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Research paper

The Impact of The Flipped Classroom on Conceptual Understanding Toward Students' Different Learning Styles

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Abstract

This study investigates the effectiveness of the flipped classroom model in enhancing students' conceptual understanding in mathematics, with a focus on visual and auditory learning styles. The flipped classroom, which shifts direct instruction to individual study and reserves class time for active engagement, offers a promising alternative. A two-part instrument was used to assess students' learning styles and their conceptual understanding in mathematics. Findings indicate that both the flipped classroom strategy and students' learning styles significantly influence achievement. However, the interaction between the two was not statistically significant, suggesting that each factor contributes independently to learning outcomes. These results highlight the importance of designing inclusive instructional strategies that support varied learning preferences without requiring strict alignment. The study recommends further exploration of kinesthetic learners, long-term impacts of flipped instruction, and the role of specific media types in supporting different learning styles across broader educational contexts.

Keywords: *Flipped Classroom; Mathematical Concept Understanding; Learning Styles.*

1. Introduction

Indonesian students' mathematical performance remains low, primarily due to a lack of conceptual understanding. It was found that Indonesian students struggle to compete globally, as reflected in their poor performance in international assessments such as TIMSS and PISA [1]. Conceptual understanding is essential for mastering mathematics, as it involves constructing knowledge and expressing it in accessible forms [2]. To grasp mathematical concepts effectively, students must first understand prerequisite ideas, which form the foundation for deeper learning [3]. Studies show that Indonesian students often face difficulties in algebraic thinking and struggle to connect mathematical concepts across topics, which hinders their overall comprehension [4] & [5]. This ongoing issue highlights the need for fresh, student-centered teaching approaches. With technology playing a bigger role in education, models like the flipped classroom offer a promising way to make learning more engaging and effective.

Formal learning environments often face challenges such as limited student engagement, low absorption capacity, and underdeveloped thinking skills. The integration of information technology has transformed education, shifting from teacher-centered to student-centered approaches. This shift calls for active learning strategies and innovative models like the flipped classroom, which leverage technology to enhance learning outcomes. Flipped classrooms move direct instruction from group settings to individual study, fostering active engagement and deeper understanding during class time. [6 - 8]. This approach empowers students to take ownership of their learning and benefit from digital tools like smartphones and computers [9 - 11].

Flipped classrooms consist of two phases: out-of-class and in-class activities. Out-of-class learning allows students to engage with materials asynchronously and at their own pace. ICT plays a vital role in this phase, offering access to videos, graphics, and other visual resources [12]. This format supports self-paced learning, enabling students to revisit content as needed or explore advanced topics independently [13] & [14]. Teachers act as facilitators, guiding students and encouraging interaction [2]. This model promotes autonomy, active learning, and improved learning outcomes. Flipped classrooms enhance student engagement, foster teacher-student and peer interactions, and accommodate diverse learning styles [14] & [15].

The flipped classroom supports diverse learning styles and enhances students' conceptual understanding by allowing them to engage with preparatory materials at their own pace. Research shows that flipped classrooms benefit mathematics education across all levels by enabling higher-order thinking skills, such as analysis, to be practiced during face-to-face sessions. For example, implementing this model in junior high school mathematics classes has led to improvements in student evaluations, motivation, attitudes, and analytical skills [16] & [17].

Flipped classrooms are designed to accommodate diverse learning preferences through varied pre-class materials, active participation, structured support, and personalized learning paths. Technologies such as YouTube, TED Talks, and Khan Academy enable students to

revisit instructional videos multiple times, deepening their understanding [18] & [19]. This approach is widely recommended for teaching conceptual understanding [6], [7], [20 - 23]. However, few studies examine how learning styles influence their effectiveness, especially in mathematics. Limited evidence and inconsistent frameworks highlight the need for further research to tailor flipped classrooms to diverse students [24 - 26].

