



EFFECTIVENESS OF FLIPPED CLASSROOMS IN ENHANCING SELF-STUDY COMPETENCY AND ACADEMIC ACHIEVEMENTS IN VIETNAM'S SECONDARY SCHOOLS

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Abstract

Self-study has been recognized as a core competency in Vietnam's General Education Curriculum, underscoring its essential role in students' holistic development. This study employed a quasi-experimental design to examine the effectiveness of the flipped classroom model in enhancing self-study competency and academic achievement among secondary students. The intervention, focusing on the topic "Mixtures and Separation of Substances" in Grade 6 Science, involved 137 students from four classes at two secondary schools in Hanoi during the second semester of the 2022–2023 academic year. Two classes ($n = 68$) were taught using the flipped classroom model (experimental class), while the other two ($n = 69$) followed conventional teacher-centered teaching (control class). Academic performance tests and a validated seven-item self-study competency scale were used to assess outcomes. Data were analyzed using descriptive statistics, Wilcoxon signed-rank tests, and Mann–Whitney U tests. Results showed that flipped teaching significantly improved both academic achievement and self-study competency, with the experimental class outperforming the control class. No significant difference was found between the two experimental classes, suggesting consistency in the intervention's effects. These findings highlight the potential of the flipped classroom model to foster autonomous learning, improve educational outcomes, and inform future teaching practices in Vietnamese secondary education.

Keywords: academic achievement, flipped classroom, secondary science education, self-study competency, Vietnam

Introduction

In today's rapidly evolving technological and professional landscape, schools are no longer the sole providers of knowledge. As a result, fostering self-study competency has become an essential prerequisite for lifelong learning. In response to this need, Vietnam's 2018 General Education Curriculum reform identified self-study as one of the core competencies to be cultivated in students, aiming to prepare them for continuous learning and meaningful engagement in both national and global development efforts (Ministry of Education and Training, 2018).

Despite this curricular emphasis, recent studies reveal persistent challenges regarding Vietnamese students' self-study abilities. Many students remain passive learners, struggle to meet academic expectations, and demonstrate limited self-directed learning skills. Moreover, active teaching strategies designed to enhance this competency are not yet widely implemented. Nonetheless, the widespread availability of digital devices and students' frequent engagement with online environments (Hong et al., 2023) offer promising conditions for deploying innovative models that could foster self-study competency more effectively.

Among these models, the flipped classroom has gained considerable attention. This approach leverages technology to invert the traditional sequence of instruction: instructional content (e.g., videos, readings) is delivered outside of class time, while in-class sessions are devoted to active learning activities such as discussion, inquiry, and problem-solving (Bergmann & Sams, 2012; Garrison & Anderson, 2003). The flipped classroom model has been widely adopted across education levels, with numerous meta-analyses and systematic reviews confirming its positive effects on student performance, engagement, and self-regulated learning (Al-Samarraie et al., 2020; Jradi, 2019; Strelan et al., 2020). The model's effectiveness is attributed to its capacity to provide structured, active learning environments that promote problem-solving and autonomy (Strelan et al., 2020), although challenges such as video length and preparation time remain (Al-Samarraie et al., 2020).

In the Vietnamese context, a growing body of literature has explored the theoretical perspectives and pedagogical approaches for developing self-study competency (Dai et al., 2021; Lê & Bui, 2017; Thai, 2022). However, most empirical studies have focused primarily on upper secondary school and university students—learners who typically possess more mature self-regulation skills. By contrast, empirical research targeting secondary school students remains scarce. Given that early adolescence represents a critical stage for cultivating foundational learning competencies, there is a pressing need for research exploring effective strategies to support self-study competency development at this educational level.

In the field of science education, the flipped classroom model holds particular promise due to its alignment with inquiry-based learning and opportunities for practical experimentation (Bergmann & Sams, 2012). However, little empirical attention has been devoted to applying the flipped model in Grade 6 Science, particularly for the topic "Mixtures and Separation of Substances." This topic builds directly upon students' prior knowledge from Grade 5, involves familiar real-world contexts, and lends itself to independent, safe learning at home through multimedia materials.

Given these gaps, the present study examined the effectiveness of a flipped classroom model in enhancing Grade 6 students' self-study competency and academic achievement using the topic "Mixtures and Separation of Substances" as a case study. The findings are expected to inform the integration of digital learning models into early secondary science education in Vietnam.

