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THE EFFECTIVENESS OF TECHNOLOGY-ENHANCED FLIPPED LEARNING IN REDUCING ACADEMIC ANXIETY

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ABSTRACT

Purpose: *This study aims to identify typologies of digital technology integration in Flipped Classroom implementation and synthesize empirical evidence regarding its effectiveness in improving learning anxiety and self-efficacy among higher education learners.*

Design/methodology/approach*:This study employs a Systematic Literature Review (SLR) following the PRISMA 2020 framework. Literature searches were conducted using the Scopus database, covering publications from 2021 to 2026. From 118 initial records, 15 empirical and conceptual research articles were selected based on PICOC eligibility criteria and MMAT/CASP quality assessment standards. The selected studies were analyzed using an integrated narrative synthesis.*

Findings:*The findings identify five primary technology typologies supporting Flipped Classroom implementation: Learning Management Systems (Moodle, Teams, Google Classroom, and WeChat), immersive 6DOF Virtual Reality, Generative Artificial Intelligence (ChatGPT), automated CRM Salesforce workflows, and synchronous Zoom platforms. Overall, Flipped Classroom interventions enhance learners' self-efficacy, practical confidence, and academic grit. However, their effectiveness in reducing learning anxiety varies across contexts. Anxiety reduction is consistently observed in within-group pretest-posttest analyses but is not uniformly superior to conventional instruction in between-group comparisons, unless supported by immersive simulations, Team-Based Learning strategies, and pre-class cognitive load management.*

Research limitations/implications*:This study is limited to 15 selected empirical and conceptual articles indexed in Scopus from 2021 to 2026. Future research should conduct empirical investigations to examine the effectiveness of specific technological approaches and pedagogical strategies in reducing learning anxiety and strengthening self-efficacy across different higher education contexts.*

Originality/value: *This study contributes to the literature by integrating digital technology typologies with psychological learning outcomes in Flipped Classroom implementation. It highlights the importance of balancing pre-class workloads, providing instructional scaffolding, and strengthening teacher self-efficacy to optimize learners' psychological well-being and learning experiences.*

Paper type: *Systematic Literature Review (SLR).*

Keywords: *Flipped Classroom, digital technology, learning anxiety, self-efficacy, higher education.*

A. INTRODUCTION

The implementation of the technology-based Flipped Classroom has developed across various educational settings, including higher education and professional education. This learning model allows learners to study materials before face-to-face sessions through digital media, enabling classroom time to be used for discussions and collaborative activities. The integration of technologies such as Learning Management Systems (LMS), Virtual Reality (VR), Artificial Intelligence (AI), and interactive videos also provides flexibility in the learning process. However, its effectiveness in relation to psychological conditions, particularly anxiety and self-efficacy, has yielded mixed results.

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Several studies have reported that technology-based Flipped Classrooms have the potential to reduce learners' anxiety. Diel et al. (2021), for example, found a reduction in anxiety among medical students following the implementation of flipped learning. Similar findings were reported by Wu et al. (2026) through the integration of VR with the Flipped Classroom in mental health education. However, Tran et al. (2025), in a study involving 221 EFL students in Vietnam, found that although reading anxiety decreased during the learning process, the difference in reduction between the Flipped Classroom group and the conventional group was not statistically significant. Meanwhile, Alfaifi and Saleem (2022) showed that the online implementation of the Flipped Classroom did not fully produce positive outcomes in learners' psychological aspects. These differing findings indicate that the effectiveness of the Flipped Classroom in reducing anxiety needs to be examined by considering learner characteristics, the types of technology used, and the instructional design implemented.

In addition to anxiety, self-efficacy and instructional readiness are also relevant aspects of Flipped Classroom implementation. Luo and Zou (2026) found that teachers' self-efficacy was significantly associated with their readiness to teach using this model. This indicates that the successful implementation of the Flipped Classroom depends not only on the use of technology but is also influenced by pedagogical readiness and design. Therefore, a Systematic Literature Review (SLR) is needed to map forms of technology integration and synthesize empirical evidence regarding the effectiveness of the Flipped Classroom in relation to learners' anxiety and self-efficacy.

