Al-Ishlah: Jurnal Pendidikan
Vol.18, 1 (March, 2026), pp. 455-465
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v18i1.8536

Evaluating the Flipped Classroom for Enhancing Student Collaboration: A Systematic Literature Review

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ARTICLE INFO

Keywords:

flipped classroom;
student collaboration;
informatics engineering education;
systematic literature review

Article history:

Received 2025-08-30
Revised 2025-09-17
Accepted 2026-03-28

ABSTRACT

The flipped classroom (FC) model has gained prominence in higher education, yet its effectiveness in fostering student collaboration remains inconclusive. This study systematically reviews existing literature to examine how FC implementation influences collaborative learning outcomes. A systematic literature review was conducted following the PRISMA framework. Ten empirical studies published between 2015 and 2023 were selected based on predefined inclusion criteria. The studies were analyzed with a focus on instructional design, assessment alignment, and the operationalization of collaboration. The findings reveal that while FC approaches are widely adopted, their impact on collaboration varies considerably. Studies that explicitly structured collaborative roles and aligned collaboration with assessment practices reported stronger outcomes. In contrast, studies that treated collaboration implicitly or descriptively demonstrated weaker or inconsistent results. Additionally, collaboration was often insufficiently defined or measured as a primary learning outcome. The review identifies significant gaps in the literature, including limited conceptualization and measurement of collaboration, as well as a lack of longitudinal and discipline-specific research, particularly in Informatics Engineering. These findings suggest that FC environments do not inherently enhance collaboration. More rigorous research designs that explicitly integrate and assess collaboration are needed to better understand and optimize its role within flipped learning contexts.

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1. INTRODUCTION

The Flipped Classroom has emerged globally as a prominent pedagogical innovation that reshapes the learning process from lecturer-centered to student-centered. This approach shifts content delivery to pre-class activities through videos, readings, and digital platforms, while class time is devoted to discussion, problem-solving, and application. Such transformation reflects broader trends in higher education aimed at fostering active learning and preparing students for complex challenges in the 21st century (Galindo-Dominguez, 2021; Strelan et al., 2020).

Extensive international research highlights the benefits of the Flipped Classroom model in enhancing student engagement, learning motivation, and higher-order thinking skills (Awidi & Paynter, 2019; Turan & Akdag-Cimen, 2020). By encouraging students to engage with materials beforehand, classroom sessions become opportunities for collaborative exploration and deeper understanding. However, its success often depends on supporting factors such as institutional infrastructure, lecturer readiness in designing interactive content, and students' digital literacy (Akçayır & Akçayır, 2018; Hew et al., 2021). Without these, the potential of Flipped Classroom may not be fully realized.

In Informatics and Engineering education, the Flipped Classroom is particularly relevant due to the emphasis on problem-solving, technical skills, and teamwork. Studies show that collaborative learning in flipped settings supports the development of essential professional competencies such as critical thinking and communication (Hall et al., 2022; Patnaik, 2020). Nevertheless, challenges remain, especially related to students' limited self-regulated learning habits and the need for instructional designs that align with complex technical content (Estriegana et al., 2019). These challenges highlight the need for careful adaptation of the model in Informatics contexts.

In Indonesia, the application of Flipped Classroom is still at a developing stage. Early studies indicate that the model can improve student motivation and participation, but issues such as uneven digital literacy, infrastructure limitations, and students' learning attitudes remain significant barriers (Hidayat et al., 2021; Novitra et al., 2025). The increasing use of Learning Management Systems (LMS) in universities offers opportunities for structured implementation, yet disparities in access and effective utilization persist (Zainuddin & Perera, 2019). These conditions suggest that while the Flipped Classroom is promising, localized challenges must be addressed for it to succeed in Indonesian higher education.