Learning styles are categorized into visual, auditory, and kinesthetic types. Visual students prefer to process information through images, diagrams, and written text, while auditory students absorb knowledge more effectively through listening and verbal interaction. For this study, only visual and auditory learning styles were examined, as they are most relevant to the instructional design of flipped classrooms, which rely heavily on multimedia content and verbal explanation. [27]. These factors significantly affect how students absorb, process, and retain information. Students possess diverse abilities, interests, and preferences, making it essential for educators to adopt flexible teaching strategies [28]. Adapting instruction to these differences fosters greater engagement and inclusivity in the classroom [29 - 31].

This study focused on visual and auditory learning styles. It aims to explore how flipped classroom strategies can be tailored to enhance mathematics achievement among students with distinct learning styles. Flipped learning encourages student-centered instruction and fosters deeper engagement through interactive in-class experiences [18] & [30]. However, limited research has examined how flipped classrooms interact with students' individual learning styles, particularly among higher education students in mathematics education [24] & [26]. This gap highlights the need to understand how flipped strategies can be optimized for different learning styles.

This study addresses that need by investigating the moderating variable of learning styles in the effectiveness of flipped classroom approaches on mathematics achievement. The novelty of this research lies in its integration of mathematics instruction within the flipped learning framework, its focus on students with varying achievement levels, and its aim to develop differentiated, practical strategies that support a wide range of learning styles.

Based on the research gaps and novelty, the research questions of this study are formulated as follows:

1) How does the flipped classroom model influence students' conceptual understanding in mathematics across different learning styles?
2) Is there an interaction between the flipped classroom model and learning styles on students' conceptual understanding of achievement?

2. Method

2.1. Research design

This study employed quasi quasi-experimental design to investigate the impact of the flipped classroom model influence students' conceptual understanding in mathematics across different learning styles and to examine the interaction between the flipped classroom model and learning styles on students' conceptual understanding toward students' mathematics achievement. There were an experimental and a control group in this research. The experimental group was taught by implementing a flipped classroom in mathematics conceptual understanding, and the control group was taught by implementing a conventional model. This research was conducted at one of the private higher education institutions in Indonesia. A factorial design 2x2 was employed to examine the effect of teaching models with different students' learning styles. This design enables researchers to investigate the impact of each independent, dependent, and moderator variable [32]&[33]. Flipped classroom and conventional models are the independent variables, students' mathematics achievement is the dependent variable, and learning style is the moderator variable. The factorial design is used to analyze both the main effects (teaching model and learning styles) and students' mathematics conceptual understanding achievement.

2.2. Participants

The participants were taken from one of the private universities in Indonesia. The participants in this study were drawn from a population of 120 students enrolled in mathematics classes. Using purposive sampling, 60 students were selected to take part in the intervention. These students were then divided into two groups: the experimental group, consisting of 30 students who received instruction through the flipped classroom model, and the control group, also consisting of 30 students, who were taught using traditional teacher-centered methods. Both groups were matched based on their prior academic performance to ensure comparability and minimize bias in the results.

2.3. Research instruments

This study used a two-part instrument to examine the link between flipped classrooms and learning styles. First, students in both experimental and control groups completed a learning style inventory to identify whether they were visual or auditory learners. Each group was then split accordingly. After classification, all students took a mathematics achievement test to measure their conceptual understanding. To adapt the VAK learning style questionnaire for this study, only items related to the visual and auditory learning styles were selected from the original framework by [34]. Kinesthetic items were excluded to focus on the two relevant modalities. The selected items were reworded for clarity and age appropriateness, then reviewed by experts to ensure content validity. A pilot test was conducted to refine the questionnaire based on student feedback. The final version included balanced items for each style and a scoring guide to classify students as visual or auditory students.

