International Journal of Instruction *January 2026 ● Vol.19, No.1*
e-ISSN: 1308-1470 ● www.e-iji.net *p-ISSN: 1694-609X*
pp. 105-130

Article submission code: 20250328145856
Received: 28/03/2025 Revision: 16/07/2025
Accepted: 27/07/2025 OnlineFirst: 01/10/2025

The Impact of an AI-Powered Flipped Classroom on Grammar Competence and Language Anxiety in EFL Learners

Asghar Moulavinafchi
Asst. Prof., corresponding author, English Language and Literature, Faculty of Literature and Humanities, Hakim Sabzevari University, Iran, *a.moulavi@hsu.ac.ir*

Samara A. Alwahhab Alhaideri
PhD candidate in TEFL at Hakim Sabzevari University, Iran & lecturer at Al Farahidi University, College of Education, Iraq, *samaraabdulwahhab@gmail.com*

Sura Nadhim Mhayyal Alfawwaz
MA Student of TEFL at Hakim Sabzevari University, Iran & Teacher at Ministry of Education, Iraq, *alfawwazsuranadhimmhayyal@gmail.com*

This quasi-experimental study investigates the impact of an AI-driven flipped classroom approach on grammatical competence (GC) and foreign language anxiety (FLA) among undergraduate English Literature students in Iran. The study compares the AI-powered flipped classroom, utilizing advanced tools such as ChatGPT and Quizlet for personalized, interactive learning, with a traditional flipped classroom model. Twenty participants, divided into experimental (AI-driven) and control (traditional flipped) groups, underwent a sixteen-week intervention covering identical content from the Modern English 2 coursebook. Pretest and posttest assessments measured GC and FLA levels. Statistical analyses, including ANCOVA, controlled for initial differences between groups. Results revealed that the AI-driven flipped classroom significantly enhanced GC and reduced FLA compared to the traditional approach. The findings highlight the potential of AI tools to provide personalized feedback, facilitate real-time grammar assistance, and reduce anxiety through interactive and student-centered learning experiences. These results have implications for designing innovative instructional strategies in foreign language education, emphasizing the integration of AI technology to optimize learning outcomes and emotional well-being. Future research could explore the long-term effects of AI-driven methods and their application in diverse educational contexts.

Keywords: artificial intelligence (AI), AI-driven flipped classroom, English literature students, foreign language anxiety (FLA), grammatical competence (GC)

INTRODUCTION

The flipped classroom model has gained prominence as an innovative teaching approach in higher education, particularly in language learning. In the 21st century,

Citation: Moulavinafchi, A., Alhaideri, S. A. A., & Alfawwaz, S. N. M. (2026). The impact of an AI-powered Flipped classroom on grammar competence and language anxiety in EFL learners. *International Journal of Instruction*, *19*(1), 105-130. https://doi.org/10.29333/iji.2026.1916a

using technology for pedagogical purposes has become the main objective for many educational authorities (Naderi, 2018). By shifting direct instruction to pre-class activities and focusing in-class time on interactive, hands-on sessions, this model promotes deeper learning, increased engagement, and improved academic performance across disciplines, including English language education (Nasrah, 2024; Bilgin, 2024; Binoy, 2024).

In the flipped model, students first interact with course materials—such as instructional videos or other resources—on their own before attending in-person classes. During face-to-face sessions, a greater emphasis is placed on active learning techniques like interactive activities, just-in-time teaching, and collaborative peer instruction. What sets the flipped classroom apart is its integration of these proven instructional methods with digital tools, including video and audio content. This approach allows more classroom time to be devoted to practical exercises, teamwork, and group discussions, enhancing students' understanding of key concepts (Ersoy et al., 2023). For English literature students, the flipped classroom is especially valuable in developing GC and reducing foreign language anxiety, both critical for language acquisition and literary analysis (Sun, 2024; Binoy, 2024). Salami (2024) emphasizes its effectiveness, describing the flipped approach as having a "comparative advantage over traditional models of instruction" (p. 17).