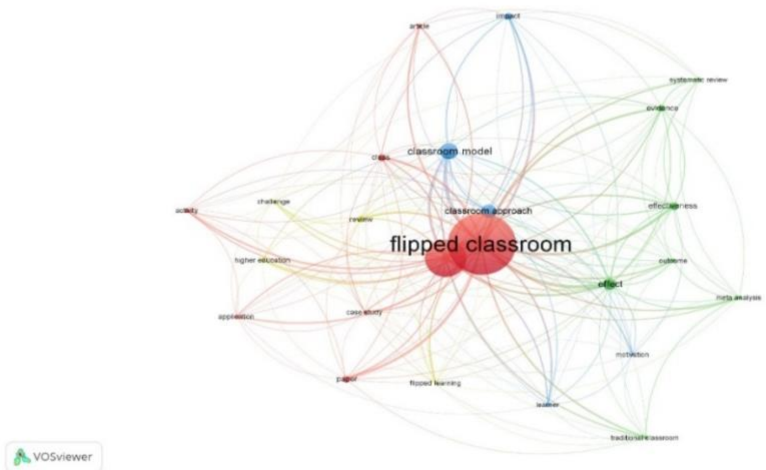

Figure 1. Flipped Classroom Research

Figure 1 illustrates the steady growth of global research on Flipped Classroom, demonstrating its widespread relevance across educational disciplines. However, the figure also reveals that studies focusing on Informatics Engineering—particularly on collaborative learning—remain scarce compared to other areas. This lack of emphasis suggests that although the effectiveness of Flipped Classroom has been broadly confirmed, there is insufficient exploration of how it fosters collaboration in technology-driven disciplines where teamwork is a core learning outcome.

Therefore, this study aims to fill the gap by systematically reviewing literature on the Flipped Classroom with a specific focus on student collaboration in Informatics Engineering education. Collaboration is a key competency for graduates who must be prepared to operate in interdisciplinary, digital, and globalized work environments (Alvendri et al., 2023). By mapping existing studies, identifying challenges, and highlighting best practices, this review contributes to both theory and practice, providing insights for lecturers, policymakers, and institutions to design more effective and collaborative learning strategies in the digital era.

2. METHODS

This study utilizes the Systematic Literature Review (SLR) approach to examine the role of the Flipped Classroom model in advancing student collaboration, especially within the Informatics Engineering Education Study Program. This method systematically identifies, analyzes, and synthesizes findings from previous studies. The purpose is to gain a deeper understanding of how Flipped Classroom affects the dynamics of collaboration between students.

The selection of the SLR method is based on its ability to provide a structured framework for reviewing the scientific literature. Thus, this research can identify emerging trends, find untapped research gaps, and formulate concrete recommendations for the future implementation of Flipped Classroom. This approach is aligned with a methodology that ensures the robustness and credibility of the resulting findings (Kitchenham et al., 2007).

Through a systematic evaluation of selected studies, this review provides a comprehensive overview. This includes understanding best practices for encouraging student collaboration through Flipped Classroom, as well as identifying factors that support or hinder its success. The findings provide a basis for developing more effective and collaborative learning strategies in the Informatics Engineering Education Study Program.

2.1 Systematic Study Design

SLR is carried out by following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol which regulates the steps of searching, selecting, and reporting articles in a transparent and replicable manner. The PRISMA framework consists of four main stages: identification, screening, feasibility determination, and synthesis (Khofifah et al., 2021)

2. 2 Literature Search Strategy

Article searches were conducted in international databases (Scopus, ScienceDirect, SpringerLink, Taylor & Francis, and ERIC) and national databases (Garuda Ristekdikti, Sinta, and Google Scholar). The main keywords used include: *Flipped Classroom Collaborative Learning, Collaboration Higher Education, University Systematic Review, Literature Review Computer Science Education, Informatics Education.*

2.3 Inclusion and Exclusion Criteria

Inclusion criteria:

a. Articles were published in the 2015–2024 time frame.
b. The article was published in a peer-reviewed journal.
c. Discussing Flipped Classroom with a focus on student collaboration in higher education.
d. Full-text is available in English or Indonesian.
e. Using an empirical approach (qualitative, quantitative, or mixed).

Exclusion criteria:

a. Articles in the form of editorial, opinions, or non-systematic reviews.
b. Duplicate articles on different databases.
c. Research at the primary or secondary education level.
d. Articles with non-academic context (informal courses, corporate training, etc.).

2.4 Screening Process

The initial search results are extracted into an Excel worksheet that records: title, author, year of publication, journal, abstract, DOI, and full-text URL. Screening is carried out in two stages:

a. The first stage: selection of titles and abstracts to check relevance.
b. The second stage: reading the full-text to determine the suitability of the inclusion criteria.

The number of articles at each stage will be visualized through the PRISMA flowchart showing the number of initial search results, the number after duplicate screening, articles eliminated, and the final articles reviewed.

2.5 Data Extraction and Synthesis

Data from selected articles is extracted using a data extraction sheet that contains:

a. Bibliographic information (author, year, journal).
b. Research objectives.
c. Research methods and designs.
d. Characteristics of the sample and the context of the study.
e. Key findings related to the implementation of the Flipped Classroom and student collaboration aspects.
f. Recommendations of practical implications.
g. The extraction process is carried out by a minimum of two independent reviewers to minimize selection bias. If there are differences in interpretation, discussions will be held until a consensus is reached.

