

Systematic Literature Review: The Role of the Flipped Classroom in Developing Student Independence in Learning Mathematics

Dhea Hafidzah¹, Lailatul Jannah², Syaharuddin³, Vera Mandailina⁴, Abdillah⁵
¹²³⁴⁵Departement of Mathematics, Universitas Muhammadiyah Mataram, Indonesia
Dheahafidzah896@gmail.com, lailatuljannah.ummat@gmail.com,
syaharuddin.ntb@gmail.com, vrmndailina@gmail.com,
abdillahahmad24041983@gmail.com

Abstrak

Penelitian ini bertujuan mengkaji peran Flipped Classroom (FC) dalam meningkatkan kemandirian belajar siswa pada pembelajaran matematika melalui metode Systematic Literature Review (SLR). Literatur dikumpulkan dari data dasar Scopus, DOAJ, dan Google Scholar dengan batasan publikasi antara tahun 2015 hingga 2025. Temuan penelitian menunjukkan bahwa FC lebih unggul dibandingkan pendekatan konvensional dalam mendorong kemandirian belajar, terutama pada aspek pengaturan diri, otonomi, motivasi intrinsik, kemampuan berpikir kritis, dan keterampilan pemecahan masalah. Selain itu, penerapan FC turut memperkuat prinsip pembelajaran konstruktivis dan kolaboratif, serta menyelaraskan dengan kebutuhan pendidikan abad ke-21 yang mendorong pembelajaran aktif, reflektif, dan berbasis teknologi. Kendati demikian, penerapan FC masih menghadapi kendala, meliputi keterbatasan sarana teknologi, kesiapan pendidik, resistensi siswa terhadap inovasi pembelajaran, serta kebutuhan akan pengembangan profesional berkelanjutan bagi guru. Secara keseluruhan, FC dapat dipandang sebagai strategi pembelajaran inovatif yang tidak hanya berkontribusi terhadap peningkatan kemampuan matematika siswa, tetapi juga berperan dalam memperkuat kemandirian belajar sebagai bagian dari pencapaian tujuan pendidikan jangka panjang.

Kata Kunci: Flipped Classroom, kemandirian belajar, matematika, SLR, pendidikan abad ke-21.

Abstract

This study aims to examine the role of the Flipped Classroom (FC) in improving student learning independence in mathematics learning through the Systematic Literature Review (SLR) method. Literature was collected from Scopus, DOAJ, and Google Scholar with publications between 2015 and 2025. The findings show that FC is superior to conventional approaches in encouraging independent learning, especially in terms of self-regulation, autonomy, intrinsic motivation, critical thinking skills, and problem-solving skills. In addition, the application of FC also reinforces the principles of constructivist and collaborative learning and aligns with the needs of 21st-century education, which encourages active, reflective, and technology-based learning. However, the implementation of FC still faces obstacles, including limited technological resources, educator readiness, student resistance to learning innovations, and the need for continuous professional development for teachers. Overall, FC can be viewed as an innovative learning strategy that not only contributes to improving students' mathematical abilities but also plays a role in strengthening independent learning as part of achieving long-term educational goals.

Keywords: Flipped Classroom, independent learning, mathematics, SLR, 21st century education

Pendahuluan

Mathematics is an essential subject in the education curriculum because it contributes significantly to the development of students' critical, logical, analytical, and systematic thinking skills (Ramdhani 2024). However, the reality in the field shows that most students still face obstacles in independent learning, so they rely more on teacher guidance and play a passive role in learning activities (Mita Tri Wahyuni et al., 2025). This situation has implications for the low level of initiative, autonomy, and skills of students in designing and managing independent learning strategies (Ilmaknun & Ulfah, 2023). Thus, there is an urgency to foster independent learning in mathematics education, not only to strengthen students' conceptual understanding but also to equip them with lifelong learning skills relevant to the needs of 21st-century education (Wahyu Purwandari et al., 2024).

The demands of education in the 21st century require students to have lifelong learning skills, independence, and adequate digital literacy in order to adapt to increasingly complex global dynamics. In this context, independent learning occupies a crucial position because it is closely related to intrinsic motivation, discipline, and long-term academic success. Independent learners are generally able to manage their learning process optimally, from the planning stage to monitoring and evaluating learning outcomes (Zhu & Doo, 2022). However, traditional teacher-centered learning patterns often do not support the development of independent learning, as students are mostly positioned as passive recipients of information. Therefore, it is necessary to implement innovative learning strategies that can increase student active participation while fostering continuous learning autonomy (Wahidin, 2025).

Advances in technology in the field of education have led to the emergence of various innovative learning strategies that are designed to be more responsive to the needs of students (A. T. Ananda et al., 2025). In its development, there has been a paradigm shift from a teacher-centered learning model to an approach that places students at the center of learning activities (student-centered learning) (Kepno et al., 2025). This shift requires the active involvement of students so that they are not merely recipients of information, but rather play a role as subjects who construct knowledge independently (Muhamad Syafiqul Humam & Muh. Hanif, 2025). One form of innovation that has been widely applied and received widespread attention is the Flipped Classroom, an approach that utilizes technology to create a more flexible, participatory, and interactive learning experience (Yusuf, 2025).