Recent research has examined technology-supported adaptations of the flipped classroom, including models that incorporate weblogs, which are both practical and effective for enhancing content learning. For instance, Sitompul (2019) demonstrated that using weblogs within the flipped classroom setting was not only feasible but also led to notable improvements in students' academic performance. These findings suggest that adopting technology-driven instructional innovations can have a substantial impact on student achievement and should be considered by educators and policymakers. The integration of artificial intelligence into this framework further enhances its potential. AI-driven flipped classrooms utilize adaptive learning technologies and intelligent tutoring systems to create personalized learning experiences, provide real-time feedback, and cater to individual learning styles (Dung, 2024; Ray & Sikdar, 2024; Zhong, 2024). Dung (2024) notes that AI revolutionizes education by offering "personalized and interactive learning experiences for students" (p. 41), which is particularly beneficial for English literature students grappling with complex grammatical structures and literary analysis.

Moreover, the use of AI tools such as ChatGPT in language education has demonstrated significant positive effects. Recent research indicates that ChatGPT can enhance English academic writing ability (content, structure, coherence, grammar, vocabulary, etc.) and increase affective, cognitive, social, and behavioral engagement among EFL undergraduates (Hongxia & Razali, 2025).

Both traditional and AI-driven flipped classrooms have been found to mitigate FLA, a significant barrier to effective language learning that often reduces motivation and performance (Tiongson et al., 2024; Bilgin, 2024). The flipped classroom fosters active learning and peer interaction, alleviating anxiety levels, while the AI-driven version

enhances this effect with personalized support and reduced assessment pressure (Binoy, 2024; R., 2024; Culpepper, 2024). Xu (2024) highlights that the flipped classroom encourages active exploration and inquiry, shifting traditional teacher-student roles to create a more supportive learning environment.

Notably, AI-powered interventions such as ChatGPT are also emerging as tools for promoting emotional and psychological well-being among university students. Alshammari (2025) found that self-help ChatGPT interventions provided effective and scalable emotional support, helping students manage stress and anxiety while offering high communication comfort and practical advice. These findings suggest that AI-powered support can complement traditional mental health resources and further enhance the learning environment.

This study aims to compare the impacts of traditional and AI-driven flipped classrooms on the GC and FLA of English literature students, addressing their unique challenges in mastering linguistic accuracy and analytical skills. Although many studies have demonstrated the effectiveness of flipped classroom models, research on integrating platforms such as weblogs and AI chatbots in flipped environments, particularly for EFL and English literature, remains limited and merits further investigation (Sitompul, 2019; Hongxia & Razali, 2025). By examining whether AI integration offers measurable advantages, the research seeks to contribute to the growing literature on innovative teaching methodologies and provide insights into effective strategies for addressing both academic and emotional needs in language education.

LITERATURE REVIEW

Flipped Classroom: Pedagogical Framework and Effectiveness

The flipped classroom, rooted in constructivist theories like Vygotsky's scaffolding, has gained prominence in language education by reversing traditional instruction. Students engage with lecture material independently, often online, while class time is reserved for interactive, application-based activities, fostering autonomy and deeper learning (Bergmann & Sams, 2012; Abeysekera & Dawson, 2015). Research shows the flipped model enhances GC by allowing more practice and collaborative learning, which are essential for mastering language structures (Hung, 2015). However, its success depends on students' engagement with pre-class materials, and its effectiveness in reducing FLA, particularly for English literature learners, remains underexplored (Lo & Hew, 2017). While the traditional flipped model promotes active learning and student engagement, it is often limited in its ability to provide individualized feedback and adapt to diverse learner needs, especially when compared to technology-enhanced approaches. Studies highlight its potential benefits, but the flipped model's integration with emerging technologies like AI is still limited, despite its promise for improving learning outcomes (Gok et al., 2023; Parvaneh et al., 2022).

AI in Language Learning: Transformative Potential

AI has reshaped education by personalizing learning through adaptive systems that provide real-time feedback and scaffolded support (Gautam, 2024; Chang et al., 2023). In language education, AI-powered tools like Grammarly and Duolingo improve

grammatical accuracy by analyzing learner input and offering targeted corrective feedback (Luxton-Reilly et al., 2018). Unlike the traditional flipped classroom, which primarily relies on teacher-generated materials and peer interactions, AI-driven flipped classrooms leverage these technologies to deliver personalized, data-driven instruction. This allows for more nuanced tracking of individual learner progress and immediate intervention, features less accessible in traditional models. AI-driven flipped classrooms extend traditional flipped models by integrating these tools, enhancing both pre-class preparation and in-class activities (López-Villanueva et al., 2024). Grounded in Bloom's two-sigma problem, AI systems simulate one-on-one tutoring, reducing cognitive load and enabling learners to focus on higher-order skills (Packer & Keates, 2023). However, critics argue that the impersonal nature of AI may sometimes heighten FLA by reducing human interaction, a factor less pronounced in traditional flipped settings. Conversely, others suggest that AI enhances learner confidence by providing private, judgment-free practice opportunities (Lin & Chen, 2024; Rajesh et al., 2024).