2.6 Analytical Techniques

The data were analyzed using a thematic analysis approach to identify key themes that often emerged. The anticipated themes are: Flipped Classroom implementation strategy, collaboration supporters/obstacles, learning motivation, active student involvement, the role of technology, and success evaluation models. The findings are presented in the form of a synthesis table, thematic diagram, and descriptive narrative that explains trends, differences in results, and research gaps.

2.7 Validation

The validity of the SLR process was maintained through transparent protocol documentation, presentation of the PRISMA flowchart, and provision of a complete list of selected articles. Validation was further supported by peer debriefing with supervisors and colleagues to ensure the appropriateness of interpretations. In addition, two independent reviewers assessed the inclusion and exclusion of articles, with any discrepancies resolved through discussion until consensus was reached, thereby strengthening the credibility of the review process. With this structured approach, the study serves as a reliable academic reference for the development of more effective flipped classroom practices, particularly in fostering student collaboration in Informatics Engineering Education.

Following the identification stage, a total of 200 records were retrieved from international and national databases using predefined keywords related to flipped classroom and student collaboration. In accordance with the PRISMA guidelines, 37 duplicate records were removed, resulting in 163 unique articles. The remaining articles underwent title and abstract screening, during which 143 studies were excluded due to irrelevance to the research focus, such as studies that did not involve flipped classroom models, did not examine collaboration outcomes, or were conducted outside higher education contexts.

Subsequently, 20 full-text articles were assessed for eligibility based on the established inclusion and exclusion criteria. At this stage, 10 articles were excluded because they did not explicitly measure collaborative learning outcomes or lacked empirical evidence. As a result, 10 empirical studies were deemed eligible and included in the final qualitative synthesis. The detailed screening and selection process is illustrated in the PRISMA flow diagram (Figure 2).

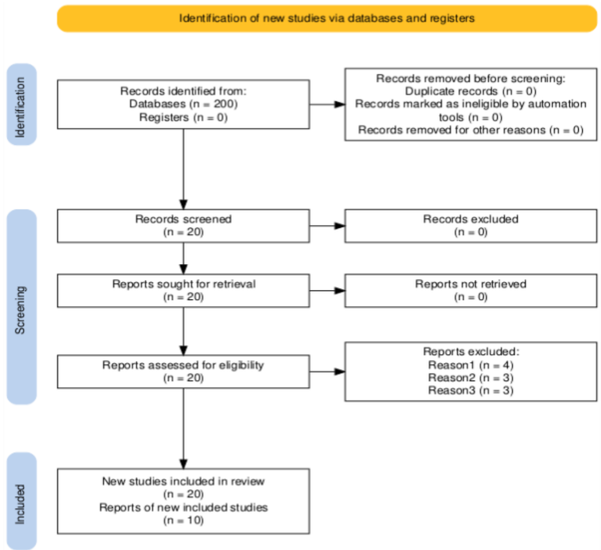

Figure 2. Step-related PRISMA Diagram Systematic Literature Review

The selection process of the reviewed articles followed the PRISMA protocol, which includes stages of identification, screening, eligibility, and inclusion. *Figure 2 illustrates the PRISMA flow diagram*, presenting the number of studies initially identified, the duplicates removed, the excluded articles, and the final set of studies that met the inclusion criteria for this review. This systematic screening process ensured transparency, rigor, and reproducibility of the review in line with the PRISMA framework.

3. FINDINGS AND DISCUSSION

3.1 Overview and table justification

The systematic search identified 200 potentially relevant records after title/abstract/full-text screening and application of inclusion criteria, 10 empirical studies were selected for synthesis. Key metadata and results are summarized in Table 1. The table is presented once as a comparative tool to extract patterns, differences, and collaboration-specific findings across studies the discussion below uses that synthesis to move beyond description toward critical comparison and interpretation.

