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Enhancing Geometry Achievement in Pre-Service Mathematics Teachers: The Impact of a Scaffolded Flipped Classroom Using a Learning Management System

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Abstract

This study investigates the effectiveness of a flipped classroom approach integrated with scaffolding through a Learning Management System (LMS) in enhancing the geometry achievement of pre-service mathematics teachers. The study utilized an experimental post-test-only control group design involving 63 randomly selected pre-service mathematics teachers. The experimental group received instruction through a flipped classroom model supplemented with scaffolding and LMS support, while the control group experienced traditional teaching methods enhanced by scaffolding and LMS. Quantitative data were collected via a geometry essay test and analyzed using descriptive and inferential statistics, including t-tests. The results revealed that the experimental group significantly outperformed the control group in geometry achievement. Additionally, qualitative data from thematic analysis of semi-structured interviews indicated that the flipped classroom approach fostered improved comprehension, peer interaction, and active discussion, despite challenges such as varying levels of motivation and scheduling conflicts. The scaffolding provided was found to be an effective strategy in clarifying complex topics and enhancing student success. This study underscores the potential of integrating a flipped classroom with scaffolding and LMS to improve geometry achievement and overall instructional quality.

Keywords: *Flipped Classroom, Scaffolding, Learning Management System, Geometry Achievement, Pre-Service Teachers.*

Introduction

A comprehensive understanding of mathematics, particularly geometry, is essential for effective teaching among pre-service mathematics educators. Geometry's abstract nature and complexity often result in significant learning challenges, leading to widespread difficulties in comprehension and decreased interest among students (Akçayır & Akçayır, 2018; Astuti et al., 2018; Mudhefi et al., 2024; Mukuka & Alex, 2024). Traditional teaching methods, characterized by a lack of interaction and engagement, exacerbate these issues, often resulting in suboptimal performance on international assessments. Consequently, students' performance in geometry, as reflected in their results on international exams, often falls short, highlighting the need for more effective teaching strategies in this domain (Domínguez Vázquez & Díaz Palencia, 2024; Jablonski & Ludwig, 2023; Juman et al., 2022).

To address these issues, innovative instructional methods such as the flipped classroom model have been increasingly advocated. The flipped classroom approach allows students to engage with learning materials at their own pace before class, freeing up in-class time for more interactive and problem-solving activities. This method has been shown to enhance students' participation, interaction, and understanding of complex concepts, making it a promising strategy for improving mathematical achievement (Cheng et al., 2019; Låg & Sæle, 2019; Somaa, 2024; Tomashevska, 2024). However, the flipped classroom model has gained traction as an innovative approach that promotes active learning, its application in geometry education remains underexplored, particularly in the context of pre-service teachers in developing countries like Indonesia.

Besides, scaffolding has emerged as a critical instructional support strategy. Scaffolding involves providing temporary assistance to students to help them accomplish tasks they might not be able to complete independently. When integrated with the flipped classroom approach, scaffolding can further enhance students' learning experiences by offering targeted support that addresses individual learning needs (Cabı,

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2018; van de Pol et al., 2015; Zhu & Wang, 2023; Zuo et al., 2023). Previous studies have demonstrated the effectiveness of scaffolding in various educational contexts, including its ability to improve students' motivation, engagement, and learning outcomes (Dy & Lapinid, 2023; Fidan, 2023; Kilic, 2018; Tazkia & Siswono, 2023).

Despite the growing body of research supporting the flipped classroom and scaffolding, limited studies have specifically examined their combined impact on geometry achievement among pre-service mathematics teachers. Most existing research has focused on the general effectiveness of the flipped classroom without exploring the synergistic effects of incorporating scaffolding (Kilavuz, 2024; Nur Fauzi et al., 2023; Puntambekar, 2022; Rajaram, 2019). Given the critical role that geometry plays in the mathematics curriculum and the challenges associated with teaching it, there is a clear need to investigate the potential benefits of combining these two instructional strategies.

This study seeks to address this gap by investigating the combined impact of a flipped classroom and scaffolding, facilitated by a Learning Management System (LMS), on the geometry achievement of pre-service mathematics teachers. The integration of these pedagogical strategies is hypothesized to provide a more interactive and supportive learning environment, thus enhancing students' conceptual understanding and engagement with geometry.