The Flipped Classroom model is characterized by student engagement with learning materials outside of class hours, for example through the use of instructional videos and digital modules, while class time is used for collaborative activities. This approach is highly relevant in mathematics learning because it encourages active learning, where students are directly involved in problem-solving activities, discussions, and projects that support conceptual understanding and mastery of the material through intensive practice (Liu & Nan, 2024 & Nikolova, 2023). Various studies show that the effectiveness of this model can vary, but successful implementations generally integrate structured classroom activities, student collaboration, and feedback from teachers, which play an

important role in improving academic achievement in mathematics (Fung et al., 2021). In addition, the Flipped Classroom also emphasizes student-centered learning, thereby encouraging more in-depth discussions and the development of higher-order thinking skills, which ultimately prepare students to become competent problem solvers (Afriantoni et al., 2025).

The Flipped Classroom (FC) model has been proven to have significant potential in improving learning outcomes, motivation, and student engagement, especially in mathematics learning. A number of studies show that FC can improve cognitive understanding, mathematical reasoning skills, and learning independence at various levels of education, from elementary school to college (Jumini, 2022). For example, a systematic review revealed that FC can encourage self-regulation, strengthen collaborative work, and foster a positive attitude towards mathematics learning (Fernández-Martín et al., 2020). In addition, other studies report that this model is 65% effective in developing student learning independence, especially in terms of goal setting and the application of more focused learning strategies (Carrillo-Yalán et al., 2024). However, despite empirical evidence supporting the benefits of FC, studies on its specific impact on the development of learning independence in mathematics are still relatively limited, requiring further research to obtain a more comprehensive picture of its effectiveness in this area (Kostaris et al., 2017).

Research on the application of the Flipped Classroom (FC) in mathematics learning generally focuses on improving academic outcomes, while studies on its impact on learning independence are still limited. Several studies indicate that FC can improve academic achievement, motivation, and student engagement, but its effectiveness in supporting independent learning has not been studied in depth (Ishartono et al., 2023 & Fung et al., 2021). As a model that combines independent learning through pre-class materials with collaborative activities in class, FC has great potential to foster autonomy and self-regulation in students (González-valiente, 2023). However, variations in implementation and the limitations of longitudinal studies remain obstacles to understanding the contribution of FC to independent learning. Therefore, a systematic review is needed to obtain a more comprehensive picture of the role of FC in developing independent learning in mathematics (Fernández-Martín et al., 2020).

Various studies show that the Flipped Classroom (FC) has a positive contribution to academic achievement, motivation, and student engagement, and even has the potential to encourage the development of self-regulation in mathematics learning. However, studies that specifically examine the role of FC in fostering independent learning are still relatively limited, fragmented, and do not provide a complete understanding due to variations in implementation and the limitations of longitudinal studies. This situation reflects a gap in research that needs to be bridged through a Systematic Literature Review, with the aim of mapping the available empirical evidence, evaluating the consistency of findings, and formulating theoretical and practical implications regarding the effectiveness of FC in developing student learning independence in mathematics learning.

Metode Penelitian

This study uses a qualitative approach through the Systematic Literature Review (SLR) method to examine the role of the Flipped Classroom in encouraging student independence in learning mathematics. The main objective is to identify, review, and synthesize relevant empirical findings, while mapping the contributions and theoretical and practical implications of applying this model. The literature search was conducted systematically through a number of reputable academic databases, including Scopus, DOAJ, and Google Scholar, using keywords such as “Flipped Classroom,” “mathematics education,” “self-regulated learning,” “independent learning,” and “learning autonomy.” This study is limited to articles published between 2015 and 2025 to ensure relevance to the latest research developments.

The inclusion criteria were set for articles in English and Indonesian published in reputable journals, discussing the application of the Flipped Classroom in the context of mathematics learning, and highlighting the aspects of independent learning, self-regulation, or learning autonomy. Conversely, exclusion criteria include non-peer-reviewed publications such as reports, proceedings, and grey literature, articles that do not examine the relationship between the Flipped Classroom and independent learning, and duplicate publications between databases. Literature selection was carried out in three stages, namely screening of titles and abstracts, full review of articles that.

Hasil Penelitian dan Pembahasan

Hasil

Based on a systematic review of the literature on the implementation of the Flipped Classroom (FC) model in mathematics learning, five main areas of focus can be identified. First, the effectiveness of FC in improving mathematics learning abilities, which is generally studied through experimental and quasi-experimental approaches. Second, the contribution of FC to student learning independence, particularly in relation to self-regulation, autonomy, and intrinsic motivation. Third, the role of FC in developing critical thinking skills, mathematical reasoning, and problem-solving abilities. Fourth, the use of technology as a key supporting element, particularly through the use of video media and digital platforms that encourage collaboration in the learning process. Fifth, the challenges and determining factors for the successful implementation of FC, which include student and teacher readiness, the availability of technological infrastructure, and appropriate pedagogical strategies. To provide a clearer picture, a synthesis of the research results is presented in the following table.