Grammatical Competence and Foreign Language Anxiety

GC, vital for effective communication, relies on exposure to comprehensible input slightly beyond learners' current proficiency levels (Canale & Swain, 1980; Krashen, 1982). While traditional grammar instruction often involves repetitive drills, the traditional flipped classroom supplements this approach by offering interactive, collaborative activities. However, AI-enhanced flipped classrooms further advance GC by providing immediate, individualized feedback and adaptive content, thereby catering to variations in learner ability and pace. Gamified AI tools further boost engagement and motivation, critical for mastering complex grammatical structures (Sung & Hwang, 2013). Additionally, FLA—characterized by communication apprehension, fear of evaluation, and test anxiety—can hinder language acquisition by impairing input processing and participation (Horwitz et al., 1986; MacIntyre & Gardner, 1994). Traditional flipped classrooms address FLA by enabling self-paced study and peer support, but AI-driven models uniquely offer anonymity and personalized feedback, which may further reduce anxiety for some learners, though potentially alienating those less comfortable with technology (Muthmainnah et al., 2024; Ponte, 2024). However, individual factors like attitudes toward technology and computer literacy influence these outcomes (Taghizadeh & Hajhosseini, 2020).

Integrating Theories: Flipped and AI-Driven Models

While both traditional and AI-driven flipped classrooms share the common goal of enhancing GC and reducing FLA, they differ significantly in their pedagogical mechanisms and potential outcomes. Traditional models leverage constructivist principles to engage learners in collaborative tasks, with teachers facilitating peer interaction and providing general feedback. AI-driven models, in contrast, emphasize personalization through adaptive feedback systems and algorithmically tailored exercises, which can address learner variability more precisely but may risk reducing meaningful human interaction in the classroom (Lo & Hew, 2017). AI enhances the flipped model by addressing variability in pre-class engagement and providing targeted interventions but raises ethical concerns like data privacy and over-reliance on

technology (Almarzouqi et al., 2024). A critical synthesis of the literature suggests that while traditional flipped models excel in fostering collaboration and social learning, AI-driven models are more effective in delivering individualized, scalable support, though they must navigate issues of accessibility and learner acceptance. Balancing these considerations is crucial to maximizing the benefits of AI-driven flipped classrooms for English literature students learning English as a foreign language. A comparative analysis of these models thus highlights not only their strengths but also the unique challenges each presents in terms of pedagogical design and learner outcomes.

Empirical Studies in Recent Years

Recent empirical studies highlight the potential of the flipped classroom model to improve students' GC by fostering a more engaging and participatory learning environment. Ying and Ayub (2022) demonstrated that students in flipped classrooms achieved a better understanding and higher academic performance than those in traditional settings, showcasing the model's effectiveness in supporting language acquisition. Similarly, Tomas et al. (2019) emphasized that tailoring the flipped classroom to accommodate the needs of diverse learners enables a smoother transition from conventional teaching methods, ultimately improving student readiness and engagement. The emphasis on active learning within the flipped classroom is pivotal for developing GC, as it allows students to apply their knowledge in practical contexts, facilitating better retention and comprehension of grammatical structures.

The integration of AI into the flipped classroom model has introduced new opportunities and challenges in enhancing GC among language learners. AI-driven tools, such as intelligent tutoring systems and chatbots, offer personalized learning experiences that address the unique needs of individual students. Lo and Hew (2023) found that incorporating AI into flipped classrooms increases student interaction with content and improves class preparation, which is critical for mastering complex grammatical concepts. Furthermore, Ray and Sikdar (2024) highlighted that AI technologies enable adaptive learning, allowing students to progress at their own pace and receive immediate feedback on their grammatical usage. This personalized approach not only enhances GC but also reduces FLA by providing tailored support. Crucially, a comparison of findings indicates that while traditional flipped classrooms benefit learners through structured, collaborative activities, AI-enhanced models are better positioned to address individual weaknesses and learning gaps. As a result, AI-powered flipped classrooms foster a more conducive and supportive learning environment, alleviating the anxiety that often hinders language acquisition.