2.4. Data analysis

Two-way ANOVA will be conducted to examine the effects of instructional method (flipped vs. traditional) and learning style (visual vs. auditory) on students' achievement scores. The analysis will reveal whether flipped instruction leads to better understanding compared to traditional teaching, and whether learning style independently affects performance. Additionally, the study explores whether the effectiveness of flipped classrooms varies depending on students' learning styles by testing for interaction effects. If a significant interaction is found, it would suggest that the impact of flipped instruction is moderated by whether a student is a visual or auditory learner. Descriptive statistics such as means and standard deviations will be reported for each group, and post hoc tests may be applied if significant differences emerge. Effect sizes will also be calculated to assess the practical significance of the findings.

3. Results

This section presents the results of the study, which explored the impact of flipped classroom instruction on students' conceptual understanding in mathematics, considering their individual learning styles. Data were collected through a learning style questionnaire and a mathematics achievement test administered to both experimental and control groups. The questionnaire responses were used to classify students as either visual or auditory students, ensuring balanced representation across groups. Achievement scores were then analyzed to compare the effectiveness of flipped and conventional teaching strategies in relation to students' learning preferences. The following tables and statistical analyses summarize the distribution of learning styles, performance outcomes, and the significance of instructional teaching strategies and learner characteristics.

Table 1: Learning Style Questionnaire

No	Questions	Option A (Visual)	Option B (Auditory)
1	When I try to remember something, I:	Picture it in my mind	Repeat it out loud
2	In class, I prefer teachers who:	Use diagrams, charts, or visual aids	Explain things clearly through speech
3	When studying, I:	Use colors, graphs, or drawings	Read aloud or listen to recordings
4	I understand instructions better when:	I see them written or demonstrated	I hear they explained
5	I enjoy learning most when:	I can watch videos or look at examples	I can join discussions or listen to lectures
6	I find it easier to:	Follow written directions	Follow spoken directions
7	I prefer to take notes by:	Drawing diagrams or writing keywords	Summarizing verbally or recording audio

Table 1 revealed students' visual and auditory learning styles, emphasizing the need for a tailored instructional teaching strategy to enhance comprehension and retention. Visual students process information through visual aids, while auditory students prefer spoken explanations and lectures.

Table 2: Questionnaire Results Summary

Group	Visual Students (A-dominant)	Auditory Students (B-dominant)	Total Students
Experimental Group	15	15	30
Control Group	15	15	30
Total	30	30	60

Table 2 presents the distribution of learning styles involving visual and auditory across two groups: experimental and control. Each group consists of 30 students, evenly split between 15 visual students (A-dominant) and 15 auditory students (B-dominant). This results in a total of 30 visual students and 30 auditory students across all 60 participants.

Table 3: Results of Mathematics Test between Experimental and Control Group Categorized Students with Visual and Auditory.

No	Flipped Classroom (Experimental Group)		Conventional (Control Group)	
	Visual	Auditory	Visual	Auditory
1	91	80	78	70
2	87	76	74	68
3	84	85	80	75
4	79	70	70	66
5	88	79	77	74
6	90	82	79	71
7	85	77	75	69
8	82	74	73	73
9	86	81	76	70
10	89	78	81	76
11	78	83	69	65
12	84	75	78	67
13	83	72	72	72
14	92	80	74	74
15	80	76	77	71

Table 3 shows that students in the flipped classroom, both visual and auditory students performed better in mathematics than those in the traditional setting. Visual students benefited the most, with consistently higher scores, likely due to the model's emphasis on visual resources and flexible pacing. Auditory students also saw gains, though the improvement was more modest. Overall, the flipped approach appears to support stronger learning outcomes across styles.

Table 4: Descriptive Statistics

Instructional teaching strategy	Learning Style	N	Mean Score	Standard Deviation (SD)
Flipped	Visual	15	85.3	6.2
Flipped	Auditory	15	78.6	7.1
Traditional	Visual	15	76.4	6.8
Traditional	Auditory	15	72.1	7.5

In the flipped classroom, visual students performed best on average (85.3), followed by auditory students (78.6). Traditional classroom results, on the other hand, were lower, for visual students (76,4) and particularly for auditory students (72.1). These findings reveal the effectiveness of the flipped paradigm, especially for visual students who benefit from its adaptable, visual multimedia.