Table 1. Synthesis of Research Results on the Flipped Classroom in Mathematics Learning

No	Field/Focus	Author Name	Research Variables
1	The effectiveness of FC on mathematics learning outcomes	Kostaris et al. (2017), Tanjung (2020), Mirlanda et al. (2020), Mulyati et al. (2022), Montenegro Muñoz et al. (2024)	FC has been proven to be more effective than traditional learning, improving conceptual understanding, cognitive achievement, and problem solving (e.g., in algebra and the Pythagorean theorem).
2	Self-regulated learning & student autonomy	Yanuarto (2018), Widodo et al. (2021), Latifah & Rindaningsih (2023), Fatimah et al. (2023), Setiyawan et al. (2024), Ananda et al. (2024), Wijayanto et al. (2022)	FC enhances autonomy, self-regulation, intrinsic motivation, and learning responsibility at the elementary, secondary, and higher education levels.
3	Strengthening critical thinking and mathematical reasoning skills	Mirlanda et al. (2019), Carrillo-Yalán et al. (2024), Erita (2023), Khardita et al. (2023), Fernández-Martín et al. (2020), Sulistiowati (2025)	FC supports the development of critical thinking, argumentation, problem-solving strategies, and mathematical reasoning.
4	The role of technology in supporting FC	Fianingrum et al. (2022), Fernández-Martín et al. (2020), Yanuarto (2018), (Wijayanto (2024)	Technology, especially instructional videos, has become the primary medium enabling learning, collaboration, and the use of ICT in mathematics education.
5	Challenges and success factors in FC implementation	Wahyuni et al. (2024), Eviota & Liangco (2020), Hariyasasti (2025), Radza (2023), Fajri et al. (2021), Husnawati (2023), Lo & Hew (2021), Muir (2019), Ishartono et al. (2023)	Success is determined by the readiness of students and teachers, pedagogical strategies, and technological support. Challenges include infrastructure limitations, teacher time management, student/teacher resistance, and the need for ongoing professional development.

Based on Table 1, it can be understood that research on the application of the Flipped Classroom (FC) in mathematics learning provides comprehensive contributions, both in theoretical and practical aspects. Each identified area shows interrelated and mutually supportive connections, where the effectiveness of FC in

improving academic outcomes is closely related to the empowerment of independent learning, critical thinking skills, and optimal use of technology. On the other hand, various implementation challenges show that the success of FC is highly determined by infrastructure readiness, teacher pedagogical competence, and active student involvement. Therefore, future research should emphasize the integration of these cross-disciplinary areas so that FC is not only seen as an alternative strategy but also as a relevant pedagogical approach in responding to the demands of mathematics education in the 21st century.

Pembahasan

1. Application of the Flipped Classroom Model in the Context of Mathematics Learning in Various Levels of Education

The Flipped Classroom (FC) model shows significant potential in improving the quality of mathematics learning at various levels, from K-12 to higher education. At the tertiary level, the success of FC implementation is greatly influenced by technological readiness, lecturer involvement, and active student participation, thus requiring continuous evaluation and institutional support (Wahyuni et al., 2024). Meanwhile, at the K-12 level, the application of FC has been proven to improve cognitive outcomes, learning motivation, and the effective use of learning time, especially in subjects such as algebra (Kostaris et al., 2017). Furthermore, FC also plays a role in accommodating the diversity of students' learning needs, reducing the gap in understanding between students with different academic abilities, and creating a more inclusive learning environment (Technique, 2025). In general, FC not only encourages active learning and learning independence, but also serves as a viable alternative to traditional and blended learning approaches, especially in challenging situations such as the pandemic (Soussi, 2024).

Research on the application of the Flipped Classroom model in mathematics learning at various levels of education shows significant effectiveness in improving student learning outcomes. A systematic literature review reveals that this model is able to strengthen conceptual understanding, critical thinking skills, and mathematical problem-solving abilities. In its implementation, video-based learning materials are the most widely used technological medium (Fianingrum et al., 2022). Experimental research results show that the Flipped Classroom is significantly more effective in improving conceptual understanding and mathematical problem-solving skills than traditional direct learning methods (Tanjung, 2020). Furthermore, this model has also been proven to contribute to improving mathematical reasoning abilities in various cognitive styles, both field-independent and field-dependent, both of which show better development compared to conventional scientific learning approaches (Mirlanda et al., 2020). The success of the Flipped Classroom implementation is influenced by several factors, including student readiness, access to technology, and effective teacher implementation strategies (Eviota & Liangco, 2020).

The results of the study show that the Flipped Classroom (FC) not only functions as an alternative method, but also as a learning strategy that can reconstruct patterns of interaction in the classroom. At the K-12 level, the application of FC provides space for students to learn at their own pace and

according to their own learning styles through pre-class materials, thereby minimizing differences in the level of understanding among students. Meanwhile, at the higher education level, this model encourages students to be more active in developing independent thinking and collaborative skills in solving complex mathematical problems. However, the effectiveness of FC is greatly influenced by a number of important factors, including student readiness, availability and accessibility of technology, quality of pre-class materials, and the competence of teachers or lecturers in designing meaningful face-to-face activities. A critical review of the literature also shows that most existing studies are still limited to the short term with quasi-experimental designs, so they do not yet provide a comprehensive picture of the long-term impact of FC on learning independence. In addition, infrastructure constraints in some educational contexts remain a challenge that can hinder the equitable distribution of the benefits of implementing this model.