FLA poses a significant barrier to effective language learning, impacting students' willingness to engage and their ability to express themselves accurately. Research indicates a strong correlation between language anxiety and GC; anxious learners frequently struggle with grammatical accuracy (Reyna et al., 2023). While both traditional and AI-driven flipped classrooms help mitigate anxiety, the mechanisms differ: traditional approaches rely on group work and peer support, whereas AI-driven formats offer private, iterative practice and feedback, which may be more effective for learners with high anxiety or introversion. For example, students benefit from practicing

their language skills in smaller, collaborative groups during class time, as opposed to the traditional lecture format, which can intensify anxiety (Sadiq, 2017). Additionally, AI tools provide students with a safe, judgment-free space to practice grammatical skills, reducing fear of failure and building confidence in language abilities (Li & Peng, 2022). This dual focus on improving GC and reducing anxiety is essential for fostering a positive and effective language learning experience.

The effectiveness of the flipped classroom and AI-driven approaches in improving GC is further supported by studies emphasizing active learning strategies. Research shows that students who engage in self-regulated learning and collaborative activities within a flipped classroom setting demonstrate significant improvements in grammatical skills (Jdaitawi, 2019). Formative assessments integrated into flipped classrooms provide valuable feedback, helping students identify areas for improvement and track their progress over time (Boumediene & Hamazaoui-Elachachi, 2017). This continuous feedback loop encourages reflection and adjustment, which are vital for developing GC. AI-driven flipped classrooms, however, can automate formative assessment and deliver instantaneous, personalized feedback, potentially making the learning cycle more efficient and responsive than in traditional models. Moreover, the incorporation of technology in flipped classrooms enhances student motivation and engagement, leading to a deeper understanding of grammatical structures and their application in real-world contexts (Dan, 2023).

Flipped Classroom, Multimodal Input, and Language Education

The flipped classroom model has garnered considerable attention as an innovative pedagogical approach that enhances student engagement and learning outcomes, particularly in language education. Zarinfard et al. (2021) highlighted the significant impact of the flipped classroom on learning outcomes, noting that the multimodal input used in flipped classrooms—such as audio, video, and text—facilitates better information processing and reduces cognitive load compared to traditional methods focused on printed materials. This multimodal approach is particularly effective for teaching complex subjects, as it enables students to interact with the material in diverse ways, thereby enhancing GC. Similarly, Helal (2023) demonstrated that a flipped learning program significantly improved grammatical achievement among Egyptian EFL students, further supporting the flipped classroom's potential to develop grammatical skills. AI-driven flipped classrooms can further optimize multimodal input by dynamically adjusting media types and difficulty based on learner analytics, thus providing a more personalized and effective learning experience than standard flipped models.

Flipped Classrooms and Foreign Language Anxiety

Beyond GC, flipped classrooms have also been shown to reduce FLA, a critical factor influencing language learning outcomes. Qiu and Luo (2022) found that flipped listening instruction not only improved listening performance but also alleviated listening anxiety among EFL students. This finding aligns with Gok et al. (2023), who reported that the online flipped classroom model significantly reduced foreign language classroom anxiety. The reduction in anxiety can be attributed to the interactive and

supportive environment of flipped classrooms, which encourages student participation without the immediate pressure of traditional classroom settings. Furthermore, Korkmaz and Mirici (2021) observed that the transition to online flipped classrooms during the COVID-19 pandemic helped students develop better self-regulation skills, further mitigating anxiety.

The integration of technology within flipped classrooms also plays a vital role in shaping students' attitudes toward learning and reducing anxiety levels. Pan et al. (2022) compared the effects of Massive Open Online Courses (MOOCs) and flipped instruction on EFL learners, finding that both approaches positively influenced motivation and reduced speaking anxiety. These results suggest that the technological elements of flipped classrooms provide students with greater control over their learning pace and environment, contributing to lower anxiety levels. Lubis and Rahmawati (2022) further supported this notion, showing that incorporating flipped learning in teaching English grammar not only improved grammar skills but also activated students' motivation and autonomy. It is important to note, however, that while technology-enhanced flipped classrooms—including those using AI—offer increased flexibility and autonomy, they may simultaneously introduce technical challenges and require higher digital literacy, which can impact their effectiveness in reducing anxiety compared to traditional approaches. These findings underscore the potential of technology-enhanced flipped classrooms to create a supportive and engaging learning atmosphere.

