EDUMASPUL
JURNAL PENDIDIKAN
Vol. 7 – No. 2, year (2023), page 5073-5081
| ISSN 2548-8201 (Print) | 2580-0469) (Online) |

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

Everhard Markiano Solissa1*, Agus Triyono[2], Dharma Gyta Sari Harahap[3], Dewi Maharani Rachmaningsih[4], Novinaty Djafri[5], Asmawati[6], Tomi Apra Santosa[7]

[1]*Universitas Pattimura, Indonesia*
[2] *Politeknik Penerbangan Surabaya, Indonesia*
[3]Universitas Musamus Marauke, Indonesia
[4] *Universitas Terbuka, Indonesia*
[5] *Universitas Negeri Gorontalo, Indonesia*
[6] *IAIN Palangkaraya, Indonesia*
[7] *Akademi Teknik Adikarya, Indonesia*
* Corresponding Author. E-mail: everhardmaskiano@gmail.com

Receive: 17/07/2023	***Accepted: 15/09/2023***	***Published: 01/10/2023***

Abstrak

Tujuan penelitian ini untuk mengetahui efek size flipped classroom terhadap kemampuan berpikir kritis siswa. Jenis penelitian ini adalah meta-analisis. Sumber data berasal dari analisis 12 jurnal nasional dan internasional yang dipublikasi tahun 2018-2023. Proses pencarian sumber data melalui Google Scholar; ERIC, ScienceDirect, Wiley; ProQuest, DOAJ dan EBSCO. Penyeleksian data melalui metode PRISMA terdiri dari identification, screening, Eligibility dan Included. Temuan ini menyimpulkan bahwa flipped classroom memberikan pengaruh positif terhadap kemampuan berpikir kritis siswa dengan nilai summary effect size (r_{RE}= 0.799). Flipped classrom memberikan pengaruh yang sedang terhadap kemampuan berpikir kritis siswa disekolah

Kata Kunci: *Flipped Classroom; Berpikir Kritis; Effect Size; Meta-analysis*

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

Abstract

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 (Mutakinati &; 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), (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 studentsto 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 clasroom 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 20 20-2023; 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.

Table 1. Effect Size Criteria

Effect Size (ES)	Category
0.00 ≤ ES ≤ 0.20	Ignored
0.20 ≤ ES ≤ 0.50	Small
0.50 ≤ ES ≤ 0.80	Medium
0.80 ≤ ES ≤ 1.30	Large
ES ≥ 1.30	Very Large

Result and Discussion

Based on the process of searching data sourcesthrough 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

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

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

	Q	Df	P
Omnibus test of Model Coefficients	104.860	1	< 0.01
Test of Residual Heterogeneity	13.545	11	< 0.01

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 byISIS 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 (Tamur &; Wijaya, 2021;Yıldırım, 2022; Diah et al., 2022) The results of checking publication bias with funnel plots can be seen in figure 1.

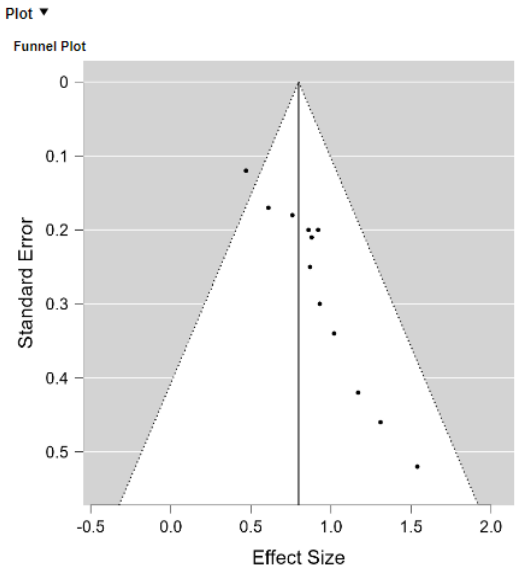

Figure 3. Funnel Plot Standard Error

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

	Z	P
Sei	3.365	0.001

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

					95 % CI	
	Estimate	Standard Error	Z	P	Lower	Upper
Intercept	0.79 9	0.078	10. 240	0.0 01	0.6 46	0.9 52