2. Aspects of Independent Learning Developed Through the Flipped Classroom in Mathematics Education

The Flipped Classroom (FC) approach has been proven to play an important role in increasing student independence in learning mathematics, especially through encouraging active engagement and independent learning. A number of studies reveal that FC supports the formation of learning autonomy by providing opportunities for students to master basic concepts independently outside the classroom, thereby encouraging them to seek additional information and apply various problem-solving strategies (Carrillo-Yalán et al., 2024). The application of this method has also been shown to strengthen mathematical reasoning abilities, argumentation skills, motivation, and students' capacity to set personal learning goals (Erita, 2023; Khardita et al., 2023). Furthermore, the integration of technology in FC creates a more flexible learning environment, which not only supports self-regulation but also cooperation among students, thereby improving academic achievement and positive attitudes toward mathematics (Fernández-Martín et al., 2020). Thus, FC can be seen as an effective pedagogical strategy in fostering independence in learning mathematics at various levels of education (Jumini, 2022).

Various studies show that the implementation of the Flipped Classroom (FC) model contributes significantly to increasing independence in learning mathematics through strengthening autonomy, student engagement with the material before face-to-face learning, and optimization of technology. Yanuarto, (2018) emphasizes that FC not only improves the quality of learning but also strengthens student independence. In line with this, Latifah & Rindaningsih, (2023) reported that 51.8% of elementary school students experienced an increase in learning independence after the implementation of FC, with most of them able to adapt to this approach. Widodo et al. (2021) also found that elementary school students could demonstrate independent learning abilities in understanding mathematical concepts and solving problems through the implementation of online-based FC. Meanwhile, a systematic review (Sulistiowati, 2025) confirmed the effectiveness of FC in strengthening conceptual understanding, critical thinking skills, and mathematical problem solving. Determining factors for the successful implementation of FC include student readiness, access to technology,

and teacher strategies, so that this model can be seen as an innovative approach that is relevant to mathematics education.

Various studies show that the Flipped Classroom (FC) model can develop various aspects of independent learning, including autonomy in managing the learning process, self-regulation skills in managing time and strategies, intrinsic motivation through active engagement with pre-class materials, and problem-solving, reasoning, and mathematical argumentation skills that are strengthened through collaborative discussion. Although empirical findings consistently show the effectiveness of FC, most studies are still limited to short-term designs, accompanied by challenges in the form of technological readiness, device availability, and teacher competence in implementation. The level of education is also a factor, with elementary school students requiring more intensive assistance than university students. Nevertheless, the consistency of research results in various contexts shows that FC has great potential in increasing learning independence, especially when supported by systematic learning planning and adequate supporting facilities.

3. The Effectiveness of the Flipped Classroom in Improving Student Learning Independence Compared to Traditional Learning Models

The effectiveness of the Flipped Classroom model in improving student learning independence compared to traditional learning methods has been proven through various studies. This approach significantly encourages the formation of learning autonomy by emphasizing independent learning and the development of critical thinking skills. Through engagement with learning materials in the form of recordings or other sources outside the classroom, students can use face-to-face time for interactive and collaborative activities that deepen understanding and increase participation (Montenegro Muñoz et al., 2020). Other findings show that this model not only contributes to improved academic achievement but also fosters a sense of responsibility for the learning process, as students are required to manage their time and resources independently (Setiyawan et al., 2024; Fatimah et al., 2023). Further quantitative analysis reveals that students in flipped classrooms demonstrate higher levels of learning independence and better academic achievement compared to traditional learning (Mulyati et al., 2022). Overall, FC can be seen as a superior approach to fostering student learning independence.

A number of studies confirm that the Flipped Classroom (FC) model is more effective in increasing learning independence than traditional learning. Ananda et al. (2024), through a systematic literature review, found that FC has a positive impact on learning independence through two stages of learning, namely the use of technology to study material outside the classroom and discussion activities and interactive activities in the classroom. The results of a quasi-experiment conducted by Mirlanda et al. (2019) show that the increase in learning independence in classes using the FC approach is higher than in control classes using the scientific model, both for students with field-dependent and field-independent cognitive styles. The effectiveness of FC was also confirmed by Z. Wijayanto et al. (2022) who proved that there was a significant increase in self-regulated learning in mathematics ($Sig = 0.044 < 0.05$).

The Flipped Classroom (FC) model has proven effective in enhancing students' learning independence, particularly in aspects such as autonomy in managing learning strategies, self-regulation in managing time and resources, and intrinsic motivation to actively engage in the learning process. By shifting the acquisition of basic concepts outside the classroom through videos or online materials, FC allows face-to-face sessions to focus on discussions, problem-solving, and concept reinforcement. This approach encourages students to take greater responsibility for their own learning compared to traditional teacher-centered instruction. However, the effectiveness of FC is not absolute, as it is highly influenced by contextual factors such as students' readiness, the availability of technological resources, and teachers' competence in designing meaningful learning experiences. Furthermore, most existing studies are limited to short-term observations, leaving the long-term impact on the development of learning independence not yet fully illustrated. Differences in educational levels also play a role, as elementary students require more intensive guidance than university students, thereby demanding adaptive strategies tailored to learners' characteristics in the implementation of FC.