Addressing Challenges in Flipped Classrooms

The relationship between flipped classrooms and anxiety is particularly evident in the development of speaking skills. Gok et al. (2023) found that the online flipped classroom model effectively reduced reading anxiety, which is often linked to speaking anxiety in language learners. However, Shams (2024) cautioned that while online learning alleviates some anxiety, it can also introduce new challenges, particularly in communication tasks, which may exacerbate anxiety. This duality highlights the need for educators to carefully design flipped classrooms to address the specific anxieties faced by language learners. Qualitative feedback from students in various studies indicates a preference for the flipped model, as it provides opportunities for more practice and interaction, which are essential for building confidence in language use (Yusufoglu & Kaya, 2024).

Despite the growing body of literature on flipped classrooms, there is a notable gap in research on the integration of AI-driven technologies within this pedagogical framework, particularly in language learning. While existing studies have explored the general effectiveness of flipped classrooms on student engagement and academic performance, few have examined the nuanced impacts of AI-enhanced flipped classrooms on specific outcomes such as GC and FLA. This distinction between traditional and AI-driven approaches represents a critical area for further investigation, as the two models may yield different outcomes depending on learner characteristics and instructional design.

METHOD

Research Questions

This study addresses this gap by focusing on two key research questions: Q1. What is the impact of the AI-driven flipped classroom approach on the GC of English literature students compared to a traditional flipped classroom setting? Q2. What is the impact of the AI-driven flipped classroom approach on the FLA of English literature students compared to a traditional flipped classroom setting?

Research Design

This study adopted a quasi-experimental pretest-posttest control group design, which is commonly used in educational research to evaluate the effects of specific interventions (Cresswell & Cresswell, 2018). This design was deemed appropriate as it allowed for a comparison between two teaching methods (AI-powered classroom and flipped classroom) while controlling for baseline differences through the use of pretests. The independent variable in this study was the instructional method, while the dependent variables were GC and FLA. The pretest scores served as covariates to account for any initial differences between the groups.

The participants were divided into two groups: an experimental group that was exposed to an AI-powered classroom approach, and a control group that followed a traditional flipped classroom model. Both groups covered the same content from their coursebook, Modern English 2. The AI-powered group used advanced AI tools, such as ChatGPT, for interactive and personalized learning, while the control group participated in a flipped classroom approach where students prepared outside the classroom and engaged in discussions and activities during class.

The study lasted sixteen weeks, with one session per week, each lasting 90 minutes. The intervention was carefully designed to ensure consistency in the delivery of content across both groups. The pretest and posttest assessments were used to measure the impact of the instructional methods on students' GC and FLA. The pretest was administered at the beginning of the study, and the posttest was conducted at the end of the sixteen-week intervention. This structure ensured that any observed differences in the outcomes could be attributed to the instructional methods rather than external factors.

To enhance the internal validity of the study, the participants were taught by the same instructor to eliminate teacher-related variability. Moreover, both groups were exposed to identical lesson plans, activities, and materials, with the only difference being the instructional approach. Such a controlled design aligns with best practices in experimental research in education (Mertens, 2019).

Despite these strengths, the relatively small sample size (n = 20) is a limitation, as it restricts the generalizability of the findings to broader populations. This limitation should be considered when interpreting the results.

Regarding randomization, after eligibility screening and consent, participants were randomly assigned to either the experimental or control group using a computer-

generated random number sequence. This process was conducted by an independent researcher not involved in the instructional activities to minimize allocation bias.

Potential sources of bias were further addressed by ensuring that all assessments were administered and scored by an instructor blinded to the group assignments, and that no communication about group allocation occurred among participants. Nevertheless, the use of purposive sampling and the small sample size may introduce selection and sampling biases, which are acknowledged limitations.

Participants

The participants in this study consisted of 20 undergraduate students majoring in English Literature at Hakim Sabzevari University of Sabzevar, Iran. All participants were enrolled in the Modern English 2 course and were at an intermediate level of English proficiency. The selection of participants was based on a purposive sampling method, which ensures that all participants meet specific inclusion criteria relevant to the study (Patton, 2015). These criteria included enrollment in the course, intermediate proficiency, and a willingness to participate in both pretest and posttest assessments. The demographic characteristics of the participants are presented in Table 1 below. It is important to note that while purposive sampling ensured relevant inclusion criteria, it inherently limits the representativeness of the sample, which poses a challenge for external validity. The demographic characteristics of the participants are presented in Table 1 below.