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 classrom has a positive influence on students' critical thinking skills. Flipped classrom students

are able to learn online and independently in understanding the concepts of lessons given by the teacher (Yavuz &; Ozdemir, 201; 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 clasroom 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 classrom 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 classrom 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

Daftar Pustaka

P Afzali, Z., & Izadpanah, S. (2051). The Effect of Implementing Flipped Classroom Model on Critical Thinking and Performance of Iranian EFL Learners in Learning Grammar 184 / The Effect of Implementing Flipped Classroom Model on Critical Thinking and …. *Journal of Language Horizons, Alzahra University*, *6*(11). https://doi.org/10.22051/LGHOR.2021.32997.1362

Al-fikry, I., & Syukri, M. (2018). Pengaruh Model Problem Based Learning Terhadap Kemampuan Berpikir Kritis Peserta Didik Pada Materi Kalor. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *06*(01), 17–23. https://doi.org/10.24815/jpsi.v6i1.10776

Al-zoubi, A. M. (2021). Flipped Classroom Strategy Based on Critical Thinking Skills : Helping Fresh Female Students Acquiring Derivative Concept. *International Journal of Instruction*, *14*(2), 791–810.

Arbain. (2021). MENINGKATKAN KETERAMPILAN BERPIKIR KRITIS MATEMATIKA MAHASISWA MELALUI PEMANFAATAN VIDEO PADA PEMBELAJARAN. *EDU-MAT: Jurnal Pendidikan Matematika*, *2759*, 33–41. https://doi.org/10.20527/edumat.v10i1.12439

Ariani, R. F. (2020). PENGARUH MODEL PEMBELAJARAN PROBLEM BASED LEARNING TERHADAP KEMAMPUAN BERPIKIR KRITIS SISWA SD. *Jurnal Imiah Pendidikan Dan Pembelajaran*, *4*(3), 422–432.

Ario, M., & Artikel, I. (2018). PENGARUH PEMBELAJARAN FLIPPED CLASSROOM TERHADAP HASIL INTEGRAL MATEMATIKA. *ANARGYA: Jurnal Ilmiah Pendidikan Matematika*, *1*(2), 82–88.

Asokawati, S., & Hamidah, A. (2023). Pengaruh PBL Terhadap Kemampuan Berpikir Kritis Peserta Didik Pada Materi Sistem Perkembangbiakan Tumbuhan. *BIODIK: Jurnal Ilmiah Pendidikan Biologi*, *09*(3), 1–6.

Astawa, I. B. M., Citrawathi, D. M., Sudiana, I. K., & Wulandari, I. G. A. A. M.

(2022). Jurnal Pendidikan IPA Indonesia THE EFFECT OF FLIPPED CLASSROOM BASED ON DISASTER MAP VISUALIZATION IN DISASTER MITIGATION LEARNING ON STUDENTS ' SELF-EFFICACY AND CRITICAL THINKING SKILLS. *Jurnal Pendidikan IPA Indonesia*, *11*(2), 303–313. https://doi.org/10.15294/jpii.v11i2.35308

Atwa, Z., & Bank, W. (2022). Flipped Classroom Effects on Grade 9 Students ' Critical Thinking Skills , Psychological Stress , and Academic Achievement. *International Journal of Instruction*, *15*(2), 737–750.

Borenstein, M., & Hedges, L. V. (2009). *Introduction to Meta-Analysis Introduction*.

Cahyono, B., Semarang, U. N., & Education, F. (2021). Problem-based learning supported by arguments scaffolding that affect critical thinking teacher candidates. *Cypriot Journal of Educational Sciences*, *16*(6), 2956–2969.