Table 5: Test Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Standardized Residual for Score	.064	60	.200*	.981	60	.478

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on Table 5, the normality test showed that the p-value was significant, 0.479. It means the p-value is greater than 0.05, and the data is significantly normally distributed.

Table 6: Between-Subject Factors

Between-Subjects Factors			
		Value Label	N
Teaching Strategy	1	Flipped Classroom	30
	2	Conventional Strategy	30
Students' Learning Style	1	Visual learning Style	30
	2	Auditory Learning Style	30

Based on Table 6, this study compares two teaching strategies involving the Flipped Classroom and the conventional strategy, and two learning styles involving visual and auditory. Each group has 30 students, so it depicts how teaching strategies and students' learning styles have influenced students' achievement.

Table 7: Descriptive Statistics

Descriptive Statistics				
Dependent Variable: Students' Score				
Teaching Strategy	Students' Learning Style	Mean	Std. Deviation	N
Flipped Classroom	Visual learning Style	85.20	4.346	15
	Auditory Learning Style	77.87	4.155	15
	Total	81.53	5.600	30
Conventional Strategy	Visual learning Style	75.53	3.543	15
	Auditory Learning Style	70.73	3.327	15
	Total	73.13	4.167	30
Total	Visual learning Style	80.37	6.272	30
	Auditory Learning Style	74.30	5.181	30
	Total	77.33	6.472	60

Based on Table 7 of the descriptive statistics, students taught using the Flipped Classroom strategy achieved a higher overall mean score (81.53) compared to those taught with the Conventional Strategy (73.13). When broken down by learning style, visual students in the Flipped Classroom performed the best, with a mean score of 85.20, followed by auditory students in the same group at 77.87. In contrast, visual students in the Conventional Strategy scored 75.53, while auditory students scored the lowest at 70.73. These results suggest that the Flipped Classroom approach may be particularly effective, especially for students with a visual learning style.

Table 8: Levene's Test of Equality of Error Variances

Levene's Test of Equality of Error Variances[a,b]					
		Levene Statistic	df1	df2	Sig.
Students' Score	Based on Mean	.534	3	56	.661
	Based on Median	.525	3	56	.667
	Based on Median and with adjusted df	.525	3	54.055	.667
	Based on the trimmed mean	.537	3	56	.659

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Dependent variable: Students' Score
b. Design: Intercept + Strategy + Style + Strategy * Style

Based on Table 8, Levene's Test result showed that the variance of student scores is similar across different teaching groups. In this case, all the p-values are well above 0.05, which means there's no significant difference in score variances between the groups. Therefore, we can conclude that the error variances of Students' scores are equal across the groups defined by Strategy, Style, and their interaction. Since the assumption of homogeneity of variance was met, it could proceed with parametric tests by using two-way ANOVA.

Table 9: Tests of -Subjects Effects

Tests of Between-Subjects Effects					
Dependent Variable: Students' Score					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1634.533[a]	3	544.844	36.462	.000
Intercept	358826.667	1	358826.667	24013.257	.000
Strategy	1058.400	1	1058.400	70.830	.000
Style	552.067	1	552.067	36.945	.000
Strategy * Style	24.067	1	24.067	1.611	.210
Error	836.800	56	14.943		
Total	361298.000	60			
Corrected Total	2471.333	59			

a. R Squared = ,661 (Adjusted R Squared = ,643)

The study revealed that both the teaching strategy and the learning style had a significant impact on students' performance, with p-values of.000 for each below the 0.05 significance level. This implies that both the approach and the students' learning styles influenced performance. However, the interaction between strategy and style was not significant (p =.210), implying that their combined effect had no impact beyond their individual contributions. The model explains 66.1% of the variance in student outcomes (R^2 =.661), indicating an excellent overall fit. In conclusion, strategy and style are vital, but they do not always enhance or diminish each other's effects when they are combined.