4. Challenges in Implementing the Flipped Classroom to Foster Students' Learning Independence

The implementation of the Flipped Classroom (FC) model is not without challenges that may hinder the development of students' learning independence. One of the main obstacles is technological limitations, such as inadequate ICT infrastructure and lack of technical support, which can reduce the effectiveness of interactions between students and educators with the required digital tools (Hariyasasti, 2025). In addition, time management issues also arise, as educators are required to provide engaging and high-quality pre-class materials, while students often struggle to manage self-directed learning and exhibit low motivation to study materials outside the classroom (Radza, 2023). Another challenge is the resistance to non-traditional teaching methods from both teachers and students, as well as the need for continuous professional development to ensure that teachers possess sufficient skills to implement this approach effectively (Fajri et al., 2021). Nevertheless, various studies indicate that if these barriers are properly addressed through institutional support, the implementation of FC has the potential to enhance students' autonomy as well as their academic performance (Husnawati, 2023).

The main challenges in implementing the Flipped Classroom (FC) to foster students' learning independence are not only related to technological limitations, such as infrastructure and technical support, but also to teachers' pedagogical readiness as well as students' motivation and self-regulation. Technological barriers often restrict access to pre-class materials that serve as the foundation for learning activities, while low motivation and limited self-directed learning skills make it difficult for some students to take full advantage of the opportunities offered by FC. Furthermore, the paradigm shift from teacher-centered to student-centered learning creates a gap between the ideal design and classroom reality, particularly in contexts with limited resources. Nevertheless, various studies emphasize that these challenges can be mitigated through institutional support, teacher competency enhancement, and appropriate motivational strategies,

thereby allowing FC to remain a potentially effective learning model for fostering student autonomy.

5. Implications of Research Findings on the Flipped Classroom for the Development of Learning Theory and Mathematics Education Practice

Research findings on the implementation of the Flipped Classroom (FC) model demonstrate a significant impact on the development of learning theory and mathematics education practice, particularly through enhancing active engagement and providing more personalized learning experiences. Several studies reveal that this model strengthens students' behavioral, emotional, and cognitive engagement, leading to improved conceptual understanding and greater satisfaction in learning mathematics (Lo & Hew, 2021). This pedagogical approach also marks a shift from traditional instructional methods toward interactive learning environments, where students engage more in problem-solving activities in the classroom, resulting in deeper understanding (Muir, 2019; Kiem & Keodavan, 2024). Moreover, the literature highlights the importance of further research, including longitudinal studies, to explore implementation challenges and the long-term effectiveness of this model (Ishartono et al., 2023). Overall, the Flipped Classroom not only reconstructs instructional practices but also enriches the development of educational theory by emphasizing student agency and collaborative learning within the context of mathematics education.

Studies on the implementation of the Flipped Classroom in mathematics education have shown positive contributions to both theoretical and practical developments in the field. Kotliņev et al. (2023) designed a learning model based on the ADDIE framework, which was found to be valid (score 3.64), practical (84.48% positive student responses), and effective, with 84% of students achieving the minimum mastery criteria (KKM) on the Pythagorean theorem topic. (Pratiwi, 2022) through an experimental study, demonstrated that the Flipped Classroom resulted in better mathematics learning outcomes compared to conventional methods, particularly during the Covid-19 pandemic. Yanuarto, (2018) emphasized that this model plays a crucial role in enhancing students' learning independence while optimizing the use of technology in mathematics education. Meanwhile, Wijayanto, (2024) through a theoretical review, concluded that the Flipped Classroom can be applied across various educational levels, as its procedural steps effectively support mathematics learning both inside and outside the classroom through the integration of technological tools.

The Flipped Classroom model holds great potential in driving a paradigm shift in mathematics learning, as it not only emphasizes the delivery of knowledge but also promotes active student engagement, the development of learning independence, and the use of technology as a supportive tool. This approach aligns with the principles of constructivism, which position students as active participants in the learning process while strengthening their self-regulation skills. Nevertheless, its implementation requires further in-depth investigation to assess long-term effectiveness and to address various challenges, such as technological infrastructure limitations, teacher readiness, and student motivation. Therefore, the success of this model's implementation largely depends on adequate learning context support and institutional policy frameworks.

As an effort to provide a more comprehensive understanding of the research findings, a concept map diagram is presented to summarize the key terms and research variables related to the implementation of the Flipped Classroom in mathematics learning. This diagram serves to illustrate the interrelationships among variables, including learning effectiveness, learning independence, cognitive and affective aspects, supporting factors, implementation challenges, and the resulting theoretical contributions.



Based on Figure 1, the implementation of the Flipped Classroom (FC) in mathematics learning is shown to be more effective than traditional models, particularly in improving learning outcomes, conceptual understanding, problem-solving skills, reasoning, and academic achievement. FC also promotes learning independence through self-regulation, autonomy, intrinsic motivation, responsibility, and more adaptive learning strategies. From cognitive and affective perspectives, this model strengthens critical thinking, argumentation, collaboration, active participation, positive attitudes, and learning satisfaction. The success of its implementation is influenced by technological readiness, teacher competence, pedagogical strategies, institutional support, and the use of digital media, although challenges remain, such as limited infrastructure, teachers' workload, low self-regulation, student resistance, the need for professional development, and time management issues. Theoretically, FC reinforces constructivism, collaborative learning, and instructional practices aligned with the demands of 21st-century education.

Simpulan dan Saran

Simpulan

Based on the evaluation results, it can be concluded that the Flipped Classroom (FC) model is more effective than traditional learning in fostering learning independence in mathematics learning, particularly in the aspects of self-regulation, autonomy, intrinsic motivation, critical thinking, and problem-solving. This model also strengthens constructivist and collaborative learning theories and

is relevant to the demands of 21st-century education, although it still faces challenges such as technological limitations, teacher readiness, student resistance, and the need for continuous professional development.