Theoretical Framework

Flipped Classroom as a Pedagogical Innovation

The flipped classroom is an emerging educational approach that leverages digital technologies to invert the conventional teaching sequence. Initially conceptualized by Bergmann (2007), this model shifts content delivery to the pre-class phase, typically through recorded videos or online materials, while repurposing class time for collaborative problem-solving, discussion, and hands-on learning (Bergmann & Sams, 2012; Bishop & Verlege, 2013).

Unlike conventional teacher-centered teaching, where theoretical content is introduced during class and practiced at home, the flipped model encourages students to engage with

foundational knowledge prior to class (Duc, 2020). Teachers then serve as facilitators during class, guiding students through inquiry-based activities that deepen conceptual understanding (Thai, 2022). As a form of blended learning (Bishop & Verlege, 2013; Marks, 2015), the flipped classroom integrates active learning, scaffolding, cooperative learning, and problem-based approaches, making it highly compatible with the competency-based orientation of Vietnam's General Education Curriculum (Akçayir & Akçayir, 2018).

Empirical studies and meta-analyses have demonstrated that flipped classrooms enhance learner autonomy, self-regulation, engagement, and academic achievement across disciplines (Hamdan et al., 2013; Shao & Liu, 2021). In science education, the model has proven particularly effective, as it supports inquiry-based practices and provides extended time for hands-on experimentation (Chen, 2021; Łopińska et al., 2022; Zhao et al., 2021). Despite its benefits, challenges such as students' readiness for self-study, unequal access to technology, and resistance to shifting classroom roles remain significant (Alqarni, 2018; Talbert, 2015).

While flipped learning is widely adopted at the secondary and tertiary levels, its implementation in secondary education—particularly in Vietnam—is still limited. Few empirical studies have examined its potential in Grade 6 science, highlighting a critical research gap that this study seeks to address.

Self-Study Competency in Contemporary Education

Self-study competency is defined as the ability of learners to plan, manage, and evaluate their own learning processes independently. Rooted in theories of self-directed and self-regulated learning (Candy, 1991; Zimmerman, 2002), this competency includes metacognitive regulation, motivational control, and strategic use of learning tools.

A widely accepted framework for self-regulated learning comprises three phases: planning, implementation, and self-assessment. These phases correspond to key skills such as goal setting, resource selection, monitoring progress, and reflective evaluation (Zimmerman, 2002). Influential educational theorists such as Dewey and Montessori emphasized active learner participation, while contemporary research highlights the importance of differentiated instruction and formative feedback (Shayer & Adey, 2002; Smith, 2008).

In Vietnam, the 2018 General Education Curriculum explicitly designates self-study as a core competency to be developed from primary through upper secondary levels (Ministry of Education and Training, 2018). Recent studies have proposed pedagogical strategies, learning tasks, and assessment frameworks aimed at fostering self-study abilities in students (Thai, 2022; Thuy & Trung, 2021). However, most empirical evidence to date has focused on upper secondary or university students. For younger learners—such as those in Grade 6—systematic interventions are still rare.

Drawing on both theoretical models and Vietnamese curricular requirements, this study employs a structured framework comprising three main components and seven specific criteria (Table 1). This framework was used to assess students' self-study competency development before and after the intervention.

Table 1
Components and Criteria of Self-Study Competency

Component	Criterion
Planning the self-study process	1. Set learning goals and select appropriate content.
	2. Develop a study plan including methods, resources, and time allocation.
Implementing the study plan	3. Search, analyze, and evaluate information for relevance and accuracy.
	4. Apply knowledge and skills to solve learning tasks.
	5. Take notes, organize knowledge, and make adjustments as needed.
Evaluating and adjusting	6. Assess learning outcomes using criteria and self-assessment tools.
	7. Reflect and modify the approach for future self-study activities.

Integration of the Flipped Classroom and Self-Study Competency

There is a strong theoretical and pedagogical alignment between the flipped classroom model and the development of self-study competency. The pre-class learning phase, a hallmark of flipped teaching, requires students to engage in goal setting, time management, and independent information processing—closely aligned with the planning and implementation components of self-study competency (Criteria 1–3).

In-class activities, which include inquiry-based discussions, peer collaboration, and problem-solving, provide opportunities for knowledge application and critical thinking (Criterion 4). Simultaneously, students are encouraged to take notes, refine their understanding, and adapt learning strategies (Criterion 5). The post-class phase often involves self-evaluation and reflection activities that promote deeper metacognitive engagement (Criteria 6–7).