Method

Research Design

This study utilized an experimental post-test-only control group design to evaluate the impact of a scaffolded flipped classroom approach on the geometry achievement of pre-service mathematics teachers (Creswell & Creswell, 2023). The design was chosen to directly compare the impact of a scaffolded flipped classroom model, facilitated by a Learning Management System (LMS), against traditional instructional methods supplemented with scaffolding. This design ensures that any observed differences in geometry achievement between the experimental and control groups can be confidently attributed to the instructional method, rather than pre-existing differences among participants.

Participants

The study involved 63 pre-service mathematics teachers enrolled in the Analytical Geometry course at Universitas Negeri Makassar, Indonesia. The participants were randomly selected and divided into two groups: 30 students in the experimental group and 33 students in the control group. Random assignment was used to control for selection bias, ensuring that both groups were comparable in terms of their baseline characteristics. The selection of pre-service teachers as participants is significant, as they represent the future workforce in mathematics education, making their mastery of geometric concepts crucial for their professional development.

Experimental Group

Participants in the experimental group were introduced to the flipped classroom model, where learning materials, including instructional videos, quizzes, and discussion forums, were made available through the SYAM-OK LMS before in-class sessions (see Figure 1).

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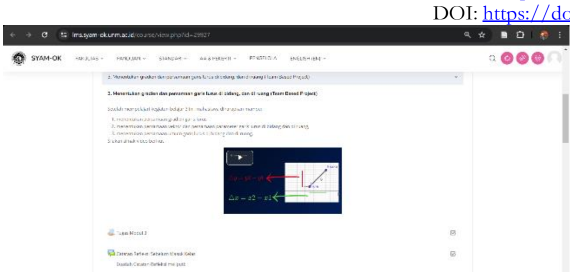

Figure 1. A Screenshot of The Video, Task, And Quiz In SYAM-OK LMS

This pre-class engagement allowed students to learn at their own pace, identifying areas of difficulty which were then addressed during the subsequent in-class sessions. The flipped classroom was supplemented with scaffolding, wherein the instructor provided targeted assistance based on students' performance in the pre-class quizzes and forum discussions. The scaffolding was designed to support students in mastering complex geometric concepts by offering personalized guidance during the in-class problem-solving activities.

Control Group

The control group received traditional classroom instruction, where the instructor delivered lectures covering the same geometric concepts as those in the flipped classroom model. In this setup, new concepts were introduced during class time, followed by problem-solving activities and guided practice. Although the control group also had access to supplementary materials on the SYAM-OK LMS, these resources were used to reinforce in-class learning rather than to prepare for it. Scaffolding in this group was provided during and after the lectures, ensuring that students received the necessary support to understand the material presented.

In both groups, the instructor provided scaffolding support tailored to students' needs. In the experimental group, this support was integrated with a flipped classroom model, which allowed instructors to address specific areas of difficulty identified through pre-class quizzes and in-class activities. In the control group, scaffolding support was provided during and after traditional lectures, ensuring that students received the help they needed to understand the material.

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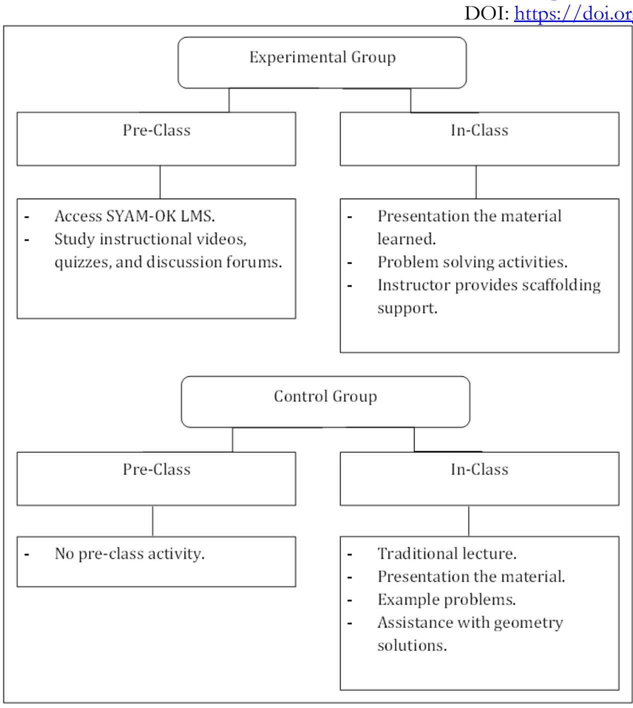