Saran

However, previous studies have shown existing gaps, particularly related to long-term effectiveness, the sustainability of learning independence, and variations in impact based on factors such as cognitive style, socio-economic background, and the availability of digital infrastructure. Therefore, future research should focus on longitudinal, multi-contextual, and mixed-method studies, prioritizing long-term effectiveness, the influence of external factors, and the development of hybrid models capable of overcoming implementation limitations. Such research is expected to strengthen theoretical foundations while offering practical solutions for optimizing the application of the Flipped Classroom in mathematics learning.

Daftar Pustaka

- Afriantoni, Dhea, A.-Z. V., Sari, W., & Nuria. (2025). Online Journal System 01. *MANJERIAL: Jurnal Inovasi Manajemen Dan Supervisi Pendidikan*, 5(1), 10-17.
- Ananda, A. T., Umar, M., & Malik, I. (2025). Adaptive Learning Islamic Education: Literature Review Model Pembelajaran Pai Adaptif. *Jurnal Pembelajaran Dan Pengajaran*, 8(2), 161-179. <https://edu.gerbangriset.com/index.php/jpp>
- Ananda, S. C. D., Salim, A., & Mastur, M. (2024). Tinjauan Literatur Sistematis Tentang Pengaruh Model Flipped Classroom terhadap Kemandirian Belajar Siswa. *Jiip - Jurnal Ilmiah Ilmu Pendidikan*, 7(6), 5269-5274. <https://doi.org/10.54371/jiip.v7i6.4465>
- Carrillo-Yalán, M. E., Vargas-Trujillo, C. E., García-Cuéllar, D., Cortez-Llanos, E., & Villarreal-Montenegro, Y. (2024). Flipped Classroom Based on Blum's Modeling and its Impact on Autonomous Learning Experienced by Mathematics Students from a University in Lima, Peru. *Academic Journal of Interdisciplinary Studies*, 13(3), 227. <https://doi.org/10.36941/ajis-2024-0077>
- Dan, K., & Abad, K. (2024). *DIKMAT: Jurnal Pendidikan Matematika*. 05(01).
- Erita, S. (2023). *Indonesian Journal of Science and Mathematics Education The Influence Of Problem-Based Learning-Flipped Classroom (PBL-FC) on Mathematical Argumentation Skills Pengaruh*. 06(3), 395-404. <https://doi.org/10.24042/ijsme.v5i1.18458>
- Eviota, J. S., & Liangco, M. M. (2020). Jurnal Pendidikan MIPA. *Jurnal Pendidikan*, 14(September), 723-731.
- Fajri, I., Suryadi, K., Anggraeni, L., Pendidikan, F., Pengetahuan, I., & Indonesia, U. P. (2021). *Open Access at: https://ejournal.undiksha.ac.id/index.php/JJPP PEMBELAJARAN KELAS Terbalik Selama Pandemi Covid-19: Sebuah Tinjauan Sistematis Review Dari Fakultas Pendidikan Ilmu Pengetahuan Sosial , Universitas Pendidikan Indonesia Open Access at : ht*. 9(3), 870-880.
- Fatimah, D., Kantun, S., & Herllindawati, D. (2023). Pengaruh Model Pembelajaran Flipped Classroom Terhadap Kemandirian dan Hasil Belajar Siswa. *PANDITA: Interdisciplinary Journal of Public Affairs*, 5(2), 1-12.