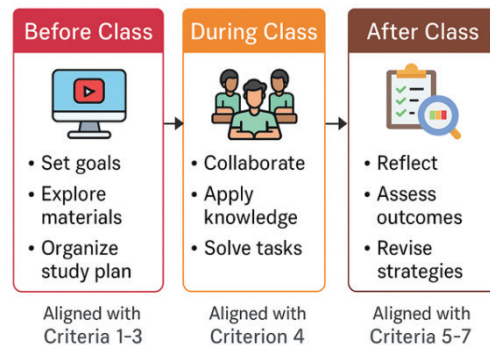
While previous studies have highlighted the benefits of flipped classrooms in improving academic performance and fostering engagement (Shao, 2021), fewer have explicitly examined their impact on core competencies—particularly self-study—among secondary students. This gap is especially relevant in the Vietnamese educational context, where competency-based education is being promoted nationally but requires more empirical validation at younger grade levels.

Accordingly, this study was designed to examine the effectiveness of a flipped classroom intervention on the development of self-study competency and academic achievement among Grade 6 students, focusing on the science topic “Mixtures and Separation of Substances.” By integrating principles of flipped learning with a structured competency framework, the study seeks to generate actionable insights for teaching innovation and curriculum implementation in Vietnamese secondary education.

The flipped classroom model supports all three components of self-study competency—planning, implementation, and evaluation—through distinct phases of instruction. Figure 1 illustrates how the before-class, during-class, and after-class stages of flipped teaching align with specific criteria of self-study competency development in the context of the Grade 6 science topic “Mixtures and Separation of Substances.”

Figure 1

Developing Self-study Competency through Flipped Classroom Instruction



Note: Each phase corresponds to specific criteria within the self-study competency framework.

Research Questions

Building on the above theoretical perspectives and addressing the identified research gaps, the present study was guided by the following research questions:

- (1) Does the flipped classroom model improve students' self-study competency?
- (2) Does the flipped classroom model enhance students' academic achievement?
- (3) Are there differences in students' self-study competency and academic achievement between students from two schools after participating in the flipped classroom course?

Research Methodology

Design

This study adopted a quasi-experimental design with a non-equivalent control class to examine the effectiveness of flipped classroom teaching in fostering self-study competency and improving academic achievement among sixth-grade students. The research design included both within-class (pre–post comparisons) and between-class (comparisons between the experimental and control classes) analyses. To ensure fairness in educational time, all classes were provided with equivalent total learning hours: while the experimental classes engaged with pre-class videos and in-class activities, the control classes received the same content entirely through traditional, in-class teaching. The study was conducted during the second semester (January to May 2023) in two secondary schools located in Hanoi, Vietnam. The topic “Mixtures and Separation of Substances” was selected based on its alignment with Grade 6 science curriculum and suitability for flipped teaching.

Participants

The study was conducted during the second semester of the 2022–2023 academic year in two secondary schools in Hanoi, Vietnam. A total of 137 sixth-grade students from four classes participated. The chosen topic, “Mixtures and Separation of Substances,” builds upon students' prior knowledge from Grade 5, involves familiar real-world contexts, and lends itself directly to independent, safe learning at home through multimedia materials. The entire enrollment of the four classes was included, resulting in a total sample size of 137 students. This intact-class design is a common approach in quasi-experimental research to preserve ecological

validity in natural classroom settings. Two classes ($n = 68$) were assigned to the experimental group (flipped classroom), and the other two classes ($n = 69$) to the control class (conventional teaching). Each group exceeded 30 participants, which is generally considered sufficient for applying inferential statistical analyses such as t-tests and ANOVA (Cohen, 1988). While the sample size is moderate, it is comparable to or larger than those employed in similar classroom-based studies, thereby supporting the validity of the experiment. Future research with larger and more diverse samples is recommended to enhance generalizability. Table 2 summarizes the participant distribution. Ethical approval was obtained from the school administrators prior to data collection. Participation was voluntary, and parental consent was secured for all students. All data were anonymized, and no personal identifiers were collected.

Table 2
Participant Distribution by School and Class

School	Experimental Class (n)	Control Class (n)	Topic
Hanoi – Amsterdam High School for the Gifted	6E (40)	6D (37)	Mixtures
Marie Curie Hanoi School – Ha Dong	6I6 (28)	6I5 (32)	Mixtures

Instruments

To evaluate the effectiveness of the flipped classroom intervention in enhancing students' self-study competency and academic achievement, a combination of teacher- and student-centered tools was employed. These instruments were designed in accordance with the competency-based orientation of the Vietnamese General Education Curriculum and were supported by contemporary educational research.