Figure 2. Diagram Of Experimental and Control Group

Data Collection

The primary data for this study were collected through a geometry essay test administered to both groups after the instructional intervention. The test comprised four problems, each designed to evaluate the participants' understanding and application of key analytic geometry concepts. Each problem was scored on a scale from 0 to 100, with the overall test score representing the student's geometry achievement. Additionally, semi-structured interviews were conducted with a subset of nine participants from both groups, selected to represent a range of achievement levels. The interviews aimed to gather qualitative insights into the participants' experiences with the flipped classroom and the effectiveness of the scaffolding provided.

Data Analysis

Quantitative data from the geometry essay test were analyzed using descriptive statistics to summarize the post-test scores of the two groups, including measures of mean, standard deviation, minimum, and maximum scores. An independent-measures t-test was conducted to compare the mean scores between the experimental and control groups, with the significance level set at $p < 0.05$. The effect size was calculated using Cohen's d to assess the practical significance of the findings (Cohen et al., 2007). Qualitative data from the semi-structured interviews were analyzed using thematic analysis to identify recurring themes related to the impact of the flipped classroom and scaffolding on student learning.

Validity Considerations

To ensure the internal validity of the study, several measures were taken, including random assignment of participants, consistent use of instructional materials, and uniform delivery of scaffolding support across both groups. Potential threats to external validity, such as the specific educational context and the sample size, were acknowledged. The study recommends future research to replicate these findings in different settings and with larger, more diverse populations to enhance the generalizability of the results.

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Results

Geometry Achievement Comparison between Flipped Classroom with Scaffolding and Traditional Learning

The results of the study indicate a significant difference in geometry achievement between the experimental group, which received instruction through the flipped classroom model with scaffolding, and the control group, which experienced traditional instruction supplemented with scaffolding. Descriptive statistics (Table 1) revealed that the experimental group achieved a higher mean score (M = 82.9, SD = 12.91) compared to the control group (M = 76.36, SD = 13.07), suggesting that the flipped classroom approach, when integrated with scaffolding, effectively enhances students' understanding and performance in geometry.

Table 1. Descriptive Statistics of Geometry Achievement

Group	N	Mean	Maximum	Minimum	Std. Deviation
Experimental	30	82.9	100	55	12.91
Control	33	76.36	100	45	13.07

A histogram (Figure 3) illustrating the distribution of scores shows that the experimental group's scores were skewed towards higher values, with a greater concentration of scores in the 80-100 range. In contrast, the control group's scores were more evenly distributed, with a concentration around the 70-80 range, indicating a broader range of achievement levels.

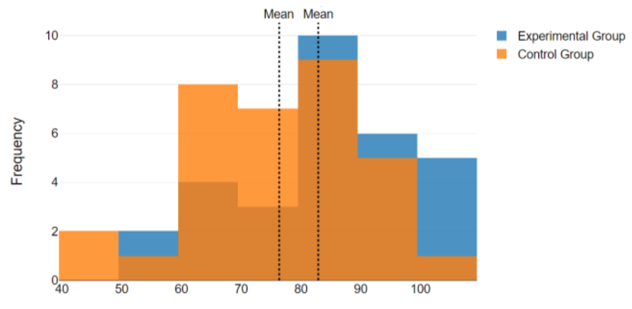

Figure 3. Distribution of Geometry Achievement

Statistical Analysis of Flipped Classroom's Impact on Geometry Achievement

To determine whether the observed difference in geometry achievement between the two groups was statistically significant, an independent-measures t-test was conducted. The analysis confirmed a statistically significant difference between the groups, with the experimental group outperforming the control group ($t(61) = 1.99$, $p = 0.025$) (Table 2).

Table 2. The T-Test of Geometry Achievement

	t	df	*p*	Cohen's *d*
Geometry Achievement (Equal variances)	1.99	61	0.025	0.5
Geometry Achievement (Unequal variances)	1.99	60.57	0.025	0.5

The effect size, calculated using Cohen's d, was 0.5, indicating a moderate to large effect. This suggests that the flipped classroom model combined with scaffolding has a meaningful and substantial impact on the geometry achievement of pre-service mathematics teachers.