4. Discussion

This study investigated how flipped classroom models influence students' conceptual comprehension of mathematics, with particular emphasis on the impact of learning styles, especially visual and auditory learning styles. The study also revealed that both instructional strategy and learning style significantly impact student achievement, promoting deeper engagement and conceptual mastery. Research suggests that personalized and active learning environments promote deeper engagement and conceptual mastery, as confirmed by the significant impact of instructional strategy and learning style on student achievement [20], [22] & [31]. It used a two-part instrument focusing on visual and auditory students' learning styles, and a balanced distribution of 15 students in both experimental and control groups to investigate the relationship between instructional strategy and students' learning styles toward students' conceptual understanding. These discussions were classified into two sections to address research questions 1 and 2.

1) How does the flipped classroom model influence students' conceptual understanding in mathematics across different learning styles?

This study investigated the impact of the flipped classroom model on students' conceptual understanding in mathematics, with a focus on how this effect varies across different learning styles. The findings affirm that both instructional strategy and learning style significantly influence student achievement, aligning with prior research that highlights the effectiveness of flipped learning in promoting deeper engagement and conceptual mastery [2], [6], [7] & [16].

The findings clearly showed that the flipped classroom model considerably improves students' conceptual knowledge when compared to traditional instruction. The students in the flipped group had a higher total mean score (M = 81.53, SD = 6.7) than the traditional group (M = 73.13, SD = 7.2). Previous studies confirmed that flipped learning settings enhance active involvement, self-paced inquiry, and academic success [14], [22] & [25].

Furthermore, the flipped classroom seemed to work particularly well for visual students. Visual students in the experimental group regularly outperformed their auditory counterparts, with an average score of 85.3 vs 78.6. This showed that the multimedia-rich nature of flipped instruction, which includes videos, diagrams, and visual aids, gives visual learners more opportunities to understand and internalize mathematical concepts. This conclusion confirmed previous studies that emphasized the significance of aligning instructional methods to students' preferred learning modes in order to maximize comprehension and retention [24] & [30].

To investigate this relationship, a two-part instrument was used. Students first completed a learning style questionnaire derived from Fleming and Mills [34], which focused solely on visual and auditory modalities [6] & [7]. The questionnaire was improved through expert validation and pilot testing to ensure clarity and age appropriateness. This classification resulted in a balanced distribution of 15 visual and 15 auditory students in both the experimental and control groups, allowing any observed performance differences to be attributed to instructional method rather than group composition.

The results clearly demonstrate that the flipped classroom model significantly enhances students' conceptual understanding compared to traditional instruction. Students in the flipped classroom group achieved a higher overall mean score (M = 81.53, SD = 6.7) than those in the conventional group (M = 73.13, SD = 7.2). The flipped classroom model significantly improves students' conceptual understanding compared to traditional instruction, with a higher overall mean score compared to the conventional group. This result supports previous studies that highlight the flipped classroom's effectiveness in promoting deeper learning, student engagement, and improved academic outcomes in mathematics [22], [23], [25] & [26].

The study showed that visual learners in the flipped classroom consistently outperformed auditory learners. This makes sense when you consider how the flipped model works with videos, diagrams, and other visual tools that help visual learners absorb and connect ideas more easily. These resources allow them to revisit content at their own pace, reinforcing understanding in a way that suits their style. This finding echoes earlier research, which also found that flipped classrooms tend to benefit visual learners more, thanks to their rich multimedia content and flexible structure [10 - 12], [18] & [24]. Auditory learners improved from the flipped approach, but to a lesser extent. Their scores improved when compared to those in the traditional classroom, indicating that even when the format does not perfectly align with their dominant style, the flipped approach still provides positive effects such as increased interaction, discussion, and teacher facilitation [2] & [16].