This study employs the PICOC framework (Population, Intervention, Comparison, Outcome, and Context) to determine the scope of the review. The Population includes university students, pre-service teachers, participants in professional or clinical education, as well as educators and lecturers. The Intervention comprises the implementation of technology-based Flipped Classroom, Flipped Learning, or Inverted Classroom approaches, such as those incorporating LMS, VR, AI, interactive videos, and synchronous learning platforms. The Comparison includes conventional learning as well as pre- and post-intervention measurements. The Outcome focuses on learning anxiety, foreign language anxiety, and reading anxiety as the primary indicators, while self-efficacy, confidence, teaching readiness, and perceived cognitive load serve as supporting indicators. The Context includes digital learning, blended learning, higher education, professional or clinical education, and the professional development of educators.

Based on this scope, this study formulates three research questions: (RQ1) What are the characteristics and forms of digital technology integration used in Flipped Classroom implementation in higher education and professional education? (RQ2) What empirical evidence is available regarding the effectiveness of technology-based Flipped Classrooms in reducing anxiety and increasing learners' self-efficacy compared with conventional learning? (RQ3) What pedagogical and methodological factors influence variations in the effectiveness of Flipped Classrooms on learners' psychological conditions?

Although several previous literature reviews have examined the implementation of Flipped Classrooms, most earlier SLRs have treated technology as a homogeneous category and measured only users' subjective perceptions, without clearly distinguishing between changes within the same group (within-group changes) and statistical comparisons with control groups (between-group comparisons). The novelty of this SLR lies in its comprehensive thematic analysis, which specifically maps the effectiveness of various digital technology ecosystems (general-purpose LMS, interactive AI, and immersive VR) in relation to students' cognitive and affective indicators (anxiety and self-efficacy). It also identifies the fundamental distinction between the significance of pre- and post-intervention improvements (within-group) and the relative advantages of these approaches over conventional learning methods (between-group).

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To examine these issues, this study uses the Systematic Literature Review (SLR) method with the PICOC framework (Population, Intervention, Comparison, Outcome, and Context). The Population focuses on school-level students, excluding university students and educators as research populations.

B. METHODOLOGY

Search Protocol and Identification Strategy

This literature review was developed in accordance with the PRISMA 2020 guidelines (Page et al., 2021). Primary literature was systematically identified in September 2026 through the Scopus academic database. The search strategy used a combination of Boolean operators, namely OR and AND, with the following keywords:
("Flipped Classroom" OR "Flipped Learning" OR "Inverted Classroom" OR "Flipped Approach") AND ("Anxiety" OR "Academic Anxiety" OR "Language Anxiety").
Pencarian dibatasi pada artikel jurnal berbahasa Inggris yang telah memasuki tahap publikasi final dan diterbitkan pada rentang tahun 2021–2026.

Inclusion and Exclusion Criteria

To maintain the relevance and validity of the data corpus, the researchers established a set of strict eligibility criteria, as presented in Table 1.

Table 1.
Literature Inclusion and Exclusion Criteria

Parameter	Inclusion Criteria (Accepted)	Exclusion Criteria (Rejected)
Year Range	Published between 2021 and 2026	Published before 2021 or after 2026
Document Type	Empirical/primary scientific journal articles (peer-reviewed)	Review papers, conference proceedings, book chapters, editorials, opinions
Population/Context	School students/learners (secondary and higher education students)	Research in non-educational fields or involving industry practitioners
Intervention	Flipped Classroom integrated with digital technology (LMS, AI, VR)	Purely conventional learning without flipped/digital components
Access and Language	English-language articles with full text available	Non-English articles and articles behind a paywall/not accessible

Data Extraction and Study Selection

The initial search in Scopus yielded 118 documents. The pre-screening stage eliminated 22 documents (non-primary articles/non-English publications), leaving 96 documents. Title and abstract screening eliminated 22 out-of-scope documents, leaving 74 documents. During full-text retrieval, 23 documents could not be accessed (paywalled); therefore, 51 full-text articles were assessed for eligibility. During the eligibility assessment, 36 documents were excluded (15 did not focus on the

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main topic, 7 did not address the research questions, and 14 were non-primary-article publication types), resulting in 15 final Scopus articles.