Cohen, L., Manion, L., Lecturer, P., Morrison, K., & Lecturer, S. (2007). *Research Methods in Education*. Routledge is an imprint of the Taylor & Francis Group, an informa business.

Diah et al. (2022). Meta-Analysis of Focusky Learning Media on Student Learning Outcomes. *INTERNATIONAL JOURNAL OF ASIAN EDUCATION*, *3*(2), 20–22. https://doi.org/10.55943/jipmukjt.v3i2.34

Elfira, I., & Santosa, T. A. (2023). Literature Study : Utilization of the PjBL Model in Science Education to Improve Creativity and Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 133–143. https://doi.org/10.29303/jppipa.v9i1.2555

Etemadfar, P., Mohammad, S., & Soozandehfar, A. (2020). An account of EFL learners ' listening comprehension and critical thinking in the flipped classroom model An account of EFL learners ' listening comprehension and critical thinking in the flipped. *Cogent Education*, *7*(1). https://doi.org/10.1080/2331186X.2020.1835150

Fatmiyati, N., & Juandi, D. (2023). EFEKTIVITAS FLIPPED CLASSROOM TERHADAP KEMAMPUAN PEMAHAMAN KONSEP DAN BERPIKIR KRITIS MATEMATIS : SYSTEMTIC LITERATURE REVIEW. *Jurnal Pembelajaran Matematika Inovatif Volume*, *6*(3), 1161–1176. https://doi.org/10.22460/jpmi.v6i3.17405

Fitriani, A. (2020). PBLPOE : A Learning Model to Enhance Students ' Critical Thinking Skills and Scientific Attitudes. *International Journal of Instruction*, *13*(2), 89–106.

Gomez-lanier, L. (2018). Building Collaboration in the Flipped Classroom : A Case Study Flipped Classroom Methods and Instrument Peer Assisted Collaborative Learning. *IJ-SoTL*, *12*(2), 1–9.

Hebebci, M. T., & Usta, E. (2022). The Effects of Integrated STEM Education Practices on Problem Solving Skills, Scientific Creativity, and Critical Thinking Dispositions. *Participatory Educational Research*, *9*(6), 358–379. https://doi.org/10.17275/per.22.143.9.6

Hidayah, R. (2023). International Journal of Educational Methodology The Influence of Teacher Efficacy on Education Quality : A Meta-Analysis. *International Journal of Educational Methodology*, *9*(2), 435–450.

Hidayati et al. (2022). The PBL vs . Digital Mind Maps Integrated PBL : Choosing Between the two with a view to Enhance Learners ' Critical Thinking

Nurkhairo Hidayati Sri Amnah. *Participatory Educational Research (PER)*, *9*(3), 330–343.

Inayah, S., Septian, A., & Komala, E. (2021). Efektivitas Model Flipped Classroom Berbasis Problem Based Learning dalam Meningkatkan Kemampuan Berpikir Kritis. *Wacana Akademika: Majalah Ilmiah Kependidikan*, *5*(November), 138–144.

Kurniahtunnisa et al. (2016). PENGARUH MODEL PROBLEM BASED LEARNING TERHADAP KEMAMPUAN BERPIKIR KRITIS SISWA MATERI SISTEM EKSKRESI. *Journal of Biology Education*, *5*(3), 310–318.

Kurniasih, E. D., & Nofiana, M. (2023). *Pengaruh Strategi Pembelajaran Flipped Classroom yang Diintegrasikan dengan Model Discovery Learning Terhadap Kemampuan Berpikir Tingkat Tinggi Siswa*. *10*(2), 85–92. https://doi.org/10.31629/kiprah.v10i2.5047

Listiqowati, I. et al. (2022). The Impact of Project-Based Flipped Classroom (PjBFC) on Critical Thinking Skills. *International Journal of Instruction*, *15*(3), 853–868.