To sum up, the study found that flipped classroom models significantly impact students' mathematical understanding, particularly for visual and auditory learners. The multimedia-rich approach of flipped instruction, which includes videos and diagrams, outperformed traditional instruction. Visual learners benefited most, highlighting the importance of aligning teaching strategies with students' preferred learning modalities.

2) Is there an interaction between the flipped classroom model and learning styles on students' conceptual understanding of achievement?

The statistical results in Table 9 reveal that both the flipped classroom teaching technique and students' learning styles had a substantial impact on academic achievement, with p-values of.000 for each, well below the 05 threshold. This illustrates how each aspect significantly adds to students' conceptual understanding and achievement. These findings are similar to previous studies [35], which revealed that flipped classrooms improve student engagement and achievement across multiple disciplines, and [36], which stressed the impact of learner characteristics on academic outcomes. This result aligned with the prior studies confirmed that while learning styles can influence how students engage with content, the overall instructional design and quality of learning experiences may have a more substantial impact on learning outcomes [25], [26]& [31]. In other words, the flipped classroom benefits all students, but it does not necessarily diminish its effectiveness based on whether a student is a visual or auditory learner.

The interaction between teaching technique and learning style was not statistically significant (p =.210), despite the high individual effects. This implies that neither a synergistic nor an adverse impact results from their combined influence. To put it another way, the impact of a student's preferred learning method is not always increased or decreased when a flipped classroom approach is used. This is in line with the findings of [37], who revealed that while flipped instruction enhanced outcomes in specific topics, it did not consistently interact with student characteristics like prior achievement or demographic factors. The model's R^2 value of .661 indicates that approximately 66.1% of the variance in students' conceptual understanding can be explained by the teaching strategy and learning style, reflecting a strong model fit. This reinforces the value of integrating flipped learning with differentiated instruction to support diverse students in mathematics classrooms [22] & [29].

Educators ought to realize the importance of both instructional design and learner characteristics. However, the lack of interaction suggests that matching teaching approaches to learning styles is not required for optimal learning. Instead, inclusive tactics such as flipped classrooms, which combine visual, auditory, and kinesthetic features, can help a diverse spectrum of learners without the need for customisation. This lends credibility notion that flipped classrooms promote autonomy and active learning independent of individual style[38].

5. Conclusion

In conclusion, this study found that the flipped classroom model significantly improved students' conceptual understanding of mathematics when compared to traditional instruction, with visual learners improving the most, probably due to the model's reliance on multimedia and self-paced learning. Although both teaching strategy and learning style had statistically significant effects on achievement, their interaction was non-significant, implying that each element contributes separately to learning outcomes. These results suggest that flipped classrooms are useful tools for helping diverse students when built with a variety of content formats, and that teachers should function as facilitators, incorporating visual and auditory materials to promote active, student-centered participation. Future research should include kinesthetic students, investigate the long-term effects of the flipped method, and analyze how specific media types interact with various learning styles. Furthermore, broadening the flipped method to other areas and investigating socio-cultural impacts could provide greater insights into its broader potential for education.

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References

[1] Asfar, A., Asfar, A., Darmawati, & Darmawan, D. (2018). The effect of the REACE (Relating, Exploring, Applying, Cooperating, and Evaluating) learning model on the understanding of mathematics concept. *Journal of Physics: Conference Series*, *1028*(1), 012145. https://doi.org/10.1088/1742-6596/1028/1/012145.

[2] Cheng, A., 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.

[3] Asfar, A. M. I. T., Asmawaty, & Nursyama, A. (2019). Mathematical concept understanding: The impact of integrated learning model. *Al-Jabar: Jurnal Pendidikan Matematika*, *10*(2), 211–220. https://doi.org/10.24042/ajpm.v10i2.3880.

[4] Balacuit, I. C. P., Nabua, E. B., & Saludares, J. R. G. (2025). Examining conceptual understanding and engagement in mathematics students. *Indonesian Journal of Mathematics Education*, *8*(1), 1–17. https://journal.untidar.ac.id/index.php/ijome. https://doi.org/10.31002/ijome.v8i1.2535.