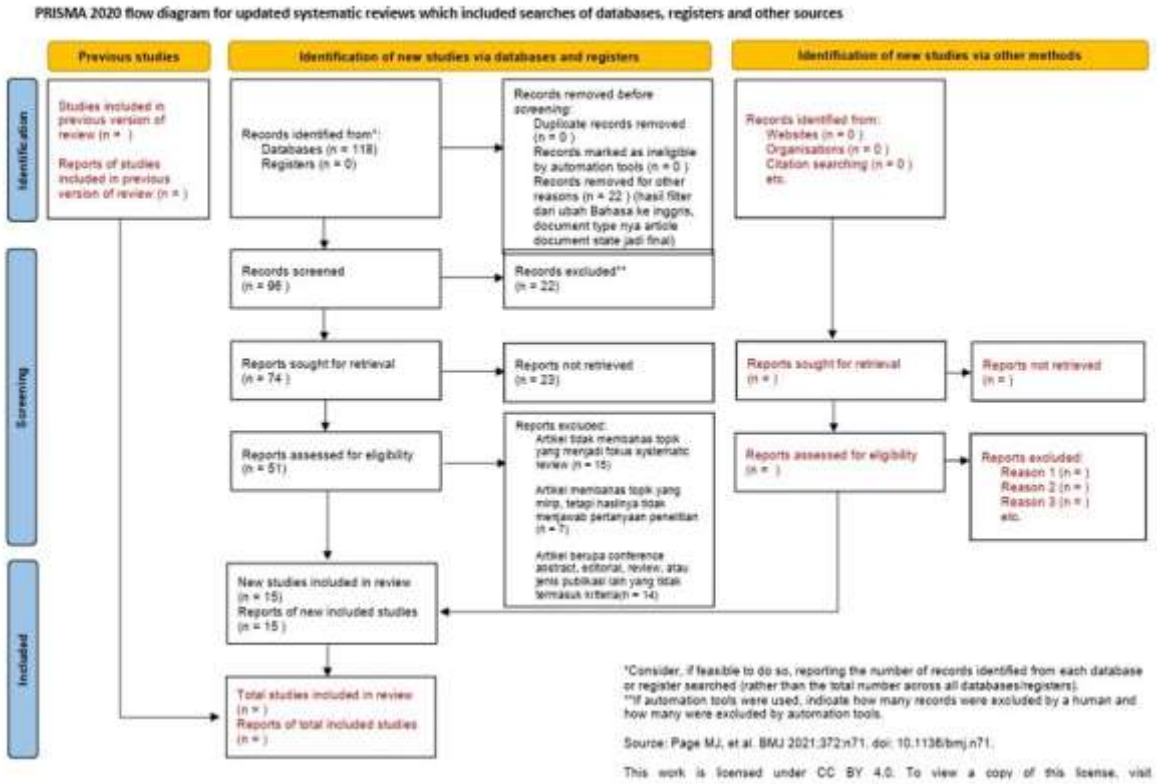

Figure 1. PRISMA 2020 Study Selection Flow Diagram

C. RESULTS AND DISCUSSION

Bibliometric Mapping and Characteristics of the Analyzed Studies

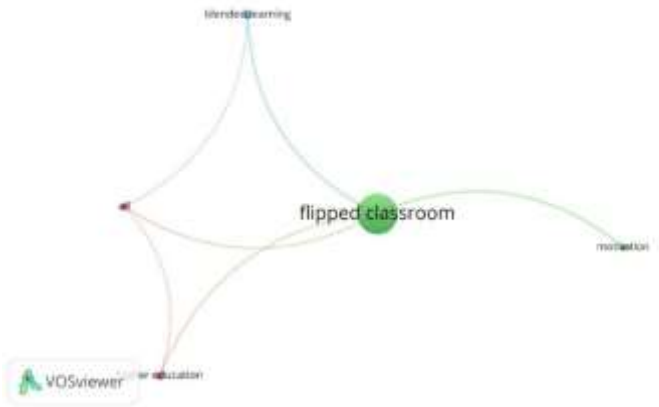

Figure 2. VOSviewer Visualization of the Main Keywords

Based on the data extraction sheet, there are 15 study records discussing the technology-assisted implementation of Flipped Classrooms in relation to learning outcomes and psychological aspects.

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These studies cover digital learning technologies, online discussion forums, Learning Management Systems (LMS), instructional videos, Virtual Reality (VR), and Artificial Intelligence (AI)-based technologies.

The variables analyzed include learning anxiety, foreign language anxiety, reading anxiety, self-efficacy, confidence, learning readiness, student perceptions, and learning outcomes. The diversity of these variables indicates that the impact of Flipped Classrooms needs to be examined separately from cognitive and psychological perspectives.