A three-level rubric was developed based on seven core indicators of self-study competency. These indicators are aligned with the structure and goals of the national curriculum for developing students' independent learning capacity (Ministry of Education and Training, 2018). The rubric was used in two ways: by teachers to observe and assess students' demonstration of self-study behaviors during classroom activities, and by students for self-monitoring and regulation of their learning throughout the flipped classroom process. This dual use aligns with findings in the literature emphasizing the value of rubrics in fostering self-regulated learning, clarifying assessment expectations, and supporting reflective practices (Huyền et al., 2023; Jonsson & Panadero, 2017; Shilpa, 2022).

However, for research purposes, only the teacher-observation data were processed and analyzed to ensure consistency and reliability in evaluating student self-study competency across classes.

Students' performance in self-study was classified into four levels for reporting: Low (< 1.50), Medium (1.50–1.99), Fair (2.00–2.49), Good (≥ 2.50).

To assess academic achievement, two written tests were employed: Test 1, administered at the beginning of the intervention, consisted of 10 multiple-choice questions (graded on a 10-point scale). Test 2, given after the in-class phase, included 5 short-answer questions (also graded on a 10-point scale). The complete test content is accessible online at the following link: https://drive.google.com/file/d/1auJvy-Hq1xHq8yDclB84t9CXF9ZtNG3/view?usp=drive_link

The use of written tests to measure learning outcomes is widely supported in educational research, as they provide structured and scalable means of evaluating both factual knowledge and application skills (Fitria, 2024).

Procedure

The study followed a three-phase flipped classroom model implemented in the topic “Mixtures and Separation of Substances” for sixth-grade students. Instructional materials included e-learning content, digital worksheets, and guiding questions accessible via an online platform. The development of self-study competency was tracked across five indicators (Criteria 1–5), aligned with each learning phase as follows:

Before Class (Self-study Phase): Students in the experimental class independently accessed learning resources and planned their learning. This phase targeted Criteria 1–3 (goal setting, planning, and material usage). At the end of this phase, students completed Test 1 (10 multiple-choice questions) in a controlled setting.

During Class (Collaborative Learning Phase): Classroom sessions emphasized problem-solving, peer collaboration, and teacher feedback. Activities supported Criterion 4 (task execution) and Criterion 5 (strategy adjustment). Teachers observed and assessed students’ performance using a three-level rubric.

After Class (Reflection Phase): Students completed a structured self-assessment, reviewed their progress, and identified strategies for improvement. Test 2 (5 short-answer questions) was administered to assess academic achievement.

Data Collection and Analysis

Quantitative data were analyzed using IBM SPSS Statistics Version 20. Tests for normality were performed using the Shapiro–Wilk test to assess the distribution of the data. Since the results indicated non-normal distributions ($p < .05$), appropriate non-parametric statistical methods (e.g., Wilcoxon signed-rank test, Mann–Whitney U test) were employed for further analysis. Table 3 summarizes the statistical procedures applied to address each research question.

Table 3
Statistical Tests Employed for Each Research Question

Research Question	Focus	Classes	Tool(s)	Timing	Statistical Test
1	Competency improvement	Experimental only	Teacher rubric	Pre and post	Wilcoxon signed-rank test
2	Learning outcomes	Experimental and control	Test 1, Test 2	Post	Mann–Whitney U test
3	Cross-class performance analysis	Two experimental classes	Rubric, Test 1, Test 2	Post	Wilcoxon and Mann–Whitney U tests

Research Results

Self-study Competency

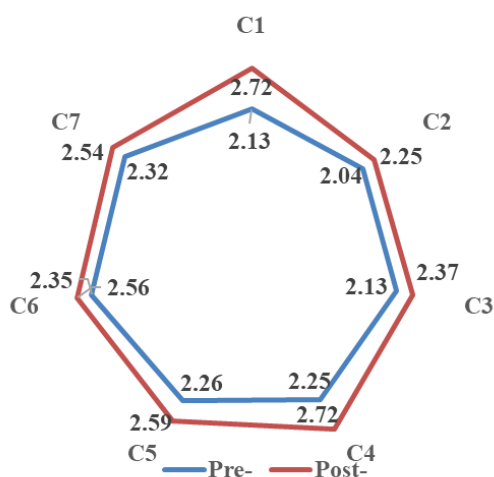
Improvement Across Self-study Criteria

The effectiveness of the flipped classroom model in enhancing students’ self-study competency was evaluated by examining changes across seven dimensions using the Wilcoxon signed-rank test. As depicted in Figure 2, a clear improvement was observed across all seven criteria following the intervention, with the orange polygon (Post- Flipped Classroom Teaching)