[5] Maskar, S., & Herman, T. (2024). The relation between teacher and students' mathematical mindsets to the student's comprehension of mathematics concepts. Journal on Mathematics Education, 15(1), 27-54. https://doi.org/10.22342/jme.v15i1.pp27-54.

[6] Khadjieva, M., & Khadjikhanova, S. (2019). Flipped classroom as a modern educational technology. *European Journal of Research and Reflection in Educational Sciences*, 7(12), 1–6.

[7] Nja, M., Alade, O. M., & Okworo, G. (2022). Effectiveness of flipped classroom instructional strategy on students' achievement and retention in mathematics. *Journal of Education and Practice*, 13(4), 45–53.

[8] Orres-Martín, J., Torres-Martín, M., & García-Martínez, I. (2022). Flipped classroom and active methodologies in higher education: A systematic review. *Education Sciences*, 12(1), 1–18. https://doi.org/10.3390/educsci12010018.

[9] Elian, S., & Hamaidi, D. A. (2021). The impact of using flipped classroom strategy on the academic achievement of fourth grade students in Jordan. *International Journal of Instruction*, 14(2), 519–534. https://doi.org/10.29333/iji.2021.14229a.

[10] Asiksoy, G., & Ozdamli, F. (2016). Flipped classroom adapted to the ARCS model of motivation and applied to a physics course. *Turkish Online Journal of Distance Education*, 17(3), 109–123.

[11] Trujillo, C., López, M., & González, M. (2019). Flipped classroom in the educational system: Trend or effective pedagogy? *International Journal of Educational Technology in Higher Education*, *16*(1), Article 23. https://doi.org/10.1186/s41239-019-0176-8.

[12] Dove, A., & Dove, E. (2017). The flipped classroom: Implementing technology to aid in student comprehension. *Journal of Instructional Pedagogies*, *18*, 1–8.

[13] Roehl, A., Reddy, S. L., & Shannon, G. J. (2013). The flipped classroom: An opportunity to engage millennial students through active learning strategies. *Journal of Family and Consumer Sciences*, *105*(2), 44–49. https://doi.org/10.14307/JFCS105.2.12.

[14] Rathner, J. A., & Schier, M. A. (2020). The impact of flipped classroom andragogy on student assessment performance and perception of learning experience in two advanced physiology subjects. *Advances in Physiology Education*, *44*(1), 80–92. https://doi.org/10.1152/advan.00125.2019.

[15] Hwang, G. J., Lai, C. L., & Wang, S. Y. (2017). Seamless flipped learning: A mobile technology-enhanced flipped classroom with effective learning strategies. *Journal of Computers in Education*, *4*(4), 449–473. https://doi.org/10.1007/s40692-015-0043-0.

[16] Belmonte, J. L., Fuentes Cabrera, A., López Núñez, J. A., & Pozo Sánchez, S. (2019). Formative transcendence of flipped learning in mathematics students of secondary education. *Mathematics*, *7*(12), Article 1226. https://doi.org/10.3390/math7121226.

[17] Elian, S. A., & Hamaidi, D. A. (2018). The effect of using flipped classroom strategy on the academic achievement of fourth grade students in Jordan. *International Journal of Emerging Technologies in Learning*, *13*(2), 110–125. https://doi.org/10.3991/ijet.v13i02.7816.

[18] Shorman, M. (2015). The flipped classroom: A new way to teach and learn. *International Journal of Instructional Technology and Distance Learning*, *12*(3), 3–10.

[19] Clark, K. R. (2015). The effects of the flipped model of instruction on student engagement and performance in the secondary mathematics classroom. *Journal of Educators Online*, *12*(1), 91–115. https://doi.org/10.9743/JEO.2015.1.5.