- <https://doi.org/10.61332/ijpa.v5i2.44>
- Fernández-Martín, F. D., Romero-Rodríguez, J. M., Gómez-García, G., & Navas-Parejo, M. R. (2020). Impact of the flipped classroom method in the mathematical area: A systematic review. *Mathematics*, 8(12), 1-11. <https://doi.org/10.3390/math8122162>
- Fianingrum, F., Novaliyosi, N., Nindiasari, H., & Syamsuri, S. (2022). Efektivitas Model Pembelajaran Flipped Classroom terhadap Pembelajaran Matematika. *Edukatif: Jurnal Ilmu Pendidikan*, 4(5), 6865-6874. <https://doi.org/10.31004/edukatif.v4i5.3387>
- Fung, C. H., Besser, M., & Poon, K. K. (2021). Systematic Literature Review of Flipped Classroom in Mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, 17(6), 1-17. <https://doi.org/10.29333/ejmste/10900>
- González-valiente, C. L. (2023). *Education in the Knowledge Society (EKS) Education in the Knowledge Society (EKS)*. 23, 1-21.
- Hariyasasti, Y. (2025). Literasi Teknologi dan Pemanfaatan Alat Digital di Sekolah Dasar. *International Journal of Social, Policy and Law*, 6(3), 1-16.
- Husnawati, Z. (2023). *Tarbawi: Journal On Islamic Education* Url: <Http://Studentjournal.Umpo.Ac.Id/Index.Php/Tarbawi> Implementasi Flipped Classroom Ditinjau Dari Penguasaan Materi Pendahuluan pembelajaran konvensional pengetahuan diperoleh melalui penjelasan guru di kelas , d. 7(1), 101-109.
- Ilmaknun, L., & Ulfah, M. (2023). Pengaruh Kemandirian Belajar Terhadap Hasil Belajar (Survei di SMA Pelita Tiga Jakarta). *Jurnal Sains Dan Teknologi*, 5(1), 416-423.
- Ishartono, N., Halili, S. H., & Razak, R. A. (2023). A review of flipped learning in innovative math education. *International Journal of Evaluation and Research in Education*, 12(4), 2194-2206. <https://doi.org/10.11591/ijere.v12i4.25842>
- Jumini, J. (2022). Flipped Classroom dalam Pembelajaran Matematika sebagai Alternatif Blended Learning: Sebuah Kajian Literatur. *Idealmathedu: Indonesian Digital Journal of Mathematics and Education*, 9(1), 51-62. <https://doi.org/10.53717/idealmathedu.v9i1.329>
- Kepno, S., Permana, N. C., Pertanian, D., Missi, L., & Republik, R. (2025). *Paradigma Konstruktivisme dalam Pendidikan Kampung: Studi Kasus Kebijakan Belis di Abenaho Papua*. 6(1), 1-17.
- Khardita, D., Isnarto, I., Asih, T. S. N., & Agoestanto, A. (2023). Analisis Kemampuan Penalaran Matematis Ditinjau Dari Kemandirian Belajar Pada Model Pembelajaran Student Facilitator and Explaining (Sfe) Dengan Metode Flipped Learning Berbantuan Google Classroom. *Symmetry: Pasundan Journal of Research in Mathematics Learning and Education*, 8(2), 178-184. <https://doi.org/10.23969/symmetry.v8i2.10806>
- Kiem, M. T., & Keodavan, X. (2024). Unpacking the advantages and challenges of flipped classrooms in initial mathematics teacher education in Vietnam. *Eurasia Journal of Mathematics, Science and Technology Education*, 20(5). <https://doi.org/10.29333/ejmste/14449>
- Kostaris, C., Sergis, S., Sampson, D. G., Giannakos, M. N., & Pelliccione, L. (2017). Investigating the potential of the flipped classroom model in K-12 ICT teaching and learning: An action research study. *Educational Technology and Society*,

20(1), 261-273.

- Latifah, U., & Rindaningsih, I. (2023). Implementasi Flipped Classroom dalam Mendukung Merdeka Belajar untuk Meningkatkan Kemandirian Belajar. *Jurnal Papeda: Jurnal Publikasi Pendidikan Dasar*, 5(2), 156-166. <https://doi.org/10.36232/jurnalpendidikandasar.v5i2.4447>
- Liu, Y., & Nan, Y. (2024). Research on Flipped Classroom Teaching Mode. *International Journal of Education and Humanities*, 12(3), 88-90. <https://doi.org/10.54097/57717225>
- Lo, C. K., & Hew, K. F. (2021). Student Engagement in Mathematics Flipped Classrooms: Implications of Journal Publications From 2011 to 2020. *Frontiers in Psychology*, 12(May), 1-17. <https://doi.org/10.3389/fpsyg.2021.672610>
- Mirlanda, E. P., Nindiasari, H., & Syamsuri, S. (2019). Pengaruh Pembelajaran Flipped Classroom Terhadap Kemandirian Belajar Siswa Ditinjau Dari Gaya Kognitif Siswa. *Symmetry: Pasundan Journal of Research in Mathematics Learning and Education*, 4, 38-49. <https://doi.org/10.23969/symmetry.v4i1.1638>
- Mirlanda, E. P., Nindiasari, H., & Syamsuri, S. (2020). Pengaruh Pembelajaran Flipped Classroom Terhadap Kemampuan Penalaran Matematis Ditinjau Dari Gaya Kognitif Siswa. *Prima: Jurnal Pendidikan Matematika*, 4(1), 11. <https://doi.org/10.31000/prima.v4i1.2081>
- Mita Tri Wahyuni, Rizky Tsalasa Amryatul Rodhiah, & M. Fahillah. (2025). Strategi Peningkatan Keterampilan Abad ke-21 Siswa SD dengan Memanfaatkan Aliran Filsafat Rekonstruksionisme. *JEMARI (Jurnal Edukasi Madrasah Ibtidaiyah)*, 7(2), 88-103. <https://doi.org/10.30599/0cbvwb74>
- Montenegro Muñoz, M. E., Bernal Párraga, A. P., Vera Peralta, Y. E., Moreira Velez, K. L., Camacho Torres, V. L., Mejía Quiñonez, J. L., & Poveda Gavilanez, D. M. (2024). Flipped Classroom: impacto en el rendimiento académico y la autonomía de los estudiantes. In *Ciencia Latina Revista Científica Multidisciplinar* (Vol. 8, Issue 3). https://doi.org/10.37811/cl_rcm.v8i3.12139
- Muhamad Syafiqul Humam, & Muh. Hanif. (2025). Strategi Pembelajaran Aktif dalam Meningkatkan Keterampilan Kritis Siswa di Era Modern. *Jurnal Bintang Pendidikan Indonesia*, 3(1), 262-281. <https://doi.org/10.55606/jubpi.v3i1.3592>
- Muir, T. (2019). Flipping the learning of mathematics: Different enactments of mathematics instruction in secondary classrooms. *International Journal for Mathematics Teaching and Learning*, 20(1), 18-32. <https://doi.org/10.4256/ijmtl.v20i1.139>
- Nikolova, E. (2023). Flipped Classroom And Traditional Method In Teaching Mathematics In Bulgarian School. *Mathematics and Informatics*. <https://doi.org/10.53656/math2023-3-5-fli>
- Pratiwi, K. A. M. (2022). Efektivitas Flipped Classroom Learning Terhadap Peningkatan Hasil Belajar Matematika Siswa SMP. *Jurnal Pendidikan Matematika Undiksha*, 12(2), 73-82. <https://doi.org/10.23887/jjpm.v12i2.37320>
- Radza, R. (2023). Challenges faced by educators in the implementation of Flipped Classroom. *LingTera*, 10(2), 35-43. <https://doi.org/10.21831/lt.v10i2.62920>
- Setiyawan, A. A., Agoestanto, A., & Isnarto, I. (2024). Enhancing self-regulated learning and critical thinking in STEM through flipped classroom models. *Jurnal Elemen*, 10(2), 341-362. <https://doi.org/10.29408/jel.v10i2.25322>
- Soussi, J. (2024). Case Study: Transforming Mathematics Education with Maple,