In this study, the population terminology is standardized as "learners" in accordance with the review focus. However, the sample characteristics in each article remain consistent with the original information recorded in the extraction sheet. Therefore, the suitability of each sample for primary and/or secondary school education must be confirmed before all studies are designated as primary evidence.

Table 2.
Summary of Study Characteristics Based on the Extraction Sheet

Aspect	Findings from the extraction sheet
Number of study records	15
Learning model	Flipped Classroom, Flipped Learning, and variations of online implementation
Technology	Digital forums, LMS, videos, H5P, AI, and Zoom
Psychological variables	Anxiety, self-efficacy, confidence, motivation, readiness, and perceptions
Cognitive variables	Learning outcomes and mathematics learning self-efficacy
Type of evidence	Quantitative, qualitative, and conceptual

The table represents the number of available records, not necessarily the number of independent studies that all meet the population criteria. The identities of the articles and the suitability of their samples still need to be verified.

Technology in Flipped Classroom Implementation

The technologies recorded in the extraction sheet are used to support material delivery, discussions, online learning activities, simulations, and learner interaction. The variety of technologies indicates that Flipped Classrooms are not implemented through a single platform.

Table 3.
Technologies and Implementation Contexts in the Studies

Technology or approach	Examples in the extraction sheet

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Digital platforms and discussion	Flipped Classroom based on online forums
LMS and interactive media	Moodle, Teams, H5P
Videos and case discussions	Instructional videos and case discussions
VR and Flipped Classroom	VR and Rain Classroom
Online learning	Fully Flipped Classroom
TPACK and TAM	Flipped Foreign Language Classroom
AI-based technology	AI in mathematics learning
Synchronous learning	Zoom
Conceptual digital media	Digital videos, Web 2.0, devices, and social media

These technologies serve different functions. Videos and digital platforms can be used to prepare learning materials before class, while LMS and interactive media support the management of learning activities. VR and AI offer different forms of interaction, but their effectiveness must be assessed based on the outcomes measured in each study. Therefore, the use of technology cannot automatically be considered the cause of anxiety reduction. This relationship must be demonstrated through research outcome data, including score comparisons and statistical significance.

Synthesis of Affective Effectiveness: Distinguishing Within-Group Changes and Between-Group Comparisons

To objectively evaluate the effectiveness of the Technology-Enhanced Flipped Classroom, this systematic review clearly distinguishes changes occurring within the same group before and after treatment (within-group changes) from differential comparisons between experimental groups and conventional control groups (between-group comparisons).

a. Analysis of Within-Group Changes
   Nearly all empirical studies in the literature corpus reported a significant positive trend in within-group changes after students experienced technology-based Flipped Classroom interventions. In the Virtual Reality (VR)-based group, SAS anxiety scores and SDS depression scores decreased with high statistical significance ($p < 0.001$) from pre-test to post-test. In the medical and pre-service teacher domains, pre- and post-treatment measurements indicated increased clinical confidence and reduced foreign language anxiety (FLCAS) as exposure to pre-class materials increased. Even in an anomalous study such as Tran et al. (2025), involving EFL students in Vietnam, within-group analysis confirmed that the Flipped Classroom group still experienced an observable internal reduction in reading anxiety from pre-test to post-test.
b. Analysis of Between-Group Comparisons

Although within-group analyses consistently indicate affective improvements, between-group analyses reveal that the relative advantage of the Flipped Classroom over conventional methods is strongly determined by the specific technology used.

Analysis of Psychological and Cognitive Outcomes

Psychological and cognitive outcomes need to be distinguished to ensure that the interpretation of the research does not go beyond the variables measured. In the study by Qiu and Ishak (2025),

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mathematics learning self-efficacy was reported to have a coefficient of $\beta = 0.382$, $t = 3.825$, and $p = 0.005$. This result indicates a statistical relationship involving the self-efficacy variable, as recorded in the extraction sheet. However, this finding is not direct evidence that mathematics anxiety decreased. The study by Dečman et al. (2025) recorded R^2 values of 80.3%, 67.1%, and 50.2%, as well as a 50% reduction in social isolation with $p < 0.001$. R^2 values indicate the proportion of variance explained by a particular statistical model, not the percentage reduction in anxiety. Therefore, these values must be linked back to the variables and analytical models in the original articles before they are interpreted further.