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Qualitative Insights

In addition to the quantitative data, qualitative insights were gathered through semi-structured interviews with a subset of participants from both groups. Thematic analysis of the interview data revealed that students in the experimental group perceived the flipped classroom model as beneficial for their understanding of geometry. Several students reported that the pre-class preparation helped them engage more actively during in-class sessions, while the scaffolding provided timely support that clarified complex topics. One participant remarked, "The flipped classroom pushed me to study on my own before attending class, which made the in-class discussions more engaging and meaningful."

Students in the control group also acknowledged the benefits of scaffolding, but some expressed challenges in maintaining motivation and managing their time effectively without the structured pre-class preparation provided by the flipped classroom model. One student noted, "It was sometimes difficult to keep up with the material without the push to prepare before class."

Effectiveness of Scaffolding in Flipped Classrooms

The integration of scaffolding in both the experimental and control groups proved beneficial, albeit with a notable difference in mean scores between the groups (mean difference of 6.54). Scaffolding within the flipped classroom model was particularly effective, as it provided timely assistance tailored to individual learning needs. This personalized support enabled students to better understand complex geometry concepts and apply them during in-class activities. The qualitative data further underscored the value of scaffolding, with students appreciating the balance between peer presentations and instructor guidance during class sessions. One participant remarked, *"The alternation between student presentations and teacher explanations helped clarify difficult topics and reinforced my understanding."*

Challenges and Advantages of the Flipped Classroom Model

While the flipped classroom model promoted active engagement and peer interaction, it also presented challenges. Some students faced difficulties with motivation and time management, which affected their ability to engage with pre-class materials. As one student noted, *"When I lacked motivation, I found it hard to watch the videos and prepare for class."* Additionally, scheduling conflicts were a common issue, as highlighted by another student who mentioned, *"Having classes later in the week made it challenging to stay on top of the flipped classroom requirements."*

Discussion

Enhanced Geometry Achievement through Flipped Classroom and Scaffolding

This study provides compelling evidence that the integration of a flipped classroom approach with scaffolding significantly enhances geometry achievement among pre-service mathematics teachers. The findings align with and extend the existing body of research that highlights the benefits of active learning strategies, such as flipped classrooms, in improving student performance (Al-Samarraie et al., 2020; Cevikbas & Kaiser, 2022; Cheng et al., 2019; Gasparic et al., 2024; Herlambang et al., 2024; Wei et al., 2020). Specifically, this study demonstrates that when pre-class preparation is paired with targeted in-class scaffolding, students are better equipped to engage with and master complex geometric concepts.

The success of the flipped classroom model in this study can be attributed to its ability to shift the learning process from a traditional, passive model to an active, student-centered one. By engaging with learning materials before class, students in the experimental group were able to identify areas of difficulty and approach the in-class sessions with a more focused and prepared mindset. This shift not only facilitated more meaningful in-class discussions but also allowed for the application of geometric principles in a collaborative setting, thereby deepening students' conceptual understanding.

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The integration of scaffolding within the flipped classroom further amplified these benefits. Scaffolding provided targeted support that addressed individual learning needs, thereby facilitating a clearer understanding of complex topics. This aligns with the findings of studies such as those by (Fidan, 2023) and (Kilic, 2018), which highlight the effectiveness of scaffolding in improving students' academic performance and engagement. In the context of this study, scaffolding within the flipped classroom not only helped students grasp fundamental geometric concepts but also encouraged them to actively participate in class discussions and problem-solving activities, leading to improved geometry achievement.

The Role of Scaffolding in Enhancing Learning Outcomes

The study's results indicated that while both the experimental and control groups benefited from scaffolding, the flipped classroom group showed greater improvement. The mean difference in geometry achievement between the two groups suggests that scaffolding is more effective when combined with a flipped classroom model. This finding is supported by the literature, which emphasizes the importance of providing students with structured support as they navigate challenging academic material (Khojasteh et al., 2021; Rajaram, 2019; Spadafora & Downes, 2020; Witt et al., 2021).

In the flipped classroom, scaffolding was particularly effective because it allowed instructors to identify and address specific areas of difficulty based on pre-class activities. By tailoring the support to individual needs, instructors were able to enhance students' understanding and ensure they were better prepared for in-class tasks. The qualitative data from student interviews further corroborated this, with students expressing that the combination of pre-class preparation and in-class scaffolding significantly enhanced their learning experience.