Table 1. Research Results on Systematic Analysis of Flipped Classroom in Higher Education

No	Author & Years	Country	Educational Context	Research Method	Collaboration Indicator	Key Findings
1	(Beran et al., 2015)	USA	Higher Education	Survey-based quantitative	Self-reported interaction scale	Flipped classroom increased engagement; collaboration was limited and not a primary outcome
2	(Dong, 2016)	China	Higher Education (English Teaching)	Quantitative	Classroom interaction observation	Learning experience improved; collaboration was not explicitly measured
3	(Gómez-Coma et al., 2023)	Spain	Chemical Engineering Education	Quasi-experimental	Group laboratory work, peer explanation	Group-based laboratory activities promoted peer-to-peer collaboration
4	(Patnaik, 2020)	India	Engineering Education	Descriptive quantitative	Group practice activities	Flipped classroom increased confidence; collaboration outcomes were not detailed

No	Author & Years	Country	Educational Context	Research Method	Collaboration Indicator	Key Findings
5	(Hall et al., 2022)	USA	Engineering Education	Mixed-methods	Peer interaction, group performance	Structured collaborative roles significantly improved teamwork quality
6	(Fedistia & Musdi, 2020)	Indonesia	Mathematics Education	Quasi-experimental	Group discussion activities	Mathematical reasoning improved; collaboration was descriptively reported
7	(Rindaningsih, 2018)	Indonesia	Teacher Education	Qualitative descriptive	Group discussion and participation	Flipped classroom increased active participation through group discussions
8	(Gumilar, 2021)	Indonesia	Mathematics Education	Quantitative	Classroom interaction	Improved comprehension; collaboration was not directly assessed
9	(Khofifah et al., 2021)	Indonesia	Higher Education	Experimental	Group discovery learning tasks	Conceptual understanding improved; collaboration was present but secondary
10	(Hernandez et al., 2023)	Mexico	Health Informatics Education	Experimental	Group case analysis	Collaborative case-based learning improved interaction and learning effectiveness

3.2 Effectiveness across Disciplines

Most reviewed studies report that the Flipped Classroom improves conceptual understanding and increases opportunities for student interaction across disciplines (languages, mathematics, and engineering). However, the magnitude of collaboration gains varies. Studies reporting larger collaboration effects typically paired the Flipped Classroom with tasks that required genuine interdependence (project work, co-authored deliverables) and used group-graded assessments. In contrast, studies showing limited collaboration tended to rely on individual pre-class checks and unstructured in-class discussions practices that increase preparation but do not automatically create teamwork. This comparison suggests that discipline alone does not determine success rather, the task design and the presence of graded, structured group work are key moderators.

3.3 Collaboration specific outcomes

When we extract collaboration specific indicators (peer interaction frequency, quality of group problem solving, clarity of role assignment, peer assessment scores), common patterns emerge. Positive outcomes include more frequent peer explanation, clearer task division, and improved peer feedback when instructors assign roles and scaffold group processes. Conversely, when collaboration was measured only via generic engagement or self-reported satisfaction, apparent "success" sometimes reflected individual learning rather than true collaborative skill development. Thus, measurement choice strongly affects reported outcomes: observational or performance-based measures more reliably capture collaborative competence than single-item self-reports.

3.4 Barriers to Implementation (and how they affect collaboration)

The principal barriers reported are: (1) student time management and lack of self-regulated study habits, (2) uneven digital literacy, (3) instructor inexperience in designing collaborative pre-class and in-class tasks, and (4) infrastructural limits. Importantly, these barriers do not simply reduce learning gains they specifically degrade collaboration by creating unequal preparation among group members, producing free-rider dynamics, and limiting the depth of discussion. Mitigation strategies that correlate with stronger collaboration include low-stakes formative checks (pre-class quizzes), role assignment, and explicit peer evaluation.

3.5 Role of technology

Technology and LMS features shape collaboration beyond content delivery. Studies that reported stronger collaboration used platforms enabling asynchronous discussion threads, peer review, shared artifacts (e.g., collaborative coding repos, shared documents), and clear tracking of contributions. Where the LMS was limited to one-way video distribution, increased preparation did not translate into richer collaboration. Hence, technological capacity must be aligned with instructional design: the LMS should support communication, artifact co-creation, and transparent assessment of group work.

3.6 Why results vary - a critical comparison

Across the sample, differences in reported collaboration outcomes can be traced to several interacting factors: (a) instructional design (project-based, role scaffolding vs. unstructured discussion), (b) assessment alignment (graded group tasks vs. only individual quizzes), (c) measurement method (observational/performance measures vs. self-report), (d) class size and composition (smaller, cohorted classes show more effective teamwork), and (e) instructor facilitation (active facilitation and feedback increase productive interaction). Contextual institutional factors policies on LMS use, availability of TA support, and cultural expectations about group work further modulate outcomes. These interacting factors explain why some studies report high collaboration benefits while others find only marginal change.