Ma, Y. (2023). Heliyon Exploration of flipped classroom approach to enhance critical thinking skills. *Heliyon*, *9*(11), e20895. https://doi.org/10.1016/j.heliyon.2023.e20895

Made Juniantari et al. (2018). PENGARUH PENDEKATAN FLIPPED CLASSROOM TERHADAP PEMAHAMAN KONSEP MATEMATIKA SISWA SMA. *Journal of Education Technology*, *2*(4), 197–204.

Musdi, E. (2022). Effectiveness of Mathematics Learning Devices Based on Flipped Classroom to Improve Mathematical Critical Thinking Ability Students. *I. J. Education and Management Engineering*, *12*(3), 41–46. https://doi.org/10.5815/ijeme.2022.03.05

Mutakinati, L., & Anwari, I. (2018). ANALYSIS OF STUDENTS ' CRITICAL THINKING SKILL OF MIDDLE SCHOOL THROUGH STEM EDUCATION PROJECT-BASED LEARNING. *Jurnal Pendidikan IPA Indonesia*, *7*(1), 54–65. https://doi.org/10.15294/jpii.v7i1.10495

N. K. Rapi*1, I. W. Suastra2, P. Widiarini3, I. W. W. (2022). Jurnal Pendidikan IPA Indonesia THE INFLUENCE OF FLIPPED CLASSROOM-BASED PROJECT ASSESSMENT ON CONCEPT UNDERSTANDING. *Jurnal Pendidikan IPA Indonesia*, *11*(3), 351–362. https://doi.org/10.15294/jpii.v11i3.38275

Noverli, M., & Cahya, E. (2021). Analysis of Student's Critical Thinking Ability Based on Gender. *Malikussaleh Journal of Mathematics Learning (MJML)*, *4*(1), 23–27. https://doi.org/10.4108/eai.19-12-2020.2309168

Nur Atikah1, Wiwit Akriani2, D. I. (2022). Pengaruh Metode Pembelajaran Flipped Clas Room Terhadap Pemahaman Konsep Matematika Mahasiswa. *Jurnal Pendidikan Islam Al-Affan*, *3*(1), 12–18.

Nurfadillah, L., Anwar, C., & Firdos, H. (2020). Pengaruh Model Pembelajaran Flipped Classroom Terhadap Kemampuan Berpikir Kritis Matematis Siswa. *WILANGAN*, *10*(10), 215–225.

Nurtamam, M. E., Santosa, T. A., Aprilisia, S., Rahman, A., & Suharyat, Y. (2023). Meta-analysis : The Effectiveness of Iot-Based Flipped Learning to Improve Students ' Problem Solving Abilities. *Edumaspul :Jurnal Pendidikan*, *7*(1), 1491–1501.

Occe Luciana1*, Tomi Apra Santosa2, Agus Rofi'i3, Taqiyuddin4, B. N. (2023). Meta-analysis: The effect of problem-

based learning on students' critical thinking skills. *Edumaspul: Jurnal Pendidikan*, *7*(2), 2058–2068. https://doi.org/10.1063/1.5139796

Oktarina, K., Santosa, T. A., Razak, A., & Ahda, Y. (2021). Meta-Analysis : The Effectiveness of Using Blended Learning on Multiple Intelligences and Student Character Education during the Covid-19 Period. *IJECA International Journal of Education & Curriculum Application*, *4*(3), 184–192.

Öztop, F. (2023). A Meta-Analysis of the Effectiveness of Digital Technology-Assisted STEM Education. *Journal of Science Learning*, *6*(November 2022), 136–142. https://doi.org/10.17509/jsl.v6i2.52316

Pebriyani, E. P. (2020). Pengaruh Model Pembelajaran Problem Based Learning (PBL) Terhadap Kemampuan Berpikir Kritis dan Hasil Belajar Peserta Didik Pada Mata Pelajaran Kearsipan Kelas X OTKP di SMK Negeri 1 Sooko Mojokerto. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, *8*(5), 47–55.

