < ES ≤ 1.45	Very Hight
1.45 > ES	Hight Influence

Sumber : (Musna et al., 2021; Zulkifli et al., 2022;Putra et al., 2023)

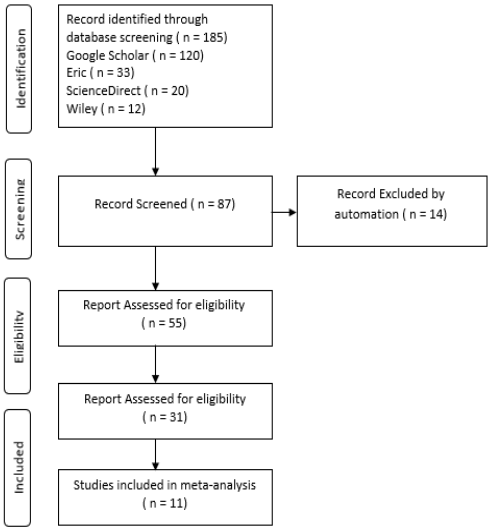

Figure 1. Study Selection Process with PRISMA

Result and Discussion

From the results of an analysis of 185 national and international journals about the effectiveness of the flipped learning model on problem solving abilities in students, only 11 journals met the inclusion criteria. Journals that met the inclusion criteria were then used as data sources in this meta-analysis, which

calculated the effect size and standard error values of each study, which can be seen in Table 2.

Table 2. Effect size and Standard Error Data Source

No	Kode Jurnal	Tahun	Effect Size	Standard Error	Kriteria
1	B1	2020	1.32	0.631	Very Hight
2	B2	2020	0.82	0.390	Hight
3	B3	2022	0.66	0.310	Medium
4	B4	2022	1.15	0.741	Very Hight
5	B5	2023	0.81	0.423	Hight
6	B6	2021	0.93	0.468	Hight
7	B7	2019	0.41	0.22	Medium
8	B8	2022	0.32	0.110	Small
9	B9	2022	0.83	0.460	Hight
10	B10	2021	0.95	0.461	Hight
11	B11	2023	1.03	0.570	Very Hight
Average effect size			**0.839**		**Hight**

Based on Table 2. Shows that the average value of effect size (ES = 0.839) with high criteria. These results explain that the Internet of Thing (IoT)-based flipped learning model can improve students' problem solving abilities. The flipped learning model helps students to be more creative and innovative in learning so as to encourage problem-solving skills in learning (Karabulut et al., 2018; Lai, 2015; Hao, 2016; Ouda & Ahmed, 2016). Research result (Prihatin & Oktaviana, 2022) states that the application of the IoT-based flipped learning model can foster problem solving abilities in students. The flipped learning model helps students more easily understand learning concepts (Juniantari et al., 2018). Furthermore, the Internet of Thing (IoT)-based flipped learning model can encourage students' digital literacy skills so that they can provide solutions in solving problems in everyday life. (Kamaruddin et al., 2022; Rusnawati, 2020; Puja et al., 2022). Next, calculate publication bias using a funnel plot which can be seen in Figure 1.

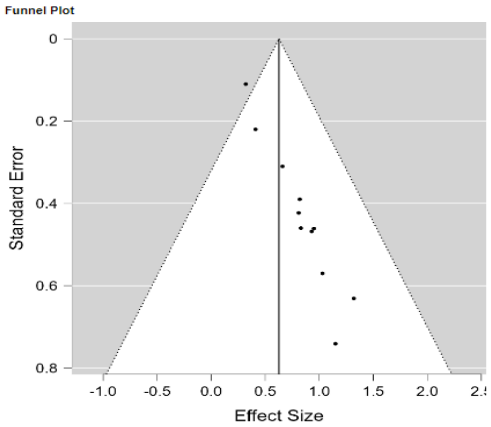

Figure 1. Funnel Plor Standar Error Hedge's

Figure 1. shows that the publication bias in the funnel plot is symmetrical on the vertical line. In addition, the distribution of effect sizes is not completely symmetrical, so the FSN value is 172, so (5.11 + 10)/k = 2.63 > 1 means that publication bias is not susceptible to publication, so a Trim and Fill test is necessary, which can be seen in Table 3.

Table 3. *Trim and Fill Test Results*

Random Effect Size					
	Omitted studies	**Point Estimate**	**Lower Limit**	**Upper limit**	**Q-Value**
Observed Value	2	0.810	0.410	1.142	82.190
Adjusted Value		0.839	0.381	1.002	152.771

Based on Table 3. Showing the results of the Trim and Fill test the observed value was 0.650 and the effect size value was 0.839 and 2 articles were omitted, a heterogeneity test was carried

out to see the heterogeneity of each study in full, can be seen in Table 4.

Table 4. Heterogeneity Test Results

Heterogenity				
Q-value	**df(Q)**	**P-Value**	**I-Squared**	**Q-Table**
31.00	10	0.000	49.156	19.953

Based on Table 4. Shows a Q-value of 31.00 with a Q-table of 19,953 meaning that the heterogeneity of the effect size affects the estimation model used, namely the random effect model. The random effect model shows the effect size of each study with a normal distribution. Then a hypothesis test was carried out to determine the effectiveness of the Internet of Thing (IoT)-based flipped learning model in improving problem solving abilities in students with the random effect model which can be seen in Table 5.

Table 5. Hypothesis Testing with the Random Effect Model

Estimation Model	n	Z	P	Effect Size	Standar Error
Random effect model	11	2.190	0.000	0.839	0.410

Based on Table 5. Shows that the p value <0.05 and the Effect Size value (ES = 0.839) means that the application of the IoT-based flipped learning model is effective in increasing students' problem solving skills compared to conventional learning. Andriyani & Suhendri (2019) states that the IoT-based flipped learning model helps students to access information without a time limit so that it supports learning activities. The application of the Internet of Things (IoT)-based flipped learning model can access learning information online which encourages students' problem-solving skills (Yulianti & Wulandari, 2021; Chrismawati et al., 2021; Imania et al., 2020; Lestari & Buton, 2021). Learning based on the Internet of Things (IoT) makes it easier for students to absorb information through certain learning platforms (Giwerc et al., 2020; Sopapradit & Piriyasurawong, 2020).

Furthermore, the results of Yunitha et al., (2021) IoT-based flipped learning can stimulate students' communication and collaboration skills in the learning process. In addition, flipped learning helps encourage interest and motivation in learning so that it encourages students to find solutions in solving problems (Zulkarnain et al., 2023; Juniantari et al., 2018). Internet of Things (IoT) helps students master learning technology quickly (Sembiring et al., 2022; Wilianto & Kurniawan, 2019). So the application of the IoT-based flipped learning model helps students develop their cognitive potential (Anggraini & Nurtamam, 2016), thereby enhancing their learning experience through technology (Jiwandono et al. 2021).

Conclusion

From this study it can be concluded that the average effect size value is 0.839 high criteria. These findings indicate that the IoT-based flipped learning model can improve students' problem solving abilities. The flipped learning model helps students to be more creative and innovative in learning. The flipped learning model helps students more quickly and easily access learning information via the internet.

Furthermore, the flipped learning model based on the Internet of Things (IoT) students become more independent, active and creative in learning

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