3.7 Implications for practice and research

For practice: prioritize task designs that require interdependence (project work, shared deliverables), align assessment to reward collective performance, incorporate formative readiness checks, assign roles, and use LMS features that enable artifact sharing and peer review. For research: future studies should (1) adopt standardized, collaboration-focused outcome measures (performance/observational + peer assessment), (2) test mixed-methods classroom interventions that combine Flipped Classroom with Project-Based Learning, and (3) conduct longitudinal designs to capture durable changes in collaborative competence.

3.8 Terminology note

For consistency, this review uses the term "Flipped Classroom". When primary studies use "Inverted Classroom", the original terminology is retained in Table 1 and treated as conceptually equivalent; any reported distinctions are noted.

3.9 Research Gaps and Future Directions

Despite the growing body of literature on the Flipped Classroom in higher education, this review reveals several critical research gaps related to student collaboration. First, most existing studies do not explicitly operationalize collaboration as a primary outcome, but instead treat it as a secondary or descriptive by-product of increased engagement. Collaboration is frequently inferred from self-reported interaction or participation measures, rather than assessed through performance-based, observational, or peer-evaluation indicators that more accurately capture collaborative competence. Second, there is a lack of comparative and design-sensitive research that systematically examines how different instructional designs (e.g., structured roles, project-based tasks, assessment-aligned collaboration) influence collaborative outcomes within flipped classroom environments. As a result, variations in findings across studies are often reported without sufficient explanation of the underlying pedagogical mechanisms. Third, longitudinal evidence remains scarce, particularly in Informatics Engineering and technology-oriented disciplines, where collaboration is a core professional competency. Most studies focus on short-term classroom interventions and immediate perceptions, leaving unanswered questions regarding the durability, transferability, and scalability of collaborative skills developed through the Flipped Classroom. These gaps indicate the need for future research that adopts collaboration-centered measurement frameworks, employs mixed-method and longitudinal designs, and situates flipped classroom interventions within authentic, discipline-specific collaborative tasks, particularly in Informatics Engineering education.

Discussion

The findings of this systematic review indicate that the Flipped Classroom (FC) model is widely adopted in higher education; however, its effectiveness in fostering student collaboration remains inconsistent and context-dependent. Although many studies report improvements in engagement, participation, and conceptual understanding, collaboration is frequently positioned as a secondary outcome rather than a primary instructional objective. This suggests that the presence of active learning alone is insufficient to guarantee meaningful collaboration. Instead, collaboration must be intentionally embedded within the pedagogical design, supported by structured activities and aligned assessment strategies. This observation is consistent with prior research emphasizing that active learning environments do not inherently produce collaborative competence without deliberate instructional scaffolding (Akçayır & Akçayır, 2018; Strelan et al., 2020).

A critical pattern emerging from the reviewed studies is that collaborative effectiveness is not determined by disciplinary differences but by the design of learning tasks and assessment mechanisms. Across fields such as engineering, mathematics, and language education, studies that incorporated structured, interdependent tasks—such as project-based learning, laboratory collaboration, and case-based analysis—reported stronger collaboration outcomes. These approaches require students to engage in shared problem-solving and collective responsibility, which are essential components of effective teamwork. In contrast, studies that relied on individual pre-class preparation combined with unstructured in-class discussions demonstrated limited collaborative impact. While such approaches may enhance individual readiness, they often fail to create the interdependence necessary for collaborative knowledge construction. This finding aligns with social constructivist perspectives, which argue that learning is most effective when individuals actively engage in shared meaning-making processes (Vygotsky, 1978; Johnson & Johnson, 2009).

The way collaboration is measured also plays a crucial role in shaping research outcomes. Studies that employed performance-based and observational indicators—such as the quality of peer interaction, effectiveness of group problem-solving, and peer assessment results—provided more robust evidence of collaborative learning. These studies show that when instructors assign explicit roles and structure group processes, students demonstrate improved communication, accountability, and task coordination (Hall et al., 2022; Hernandez et al., 2023). In contrast, studies relying on self-reported measures of engagement or satisfaction tend to overestimate collaboration, as these metrics often reflect individual perceptions rather than actual collaborative performance. This methodological limitation has been widely noted in collaborative learning research, which stresses the importance of using multi-dimensional assessment approaches to capture the complexity of group interactions (Dillenbourg, 1999).