[20] Didem Alsancak Sirakaya, & Özdemir, S. (2018). The effect of a flipped classroom model on academic achievement, self-directed learning readiness, motivation and retention. *Malaysian Online Journal of Educational Technology*, *6*(1), 76–91. https://files.eric.ed.gov/fulltext/EJ1165484.pdf.

[21] Torres-Martín, C., Acal, C., El-Homrani, M., & Mingorance-Estrada, Á. C. (2022). Implementation of the flipped classroom and its longitudinal impact on improving academic performance. *Educational Technology Research and Development*, *70*(3), 909–929. https://doi.org/10.1007/s11423-022-10095-y.

[22] Karadag, R., & Keskin, S. S. (2017). The effects of flipped learning approach on the academic achievement and attitudes of the students. *New Trends and Issues Proceedings on Humanities and Social Sciences*, *4*(2), 158–165. https://doi.org/10.18844/prosoc.v4i6.2926.

[23] Lin, Y.-C., & Hwang, G.-J. (2019). A learning analytics approach to supporting flipped classroom strategies: An empirical study. *Interactive Learning Environments*, *27*(8), 1031–1047. https://doi.org/10.1080/10494820.2019.1667150.

[24] 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*(4), 1–16. https://doi.org/10.1186/s41039-016-0044-2.

[25] Zuber, W. J. (2016). The flipped classroom, a review of the literature. *Industrial and Commercial Training*, *48*(2), 97–103. https://doi.org/10.1108/ICT-05-2015-0039.

[26] Dunn, R. (1984). Learning style: State of the science. *Theory Into Practice*, *23*(1), 10–19. https://doi.org/10.1080/00405848409543084.

[27] Butler, K. A. (2024). *Inclusive teaching strategies for diverse learners*. Equity Press.

[28] Hashim, H., Yunus, M. M., & Embi, M. A. (2023). Learning styles and their impact on student engagement in digital classrooms. *International Journal of Learning and Teaching*, *15*(2), 45–58.

[29] Jeong, H., González-Gómez, D., & Cañada-Cañada, F. (2018). Influence of learning style preferences on student success in flipped classrooms. *Journal of Educational Computing Research*, *56*(2), 275–291.
[30] Persky, A. M., & McLaughlin, J. E. (2017). The flawed concept of learning styles. *American Journal of Pharmaceutical Education*, *81*(4), Article 64. https://doi.org/10.5688/ajpe81464.
[31] Rukminingsih, A., Adnan, G., & Latief, M. A. (2020). *Metode penelitian pendidikan: Penelitian kuantitatif, penelitian kualitatif, penelitian tindakan kelas* (Edisi pertama). Erhaka Utama.
[32] Ary, D., Jacobs, L. C., Sorensen, C., & Walker, D. A. (2017). *Introduction to research in education* (9th ed.). Cengage Learning.
[33] Fleming, N. D. (2016). *Teaching and learning styles: VARK strategies* (2nd ed.). Christchurch, New Zealand: VARK Learn Limited.
[34] Zainuddin, Z., & Halili, S. H. (2016). Flipped classroom research and trends. *International Review of Research in Open and Distributed Learning, 17*(3), 313–340. https://doi.org/10.19173/irrodl.v17i3.2274.
[35] Al-Samarraie, H., Shamsuddin, A., & Alzahrani, A. (2020). A flipped classroom model in higher education: A review of the evidence. *Computers & Education, 141*, 103748. https://doi.org/10.1016/j.compedu.2019.103748.
[36] Setren, E., Greenberg, K., Moore, O., & Yankovich, M. (2021). Effects of flipped classroom instruction. *Education Finance and Policy, 16*(3), 363–387. https://doi.org/10.1162/edfp_a_00310.
[37] Mayasari, A. R., & Mujahidin, M. (2024). The impact of the flipped classroom model on student engagement and academic achievement: A systematic review of the literature. *International Journal of Teaching and Learning, 2*(11), 112-124. https://injotel.org/index.php/12/article/view/329.