Zheng et al. (2024) used group discussions to examine self-efficacy and psychological experiences. Because the extraction sheet does not provide quantitative measures of changes in self-efficacy, these findings are more appropriately presented as qualitative evidence. Liu (2022) discusses the conceptual relationship between Flipped Learning, value perception, control, and anxiety. Since this study is recorded as not having been empirically tested, its content can support conceptual explanations but cannot be used as numerical evidence of intervention effectiveness.

Synthesis of Findings Across Studies

Based on the available figures, several patterns can be identified. First, some studies reported changes in anxiety scores. Diel et al. (2021), for example, recorded a score reduction of 0.57 points. Wu et al. (2026) recorded an 8.84-point difference in anxiety scores between two groups. However, interpreting the benefits still requires verification of the group order and measurement instruments.
Second, not all studies demonstrated a significant advantage of the Flipped Classroom. Tran et al. (2025) reported $p = 0.38$ for the between-group difference. This result does not support the claim that the Flipped Classroom model was significantly more effective than traditional methods in reducing reading anxiety in that study.

Third, some studies provide stronger explanations of related psychological variables than of anxiety directly. The self-efficacy finding with $p = 0.005$ in Qiu and Ishak (2025), for example, is relevant to understanding the learning experience but cannot be counted as direct evidence of anxiety reduction.

Fourth, the technologies used are highly diverse, ranging from digital forums and videos to LMS, VR, and AI. This diversity does not yet allow any single technology to be identified as the most effective for reducing anxiety without comparable cross-study evaluations.

Limitations of the Reviewed Studies

Based on the extraction sheet, the recorded limitations include small samples, studies conducted at a single institution, the use of questionnaires or self-reports, short intervention durations, the absence of control groups, and limited follow-up. In addition, some studies do not report complete quantitative figures, while others use different variables. These conditions limit the possibility of combining the results into a single effect measure.

Population suitability also needs to be considered. The term “learners” in the main synthesis refers to primary and/or secondary school students in accordance with the PICOC framework. Records involving only university students, lecturers, or educators need to be verified and must not automatically be treated as evidence from school populations.

D. CONCLUSION

This systematic literature review of 15 internationally reputable Scopus articles explicitly addresses two main research questions. Regarding RQ1, technology adoption trends confirm a functional evolution from the passive distribution of pre-class materials through Learning Management Systems (LMS), such as Google Classroom and Moodle, toward the integration of intelligent and immersive technology ecosystems. These include Artificial Intelligence (Generative AI

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such as ChatGPT and AI-Assisting Technology/AIT), Virtual Reality (VR Psychological Practice System), and synchronous collaborative platforms based on the Synchronous Online Flipped Learning Approach (SOFLA) framework. Regarding RQ2, the efficacy of these interventions has been shown to significantly moderate students' cognitive achievement and affective responses. In the cognitive domain, the use of AI and metacognitive strategies contributes to learning achievement gains of up to 26% (partial $\eta^2 = 0.26$; $p < 0.001$), improves essay-writing scores (72.57 vs. 61.37), and stimulates self-efficacy that promotes deep learning ($\beta = 0.475$). In the affective domain, the most substantial reductions in academic anxiety (classroom and language anxiety) and depression were achieved through the integration of VR and interactive clinical case simulations ($p < 0.001$). However, between-group analysis demonstrates that passive LMS use failed to show a significant comparative advantage over conventional classes ($p = 0.38$) and may also risk triggering peer-teaching anxiety and digital overload when not supported by appropriate pedagogical scaffolding.

The main empirical limitations of the reviewed literature corpus lie in the dominance of self-report questionnaire instruments, such as FLCAS, FLRAS, SAS, and SDS, which are highly susceptible to social desirability bias and unable to capture fluctuations in students' cognitive load and emotions in real time. In addition, most primary research designs are short-term quasi-experimental interventions with limited sample sizes in specific qualitative study groups. Consequently, they have not yet been able to map cognitive retention and the sustainability of long-term psychological effects.

The practical implications of this study recommend that educators design structured pre-class pedagogical scaffolding by limiting the duration of learning materials to prevent digital overload. During synchronous collaborative sessions, educators should intervene in the group-formation process in a planned manner to reduce peer-teaching anxiety. For future research, large-scale longitudinal experimental studies are recommended, combining questionnaire data with real-time physiological measurements (such as eye-tracking or skin conductance responses) to objectively measure students' cognitive load and anxiety.

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