Several barriers to effective collaboration in FC environments were also identified. These include students' limited self-regulated learning skills, poor time management, uneven digital literacy, and instructors' lack of experience in designing collaborative activities . These challenges significantly affect group dynamics by creating unequal levels of preparation among students, which can lead to disengagement or free-rider behavior. In addition, infrastructural limitations, particularly in developing educational contexts, may restrict access to digital tools necessary for supporting collaborative learning. Previous studies have similarly highlighted that the success of FC implementation depends heavily on both student readiness and institutional support (Hew et al., 2021; Zainuddin & Perera, 2019).

Importantly, the review identifies several strategies that can mitigate these challenges and enhance collaboration. The use of formative assessments, such as pre-class quizzes, helps ensure that students come prepared for in-class activities, thereby improving the quality of group interaction. Assigning clearly defined roles within groups promotes accountability and balanced participation, while peer evaluation mechanisms encourage individual responsibility within collaborative tasks. These strategies are grounded in cooperative learning theory, which emphasizes positive interdependence, individual accountability, and structured interaction as key elements of effective collaboration (Johnson & Johnson, 2009).

Technology also plays a pivotal role in shaping collaborative experiences within FC environments. While digital platforms are integral to the flipped model, their effectiveness depends on how they are utilized. The review shows that Learning Management Systems (LMS) that support interactive features—such as discussion forums, collaborative document editing, and peer feedback tools—significantly enhance collaboration by enabling continuous interaction and shared knowledge construction . Conversely, when technology is used primarily for one-way content delivery, such as video lectures, it does not substantially contribute to collaborative learning. This finding supports the Technological Pedagogical Content Knowledge (TPACK) framework, which emphasizes the need for alignment between technology, pedagogy, and content to achieve effective learning outcomes (Mishra & Koehler, 2006).

The variation in collaboration outcomes across studies can be attributed to the interaction of several key factors, including instructional design, assessment alignment, measurement methods, class size, and instructor facilitation. Structured, project-based approaches combined with group-based assessment consistently yield stronger collaboration outcomes than unstructured or individually assessed models. Additionally, smaller class sizes and active instructor facilitation contribute to more effective teamwork by enabling closer monitoring and guidance. Institutional factors, such as policies on technology use and availability of support resources, further influence the success of FC implementation. These findings reinforce the idea that collaboration is not an automatic outcome of the flipped model but a result of carefully orchestrated educational practices (Awidi & Paynter, 2019).

Despite the growing body of research on the Flipped Classroom, this review highlights several critical gaps. First, collaboration is rarely operationalized as a primary learning outcome, leading to inconsistencies in both conceptualization and measurement. Second, there is a lack of comparative studies examining how different instructional designs influence collaborative outcomes, limiting understanding of the mechanisms underlying effective collaboration. Third, longitudinal research remains scarce, particularly in Informatics Engineering education, where collaboration is a core professional competency. Most existing studies focus on short-term interventions, leaving unanswered questions about the long-term development and transferability of collaborative skills . Addressing these gaps will require more rigorous, design-sensitive, and longitudinal research approaches.

In conclusion, while the Flipped Classroom offers significant potential to enhance student collaboration, its effectiveness depends on intentional design, aligned assessment, appropriate use of technology, and rigorous evaluation methods. Without these elements, the model may improve individual learning without substantially developing collaborative competence. Therefore, educators and researchers must move beyond viewing collaboration as an implicit outcome and instead treat it as a central objective in the design and evaluation of flipped learning environments.

4. CONCLUSION

The findings of this systematic review demonstrate that the Flipped Classroom (FC) model has the potential to enhance student collaboration in higher education when collaborative activities are intentionally structured, aligned with assessment, and supported by interactive learning environments. By integrating pre-class preparation with active, discussion-based in-class sessions, the FC approach promotes not only participation but also the development of critical thinking and independent learning skills, which are essential for 21st-century education. However, the effectiveness of its implementation is contingent upon several factors, including the availability of adequate technological infrastructure, lecturers' pedagogical readiness, and students' digital literacy, all of which remain uneven across institutions. This study is subject to several limitations, including its reliance on a limited number of published studies between 2015 and 2024, restricted database coverage, potential language bias, and the absence of primary empirical data to validate findings in real classroom contexts. Therefore, future research should adopt more rigorous and comprehensive approaches, such as mixed-method and longitudinal designs, to examine the sustained impact of the FC model on collaborative skills, as well as explore discipline-specific implementations, particularly in Informatics Engineering. Additionally, further studies should investigate the integration of FC with pedagogical models such as Project-Based Learning and Problem-Based Learning to better support authentic collaboration and align educational practices with evolving technological and workforce demands.

Conflicts of Interest: The authors declare no conflict of interest.

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