enveloping the blue polygon (Pre- Flipped Classroom Teaching). Statistically significant improvements ($p < .05$) were found in five of the seven criteria. The most pronounced gain was in C1 (defining learning objectives), with the average score increasing from 2.13 to 2.72. Significant improvements were also noted in C2 (organizing learning tasks), which rose from 2.04 to 2.25, and in C3 (using digital resources), increasing from 2.13 to 2.37. Furthermore, gains were registered in C6 (self-monitoring), which rose from 2.35 to 2.56, and in C7 (intrinsic motivation), with scores increasing from 2.32 to 2.54.

Figure 2

Changes in Students' Self-Study Competency Scores Pre- and Post-Flipped Classroom Teaching



Limited Gains in Higher-Order Competencies

While overall trends were positive, improvements in C4 (applying knowledge to solve problems) and C5 (note-taking and the organization of knowledge) were not statistically significant ($p > .05$). These dimensions involve higher-order cognitive skills that typically require prolonged engagement and explicit strategy instruction. The limited duration of the intervention, along with students' early stage of cognitive development, may have constrained growth in these areas.

Consistency Across School Contexts

To assess the generalizability of the intervention, post-intervention self-study scores were compared between the experimental classes at Hanoi–Amsterdam and Marie Curie schools. Analysis using the Mann–Whitney U test showed no statistically significant differences across all seven criteria ($p > .05$), suggesting that the flipped classroom model had consistent effects regardless of school-specific factors such as student demographics or institutional context.

Academic Achievement

Students' academic achievement was assessed through two tests conducted before and after the flipped classroom intervention. Prior to the implementation, both the experimental and

control classes achieved the same average score on Test 1 ($M = 8.01$), and the Mann–Whitney U test confirmed no significant difference between the two groups ($U = 2304.50, p = .853$). This suggests equivalence in students' baseline knowledge, thereby validating the comparability of the two groups at the outset.

After the intervention, the experimental class outperformed the control class on Test 2, with a higher mean score ($M = 8.63$ and 8.00) and a narrower standard deviation (1.208 and 1.404), indicating not only improved performance but also more consistent outcomes. The difference was statistically significant ($U = 1736.00, p = .007$), supporting the effectiveness of the flipped classroom in enhancing academic achievement.

Within-group analysis using the Wilcoxon signed-rank test showed that students in the experimental class significantly improved from Test 1 to Test 2 ($Z = -4.189, p < .001$), providing further evidence of the intervention's positive impact.

When comparing the two experimental classes from Hanoi–Amsterdam and Marie Curie schools, results indicated no statistically significant difference in Test 2 scores ($M = 8.93$ vs. $8.46; U = 437.50, p = .110$). This suggests that the flipped classroom model yields consistent benefits across different educational settings, irrespective of school-specific characteristics.

In sum, the flipped classroom model contributed not only to enhanced self-study competencies but also to statistically significant and educationally meaningful gains in academic performance. These results reinforce the model's potential as a scalable and effective educational strategy in secondary science education.

Discussion

This study's findings provide empirical evidence for the effectiveness of the flipped classroom model in enhancing both self-study competency and academic achievement among secondary school students.

Interpreting Key Findings

The intervention effectively enhanced students' planning, resource management, and intrinsic motivation—all core components of self-regulated learning (Zimmerman, 2002). The most significant gains were in students' ability to define learning objectives (C1) and manage digital resources (C3). This suggests that the structured pre-class content and tasks provided a scaffolded environment for fostering autonomous learning habits. This aligns with prior research emphasizing the value of combining multimedia with learner-centered strategies to promote self-regulation (Strelan et al., 2020). The observed increase in intrinsic motivation (C7) further reinforces the role of autonomy-supportive environments in sustaining engagement, a particularly relevant factor for learners in transitional developmental stages. The improved digital literacy among students highlights the potential of technology to cultivate academic independence, a goal consistent with Vietnam's 2018 General Education Curriculum (Ministry of Education and Training, 2018). These results collectively support flipped teaching as a mechanism for promoting self-study in secondary contexts.