Table 1
The demographic information of the participants

Variable	Frequency (n)	Percentage (%)
Gender		
Male	8	40
Female	12	60
Age Range		
18–20	7	35
21–23	13	65
Academic Year		
First Year	34	85
Second Year	6	15
Proficiency Level		
Intermediate	20	100
Previous Experience with AI Tools		
Yes	4	20
No	16	80

The participants were randomly assigned to two groups: 10 students in the experimental group (AI-powered classroom) and 10 students in the control group (flipped classroom).

To ensure the homogeneity of the groups, an initial placement test was administered to assess their GC. This test, based on the coursebook content, confirmed that there were no statistically significant differences between the two groups prior to the intervention ($p > 0.05$). Additionally, the FLA scale was administered pre-intervention to confirm

baseline similarities in anxiety levels. The results of these tests are summarized in Table 2.

Table 2
The homogeneity results of GC and FLA of participants

Variable	Experimental Group (Mean ± SD)	Control Group (Mean ± SD)	p-value
GC Pretest	25.3 ± 3.1	24.9 ± 3.4	0.72
FLA Pretest	3.8 ± 0.5	3.7 ± 0.6	0.68

The results confirm that the two groups were homogeneous at the start of the study.

Instruments

Grammatical Test

The grammatical test was a researcher-made multiple-choice test comprising 40 items. The test was developed based on the *Modern English 2* coursebook and covered key grammatical structures such as tenses, passive voice, conditional sentences, relative clauses, etc. The test was administered as both a pretest and a posttest, with slight variations in the items to prevent memorization. The difficulty level of the pretest and posttest was carefully matched.

The content validity of the grammatical test was ensured by consulting two experts in English language teaching. Their feedback was used to refine the test items and ensure alignment with the course objectives. The reliability of the test was evaluated through a pilot study with 15 students who were not part of the main study. The internal consistency was measured using the KR-21 reliability index, which yielded a reliability coefficient of 0.87, indicating high reliability.

Foreign Language Anxiety (FLA) Scale

The FLA scale, adapted from Horwitz et al. (1986), consisted of 33 Likert-scale items rated on a 5-point scale (1 = Strongly Disagree to 5 = Strongly Agree). The scale measured anxiety levels in various areas, such as speaking, listening, test-taking, and classroom participation.

The FLA scale is a widely validated instrument in second language acquisition research. To ensure its suitability for this study, the scale was re-evaluated, and its internal consistency was measured using the KR-21 reliability index, which yielded a coefficient of 0.91.

Data Collection Procedure

The data collection process was conducted in three distinct phases: pretest administration, intervention, and posttest administration. These phases were carefully designed to ensure consistency, reliability, and the collection of sufficient data to answer the research questions. Each step was executed methodically to minimize external influences and to ensure that the observed outcomes could be attributed solely to the instructional methods employed.

Pretest Administration

The study commenced with the administration of two pretests to both the experimental and control groups: the GC test and the FLA Scale. These assessments were conducted in a controlled classroom environment. All participants were briefed about the purpose of the tests, and clear instructions were provided to ensure that they understood the procedures. The grammatical test consisted of 40 multiple-choice items and was designed to measure the students' baseline understanding of key grammatical structures, including those covered in the *Modern English 2* coursebook. Participants were given 60 minutes to complete this test. The FLA scale, which consisted of 33 Likert-scale items, was administered immediately after the grammatical test. This scale required students to indicate their levels of agreement or disagreement with statements related to anxiety-inducing situations in their language classroom. The FLA scale took approximately 15 minutes to complete. Both tests were administered on paper, and participants were monitored by the instructor to ensure adherence to testing protocols. The pretest results were crucial for confirming the homogeneity of the two groups in terms of GC and anxiety levels before the intervention.

Intervention Phase

Following the pretests, the intervention phase began and lasted for sixteen weeks, with participants attending two 90-minute sessions per week. During this phase, the two groups were exposed to different instructional methods while studying the same content from the *Modern English 2* coursebook.

For the experimental group, an AI-powered classroom approach was implemented. This group used advanced AI tools to facilitate learning. ChatGPT served as the primary AI platform, providing real-time grammar explanations, personalized feedback, and interactive problem-solving opportunities. For example, students could input grammar-related questions into ChatGPT and receive tailored responses that clarified concepts and provided practice exercises. Additionally, Quizlet was used to create digital flashcards and quizzes, allowing students to engage in self-paced grammar practice. Collaborative tools such as Google Docs were employed for group writing assignments, where AI-assisted suggestions helped students refine their grammar in real-time. During class sessions, students interacted with these tools under the instructor's guidance, combining independent exploration with collaborative learning.