Practical Implications for Mathematics Education

The findings of this study have significant implications for mathematics education, particularly in the training of pre-service teachers. The success of the flipped classroom model, when integrated with scaffolding and supported by an LMS, suggests that this approach could be a valuable tool for enhancing the teaching and learning of geometry. As pre-service teachers are often tasked with mastering complex content while also learning effective pedagogical strategies, this model offers a dual benefit: it improves their own understanding of geometry while simultaneously modeling an innovative teaching method they can use in their future classrooms (Nugraheni et al., 2024).

Moreover, the use of an LMS to facilitate the flipped classroom model offers a scalable solution that can be easily adapted to other educational contexts. The ability to provide students with structured, self-paced learning opportunities before class, combined with personalized in-class support, is particularly beneficial in settings where traditional instructional methods may be insufficient to meet diverse learning needs.

Challenges and Considerations

While the study highlights the benefits of the flipped classroom approach, it also reveals some challenges that need to be addressed for its successful implementation. One of the primary challenges noted by students in the experimental group was the need for self-discipline and effective time management to keep up with pre-class activities. This challenge is consistent with the findings of other studies on flipped classrooms, which have identified student motivation and engagement as potential barriers to the success of this model (Cheng et al., 2019; Gasparic et al., 2024; Goedhart et al., 2019; Lo & Hew, 2017; McNally et al., 2017; Nuryadi̇n et al., 2023).

Additionally, while the study focused on pre-service teachers in a developing country, the generalizability of the findings to other contexts should be approached with caution. The specific educational environment, cultural factors, and technological infrastructure available in this study may differ from those in other regions, which could impact the effectiveness of the flipped classroom and scaffolding strategies.

Conclusion

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This study provides strong evidence that the integration of a flipped classroom approach with scaffolding via an LMS significantly enhances the geometry achievement of pre-service mathematics teachers. By allowing students to engage with learning materials at their own pace and receive targeted support through scaffolding, this instructional model addresses key challenges in geometry education. The positive outcomes observed in this study suggest that such an approach not only improves academic performance but also offers a practical and scalable solution for enhancing mathematics education in diverse contexts.

Future research should explore strategies to address the challenges associated with the flipped classroom model, particularly in terms of student motivation and time management. Investigating the integration of motivational supports, such as gamification elements or time management tools within the LMS, could enhance the effectiveness of this approach. Additionally, longitudinal studies that examine the long-term impacts of flipped classrooms on both student achievement and teaching practices would provide valuable insights into the sustainability of this model.

Expanding the research to include diverse educational settings and student populations is also essential to better understand the broader applicability of the flipped classroom and scaffolding strategies. By exploring how these methods work in various contexts, educators can develop more effective and inclusive teaching practices that meet the needs of all learners.