Putra, M., Rahman, A., Suhayat, Y., Santosa, T. A., & Putra, R. (2023). The Effect of STEM-Based REACT Model on Students ' Critical Thinking Skills : A Meta-Analysis Study. *LITERACY : International Scientific Journals Of Social, Education and Humaniora*, *2*(1), 207–217.

Putri, Y., Cahyono, E., & Indriyanti, D. R. (2021). Implementation of Flipped Classroom Learning Model to Increase Student's Critical Thinking Ability. *Journal of Innovative Science Education*, *10*(2), 143–151. https://journal.unnes.ac.id/sju/index.php/jise/article/view/41408

Rahmatan, H., Artika, W., Ulfa, A., Pada, T., & Huda, I. (2022). The Effect of Applying Blended Learning Strategies Flipped Classroom Model on Students ' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 86–93. https://doi.org/10.29303/jppipa.v8i1.1186

Rijal, M., Mastuti, A. G., Safitri, D., Bachtiar, S., & Samputri, S. (2021). Differences in learners ' critical thinking by ability level in conventional , NHT , PBL , and integrated NHT-PBL classrooms. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(4), 1133–1139. https://doi.org/10.11591/ijere.v10i4.21408

Rusilowati, A. (2020). Improving Students' Critical Thinking Skills through the STEM Digital Book. *Jise*, *9*(2), 237–243. http://journal.unnes.ac.id/sju/index.php/jise

Sahara, R., Sofya, R., Ekonomi, J. P., Ekonomi, F., & Padang, U. N. (2020). *Pengaruh Penerapan Model Flipped Learning dan Motivasi Belajar Terhadap Hasil Belajar Siswa*. *3*(3), 419–431.

Santosa, T. A., Razak, A., Arsih, F., & Sepriyani, E. M. (2021). Meta-Analysis : Science Learning Based on Local Wisdom Against Preserving School Environments During the Covid-19 Pandemic. *Journal of Biology Education*, *10*(2), 244–251.

Shahani, S., Orcid, A. C., Heidari, H., & Orcid, T. (2022). IMPACT OF CRITICAL THINKING INSTRUCTION THROUGH FLIPPED TEACHING ON IRANIAN EFL LEARNERS ' LISTENING COMPREHENSION. *Turkish Online Journal of Distance Education-TOJDE*, *23*(2), 236–251.

Sofianora, A., Suharyat, Y., & Santosa, T. A. (2023). *PENGARUH PROFESIONALITAS GURU MATEMATIKA DALAM MENINGKATKAN KOMPETENSI SISWA ERA REVOLUSI INDUSTRI 5 . 0 DI INDONESIA : SEBUAH META-ANALISIS*.

10(2).

Suci, S., Siburian, J., & Yelianti, U. (2021). IMPLEMENTASI MODEL PROJECT BASED LEARNING BERBASIS FLIPPED CLASSROOM. *Edu Sains*, *10*(2), 2022.

Suharyat, Y., Ichsan, Satria, E., Santosa, T. A., & Amalia, K. N. (2022). Meta-Analisis Penerapan Model Pembelajaran Problem Based Learning Untuk Meningkatkan Ketrampilan Abad-21 Siswa Dalam Pembelajaran IPA. *Jurnal Pendidikan Dan Konseling*, *4*(5), 5081–5088.

Suharyat, Y., Santosa, T. A., Yulianti, S., & Amalia, K. N. (2022). *International Journal of Education and Literature (IJEL) Literature Review : TPACK-Based Science Learning in Supporting Teacher Quality in Indonesia*. 2014–2020.

Sulisworo, D., & Sari, L. (2019). Comparing the Effectiveness of Flipped Classroom and Online Learning on Improving Critical Thinking Skills in High School Physics Learning. *Advances in Social Science, Education and Humanities Research, 349*(Iccd), 645–649.