In addition, the significant improvements in academic achievement within the experimental group resonate with previous research affirming the benefits of flipped teaching. The combination of pre-class preparation and interactive, problem-based in-class activities appears to have deepened students' conceptual understanding and knowledge retention, an effectiveness observed in various secondary education contexts (Wei et al., 2020). This outcome supports the notion that integrating technology with student-centered learning environments fosters engagement, comprehension, and knowledge retention (Al-Zahrani, 2015; McLaughlin et al., 2014; O'Flaherty & Phillips, 2015).

Explaining Limited Gains

Despite overall positive trends, the intervention did not yield statistically significant improvements in higher-order competencies related to problem-solving (C4) and information organization (C5). This outcome can be interpreted in light of two key factors: cognitive development and intervention design. These skills require advanced metacognitive regulation and explicit instruction—elements that may have been constrained by both the limited duration of the intervention and the developmental stage of sixth-grade students.

The challenges faced by younger students in engaging with complex inquiry tasks and applying systematic note-taking strategies align with recent findings from studies on cognitive development in science learning (Fernández et al., 2022; Teo & Goh, 2019). Similarly, recent research has highlighted that middle school students frequently underperform in recognizing interconnections and understanding systems thinking (Li & Li, 2023). Therefore, while the flipped model successfully fostered foundational self-study skills, it may require a longer intervention period and more targeted, explicit scaffolding to cultivate higher-order cognitive competencies.

Implications for Practice and Policy

The findings of this study have important implications for both educational practice and policy. First, the comparable outcomes across both study sites indicate that the flipped classroom model is adaptable and can be implemented effectively in varied institutional settings. The consistency of results suggests that when core principles—such as curricular alignment, effective teacher facilitation, and equitable access to digital resources—are met, flipped learning can yield positive outcomes across diverse educational settings (Lo & Hew, 2018; Sarker et al., 2023). This adaptability enhances the model's scalability and positions it as a viable strategy for achieving broader equity goals in national education systems (UNESCO, 2015).

For practical application, the study highlights the importance of age-appropriate pre-class scaffolds and structured in-class activities. To foster deeper cognitive skills, educators could integrate strategic tools such as digital notebooks and inquiry templates, along with continuous formative feedback (Jonsson & Panadero, 2017). The benefits of such scaffolding and instructional sequencing in enhancing self-regulation and resource management have been further emphasized by recent research (Subagyo & Widodo, 2024; YunLin Sun et al., 2023). At the policy level, these findings affirm the feasibility of embedding flipped teaching into competency-based curricula. The model provides a practical framework for balancing digital innovation with pedagogical reform, particularly in the Vietnamese context, where such approaches remain underutilized at the secondary level.

Conclusions and Implications

This study has confirmed that the flipped classroom model is an effective pedagogical approach to enhance both self-study competencies and academic achievement among Grade 6 students in Vietnam. By applying this model in two contrasting school contexts, the study has established its broad applicability and scalability, regardless of students' academic backgrounds or school profiles.

Furthermore, the research has addressed a significant gap in the literature by providing empirical evidence on the use of flipped learning at the secondary level – a domain largely underexplored in prior studies that often focused on higher education.

These findings underscore the value of integrating student-centered, technology-enhanced methods in secondary education, especially in alignment with Vietnam's General

Education Curriculum. The study has demonstrated that flipped classrooms can not only improve academic outcomes but also cultivate essential learning competencies in younger learners.

The study has also highlighted the importance of teacher facilitation and digital resource design in optimizing the benefits of flipped learning. As such, it serves as a practical reference for policymakers and educators seeking to innovate classroom practice within the context of curricular reform.

Looking ahead, this research lays a foundation for further investigation into the long-term impacts of flipped learning across diverse subjects and educational levels. Future studies should adopt longitudinal designs to assess the sustainability of self-study gains, and explore how contextual variables—such as teacher feedback, family support, and socio-economic conditions—influence student engagement. Comparative studies across disciplines and school types would further clarify how to tailor the flipped classroom model to meet the needs of different learner populations.

Declaration of Interest

The authors declare no competing interest.

Note

Relevant learning materials cited in this framework are available in the supplementary resources section:

<https://drive.google.com/drive/u/1/folders/1H5C3EisBXsVa1yUkqziz0asx9hL6HzBG>

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