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References

Akçayır, G., & Akçayır, M. (2018). The flipped classroom: A review of its advantages and challenges. Computers & Education, 126, 334–345. https://doi.org/10.1016/j.compedu.2018.07.021
Al-Samarraie, H., Shamsuddin, A., & Alzahrani, A. I. (2020). A flipped classroom model in higher education: A review of the evidence across disciplines. Educational Technology Research and Development, 68(3), 1017–1051. https://doi.org/10.1007/s11423-019-09718-8
Astuti, R., Suryadi, D., & Turmudi. (2018). Analysis on geometry skills of junior high school students on the concept congruence based on Van Hiele's geometric thinking level. Journal of Physics: Conference Series, 1132, 012036. https://doi.org/10.1088/1742-6596/1132/1/012036
Cabı, E. (2018). The Impact of the Flipped Classroom Model on Students' Academic Achievement. The International Review of Research in Open and Distributed Learning, 19(3). https://doi.org/10.19173/irrodl.v19i3.3482
Cevikbas, M., & Kaiser, G. (2022). Student Engagement in a Flipped Secondary Mathematics Classroom. International Journal of Science and Mathematics Education, 20(7), 1455–1480. https://doi.org/10.1007/s10763-021-10213-x
Cheng, L., Ritzhaupt, A. D., & Antonenko, P. (2019). Effects of the flipped classroom instructional strategy on students' learning outcomes: A meta-analysis. Educational Technology Research and Development, 67(4), 793–824. https://doi.org/10.1007/s11423-018-9633-7
Cohen, L., Manion, L., & Morrison, K. (2007). Research methods in education (6th ed). Routledge.
Creswell, J. W., & Creswell, J. D. (2023). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (6th ed.). SAGE Publications, Inc.
Domínguez Vázquez, B. C., & Díaz Palencia, J. L. (2024). A classroom experience for teaching and learning of high school geometry through virtual reality. Pedagogical Research, 9(3), em0210. https://doi.org/10.29333/pr/14634
Dy, A. C. P., & Lapinid, M. R. C. (2023). The Effects of Instructional Scaffolding in Students' Conceptual Understanding, Proving Skills, Attitudes, and Perceptions Towards Direct Proofs of Integers. 65–76. https://doi.org/10.22492/issn.2189-101X.2023.6
Fidan, M. (2023). The effects of microlearning-supported flipped classroom on pre-service teachers' learning performance, motivation and engagement. Education and Information Technologies, 28(10), 12687–12714. https://doi.org/10.1007/s10639-023-11639-2
Gasparic, R. P., Glavan, M., Mihelič, M. Ž., & Zuljan, M. V. (2024). Effectiveness of Flipped Learning and Teaching: Knowledge Retention and Students' Perceptions. Journal of Information Technology Education: Research, 23, 001. https://doi.org/doi.org/10.28945/5237
Goedhart, N. S., Blignaut-van Westrhenen, N., Moser, C., & Zweekhorst, M. B. M. (2019). The flipped classroom: Supporting a diverse group of students in their learning. Learning Environments Research, 22(2), 297–310. https://doi.org/10.1007/s10984-019-09281-2
Herlambang, A. D., Ririn, R., & Rachmadi, A. (2024). The flipped-classroom effect on vocational high school students' learning outcomes. International Journal of Evaluation and Research in Education (IJERE), 13(3), Article 3. https://doi.org/10.11591/ijere.v13i3.26757

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DOI: https://doi.org/10.62754/joe.v3i6.403510.62754

Jablonski, S., & Ludwig, M. (2023). Teaching and Learning of Geometry—A Literature Review on Current Developments in Theory and Practice. Education Sciences, 13(7), 682. https://doi.org/10.3390/educsci13070682

Juman, Z. A. M. S., Mathavan, M., Ambegedara, A. S., & Udagedara, I. G. K. (2022). Difficulties in Learning Geometry Component in Mathematics and Active-Based Learning Methods to Overcome the Difficulties. Shanlax International Journal of Education, 10(2), 41–58. https://doi.org/10.34293/education.v10i2.4299

Khojasteh, L., Hosseini, S. A., & Nasiri, E. (2021). The impact of mediated learning on the academic writing performance of medical students in flipped and traditional classrooms: Scaffolding techniques. Research and Practice in Technology Enhanced Learning, 16(1), 17. https://doi.org/10.1186/s41039-021-00165-9

Kilavuz, F. (2024). Exploring research trends in the implementation of the flipped classroom model in educational research: A review of literature. Pedagogical Research, 9(3), em0216. https://doi.org/10.29333/pr/14730

Kilic, H. (2018). Pre-service Mathematics Teachers' Noticing Skills and Scaffolding Practices. International Journal of Science and Mathematics Education, 16(2), 377–400. https://doi.org/10.1007/s10763-016-9784-0

Låg, T., & Sæle, R. G. (2019). Does the Flipped Classroom Improve Student Learning and Satisfaction? A Systematic Review and Meta-Analysis. AERA Open, 5(3), 233285841987048. https://doi.org/10.1177/2332858419870489

Lo, C. K., & Hew, K. F. (2017). A critical review of flipped classroom challenges in K-12 education: Possible solutions and recommendations for future research. Research and Practice in Technology Enhanced Learning, 12(1), 4. https://doi.org/10.1186/s41039-016-0044-2

McNally, B., Chipperfield, J., Dorsett, P., Del Fabbro, L., Frommolt, V., Goetz, S., Lewohl, J., Molineux, M., Pearson, A., Reddan, G., Roiko, A., & Rung, A. (2017). Flipped classroom experiences: Student preferences and flip strategy in a higher education context. Higher Education, 73(2), 281–298. https://doi.org/10.1007/s10734-016-0014-z