Suryono, W., Haryanto, B. B., Santosa, T. A., Suharyat, Y., & Sappaile, B. I. (2023). The Effect of The Blended Learning Model on Student Critical Thinking Skill : Meta-analysis. *Edumaspul - Jurnal Pendidikan*, *7*(1), 1386–1397.

Suswandi, I. (2018). PENGARUH MODEL PEMBELAJARAN GROUP INVESTIGATION FLIPPED CLASSROOM TERHADAP KEMAMPUAN BERPIKIR. *JPPF*, *8*(1), 80–100.

Tamur, M., & Wijaya, T. T. (2021). Using Problem-Based Learning to Enhance Mathematical Abilities of Primary School Students : A Systematic Review and Meta-Analysis. *JTAM (Jurnal Teori Dan Aplikasi Matematika)*, *5*(1), 144–161.

Taşdemir, F. (2022). Examination of the Effect of Stem Education on Academic Achievement: A Meta-Analysis Study. *Education Quarterly Reviews*, *5*(2), 282–298. https://doi.org/10.31014/aior.1993.05.02.489

Utomo, W., Suryono, W., Santosa, T. A., & Agustina, I. (2023). The Effect of STEAM-Based Hybrid Based Learning Model on Students ' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 742–750. https://doi.org/10.29303/jppipa.v9i9.5147

V S Andrini1, H Pratama2, and T. W. M. (2019). *The effect of flipped classroom and project based learning model on student ' s critical thinking ability The effect of flipped classroom and project based learning model on s tudent ' s critical thinking ability*. https://doi.org/10.1088/1742-6596/1171/1/012010

Wahyuni, A. &. (2021). The Effect of Concept Attainment Model on Mathematical Critical Thinking Ability. *International Journal of Instruction*, *14*(1), 727–742.

Walidah, Z., Wijayanti, R., & Affaf, M. (2020). Pengaruh Model Pembelajaran Flipped Classroom (FC) terhadap Hasil Belajar The Effect of Learning Model Flipped Classroom (FC) on Learning Outcomes. *Edumatica |Jurnal Pendidikan Matematika*, *10*(September).

Widodo, W. (2022). Online Flipped Classroom: Developing Postgraduate Science Education Students' Critical Thinking Skills. *Journal of Science Learning*, *5*(3), 469–477. https://doi.org/10.17509/jsl.v5i3.43107

Widyasari, S. F., Masykur, R., & Sugiharta, I. (2021). FLIPPED CLASSROOM : PENINGKATAN KEMAMPUAN BERPIKIR KRITIS MATEMATIS DAN

MOTIVASI BELAJAR PESERTA DIDIK. *JOMES*, *4*(1), 15–22.

Wiratama Darmawan, Dedi Kuswandi, H. P. (2020). Pengaruh Blended Learing Berbasis Flipped Classroom pada Mata Pelajaran Prakarya Terhadap Hasil Belajar Siswa Kelas X SMK. *Edcomtech*, *5*(2), 170–179.

Yavuz, F., & Ozdemir, S. (2019). Flipped classroom approach in efl context: Some associated factors. *World Journal on Educational Technology: Current Issues*, *11*(4), 238–244. https://doi.org/10.18844/wjet.v11i4.4296

Yıldırım, E. (2022). The Effect of Drama Method on Academic Achievement and Attitude : A Comparative Meta-Analysis and Meta- Synthesis To cite this article : Yildirim , E . (2022). The effect of drama method on academic achievement and attitude : A The Effect of Drama Metho. *International Journal of Research in Education and Science 2022, 8*(1), 18–49.

Zulyusri1*, Tomi Apra Santosa1, 2, Festiyed1, Yerimadesi1, Yohandri1, Abdul Razak1, S. (2023). Effectiveness of STEM Learning Based on Design Thiking in Improving Critical Thinking Skills in Science Learning : A. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 112–119. https://doi.org/10.29303/jppipa.v9i6.3709