- Maple Learn, and the Flipped Classroom Approach. *Maple Transactions*, 4(4). <https://doi.org/10.5206/mt.v4i4.22134>
- Tanjung, M. (2020). Tanjung, M. (2020). "Keselamatan dalam Perspektif Alkitabiah: Antara Temporal dan Eternal." *Jurnal Teologi dan Misi*, 11(2), 90-105. "Keselamatan Dalam Perspektif Alkitabiah: Antara Temporal Dan Eternal." *Jurnal Teologi Dan Misi*, 10(1), 17.
- Technique, M. E. (2025). 杜志坚 1 , 廖道争 1 , 程 (1. 26(Juni), 60-78.
- Wahidin, W. (2025). Inovasi Strategi Pembelajaran Untuk Meningkatkan Keterlibatan Siswa Dalam Kurikulum Merdeka. *Jurnal Ilmu Pendidikan Dan Kearifan Lokal*, 5(3 SE-Articles), 833-843. <https://www.jipkl.com/index.php/JIPKL/article/view/284>
- Wahyu Purwandari, Ika Nur Safitri, & Maulidiya Mutiara Karimah. (2024). Eksplorasi Hakekat Pembelajaran Matematika di Madrasah Ibtidaiyah dalam Konteks Kurikulum Merdeka. *Indonesian Research Journal on Education*, 4, 1045-1060. <https://irje.org/index.php/irje>
- Wahyuni, L., Salingkat, S., Tamagola, R. H. A., Palayukan, H., Haidar, I., & Sitopu, J. W. (2024). Analisis Keberhasilan Implementasi Model Flipped Classroom dalam Pembelajaran Matematika Tingkat Perguruan Tinggi. *Journal on Education*, 6(4), 18954-18964. <https://doi.org/10.31004/joe.v6i4.5877>
- Widodo, L. S., Prayitno, H. J., & Widayarsi, C. (2021). Kemandirian Belajar Matematika Siswa Sekolah Dasar melalui Daring dengan Model Pembelajaran Flipped Classroom. *Jurnal Basicedu*, 5(5), 3902-3911. <https://doi.org/10.31004/basicedu.v5i5.1404>
- Wijayanto, A. (2024). *Revitalisasi penggunaan media serta metode belajar dalam* (Issue January).
- Wijayanto, Z., Mutiara, H., & Pardimin, P. (2022). Implementation of the Flipped Classroom Learning Model to Improve Students' Self-Regulated Learning. *Jurnal Pendidikan MIPA*, 23(3), 1123-1134. <https://doi.org/10.23960/jpmpipa/v23i3.pp1123-1134>
- Yanuarto, W. N. (2018). The Flipped Classroom Learning Model Untuk Menumbuhkan Kemandirian Belajar Matematika Dan Memaksimalkan Peran Teknologi Pada Pendidikan. *De Fermat: Jurnal Pendidikan Matematika*, 1(1), 13-19. <https://doi.org/10.36277/deferemat.v1i1.10>
- Yusuf, M. (2025). Flipped Classroom: Revolusi Pengajaran dalam Meningkatkan Partisipasi Siswa. *Academicus: Journal of Teaching and Learning*, 4(1), 27-44. <https://doi.org/10.59373/academicus.v4i1.80>
- Zhu, M., & Doo, M. Y. (2022). The relationship among motivation, self-monitoring, self-management, and learning strategies of MOOC learners. *Journal of Computing in Higher Education*, 34(2), 321-342. <https://doi.org/10.1007/s12528-021-09301-2>
- Котлер, Ф., Wiesenthal, D. L., Hennessy, D. A., Totten, B., Vazquez, J., Adquisiciones, L. E. Y. D. E., Vigente, T., Frampton, P., Azar, S., Jacobson, S., Perrelli, T. J., Washington, B. L. L. P., No, Ars, P. R. D. a T. a W., Kibbe, L., Golbère, B., Nystrom, J., Tobey, R., Conner, P., ... Chraif, M. (2023). No 主観的健康感を中心とした在宅高齢者における健康関連指標に関する共分散構造分析 Title. *Accident Analysis and Prevention*, 183(2), 153-164.