Mudhefi, F., Mabotja, K., & Muthelo, D. (2024). The use of Van Hiele's geometric thinking model to interpret Grade 12 learners' learning difficulties in Euclidean Geometry. Perspectives in Education, 42(2), 162–175. https://doi.org/10.38140/pie.v42i2.8350

Mukuka, A., & Alex, J. K. (2024). Student Teachers' Knowledge of School-level Geometry: Implications for Teaching and Learning. European Journal of Educational Research, 13(3), 1375–1389. https://doi.org/10.12973/eu-jer.13.3.1375

Nugraheni, B. I., Sukirno, Hendrowibowo, L., Johari, R. J., & Listianto, G. A. (2024). Development of an integrative flipped classroom model to improve students' critical thinking skills and learning responsibility. Journal of Ecohumanism, 3(3), Article 3. https://doi.org/10.62754/joe.v3i3.3263

Nur Fauzi, Y., Irawati, R., & Aeni, A. N. (2023). The effectiveness of the flipped classroom learning model with the assistance of learning videos on mathematics learning "Data" material. Sekumpul: Journal of Multidisciplinary Education Sciences, 1(1), 20–27. https://doi.org/10.62568/jomes.v1i1.21

Nuryadĭn, A., Karlĭmah, K., Lĭdĭnĭllah, D. A. M., & Aprĭanĭ, I. F. (2023). Blended Learning after the Pandemic: The Flipped Classroom as an Alternative Learning Model for Elementary Classrooms. Participatory Educational Research, 10(3), Article 3. https://doi.org/10.17275/per.23.52.10.3

Puntambekar, S. (2022). Distributed Scaffolding: Scaffolding Students in Classroom Environments. Educational Psychology Review, 34(1), 451–472. https://doi.org/10.1007/s10648-021-09636-3

Rajaram, K. (2019). Flipped Classrooms: Providing a Scaffolding Support System with Real-time Learning Interventions. Asian Journal of the Scholarship of Teaching and Learning, 9(1), 30–58.

Somaa, F. (2024). The Flipped Classroom Approach: A Review of Cognitive Styles and Academic Performances. Cureus. https://doi.org/10.7759/cureus.63729

Spadafora, N., & Downes, T. (2020). Scaffolding in Learning. In T. K. Shackelford & V. A. Weekes-Shackelford (Eds.), Encyclopedia of Evolutionary Psychological Science (pp. 1–4). Springer International Publishing. https://doi.org/10.1007/978-3-319-16999-6_1350-1

Tazkia, S., & Siswono, T. Y. E. (2023). Scaffolding to Help Middle School Students' Critical Thinking Skill in Solving Social Arithmetic Material. Journal of Mathematical Pedagogy (JoMP), 3(2), 55–67. https://doi.org/10.26740/jomp.v3n2.p55-67

Tomashevska, M. (2024). FLIPPED LEARNING: ENHANCING EDUCATION. Scientific Journal of Polonia University, 63(2), 102–106. https://doi.org/10.23856/6312

van de Pol, J., Volman, M., Oort, F., & Beishuizen, J. (2015). The effects of scaffolding in the classroom: Support contingency and student independent working time in relation to student achievement, task effort and appreciation of support. Instructional Science, 43(5), 615–641. https://doi.org/10.1007/s11251-015-9351-z

Wei, X., Cheng, I.-L., Chen, N.-S., Yang, X., Liu, Y., Dong, Y., Zhai, X., & Kinshuk. (2020). Effect of the flipped classroom on the mathematics performance of middle school students. Educational Technology Research and Development, 68(3), 1461–1484. https://doi.org/10.1007/s11423-020-09752-x

Witt, C. M., Trivedi, C., & Aminalroayae, F. (2021). Using Flipped Instruction in a Technology-enhanced Learning Environment: The Case for Scaffolding. Issues in Information Systems, 22(2), 52–62. https://doi.org/10.48009/2_iis_2021_52-62

Zhu, C., & Wang, H. (2023). A Study on the Application of Scaffolding Teaching Model in Middle School Mathematics Teaching. 2023 13th International Conference on Information Technology in Medicine and Education (ITME), 634–638. https://doi.org/10.1109/ITME60234.2023.00132

Zuo, M., Kong, S., Ma, Y., Hu, Y., & Xiao, M. (2023). The Effects of Using Scaffolding in Online Learning: A Meta-Analysis. Education Sciences, 13(7), Article 7. https://doi.org/10.3390/educsci13070705.