In contrast, the control group followed a traditional flipped classroom model. In this approach, students were assigned preparatory tasks, such as reading chapters from the coursebook and watching instructor-provided tutorial videos, before attending class. Classroom sessions were devoted to discussions, group activities, and instructor-led exercises designed to reinforce the material studied independently. While the flipped classroom model encouraged active in-class participation, it lacked the personalized, interactive feedback provided by AI tools.

Throughout the intervention phase, both groups covered identical grammatical topics and completed equivalent practice exercises to ensure that the only variable was the

instructional method. The instructor maintained detailed session logs to track attendance, engagement, and task completion.

Posttest Administration

At the conclusion of the sixteen-week intervention, both groups were re-assessed using the same two instruments: the GC test and the FLA scale. The posttests were administered under conditions identical to the pretests to maintain consistency. Participants were again given 60 minutes to complete the grammatical test and 15 minutes for the FLA scale. To minimize test fatigue, the assessments were conducted on separate days. The posttest scores were used to evaluate changes in GC and anxiety levels in both groups, providing the data needed to address the research questions.

Data Analysis Procedure

The data collected from the pretests and posttests underwent comprehensive statistical analysis using SPSS software to ensure a rigorous evaluation of the research findings. Multiple analytical procedures were employed to address the research questions, verify the reliability of the instruments, and interpret the results accurately.

The first step in the analysis involved assessing the normality of the pretest and posttest scores for both GC and FLA. This was achieved by calculating the skewness and kurtosis indices for each set of scores. Skewness measures the symmetry of the distribution, while kurtosis evaluates the "tailedness." According to Kline (2015), values within the range of ±2 are considered indicative of a normal distribution. This step was crucial because many statistical tests, including ANCOVA (Analysis of Covariance), assume that the data are normally distributed. If the data had been found to deviate significantly from normality, alternative non-parametric tests would have been considered. However, the skewness and kurtosis values for all datasets fell within acceptable limits, confirming the suitability of the data for parametric analysis.

To ensure the consistency and reliability of the instruments, the KR-21 reliability index was calculated for the pretest and posttest scores of the grammatical test and the FLA scale. The KR-21 index is a widely used measure of internal consistency, particularly for dichotomous and Likert-scale data (Brown, 2014). The grammatical test yielded a reliability coefficient of 0.87, indicating high reliability, while the FLA scale achieved a coefficient of 0.91, reflecting excellent reliability. These results confirmed that both instruments were reliable tools for measuring GC and FLA levels.

Descriptive statistics, including means and standard deviations, were calculated for the pretest and posttest scores of both groups. These statistics provided an overview of the central tendencies and variability within the data.

To address the research questions, two one-way ANCOVAs were conducted. ANCOVA was chosen because it allows for the comparison of posttest scores between groups while controlling for pretest scores, thereby accounting for any initial differences. The first ANCOVA examined the impact of the instructional method on GC, while the second ANCOVA focused on FLA.

FINDINGS

Overview

This study aimed at investigating the effect of AI-powered classroom approach on the GC, and FLA of English literature students compared to a traditional flipped classroom setting. The two research questions raised in this study were analyzed through One-Way ANCOVA which besides its specific assumptions requires normality of data. Table 3 shows the skewness and kurtosis indices of normality which probes symmetry of the data, and their relative height respectively. In an ideally normal distribution, the skewness and kurtosis indices are equal to zero.

As shown in Table 3 the skewness and kurtosis indices ranged between ±2. Thus; it was concluded that the present data did not show any significant deviation from normality. It should be noted that the criteria of ±2 were proposed by Bachman, 2005; Bae & Bachman, 2010; and George & Mallery, 2020. It should also be noted that Zhu et al, 2019; suggested the criteria of ±3. However, Watkins, 2021; suggested different criteria for skewness and kurtosis. He believed that skewness values should be less than ±2; while kurtosis indices should be evaluated against the criteria of ±7.

Table 3
Skewness and kurtosis indices of normality

		N	Skewness		Kurtosis	
Group		Statistic	Statistic	Std. Error	Statistic	Std. Error
AI	PreGrammar	10	.328	.687	-.446	1.334
	PostGrammar	10	-.733	.687	.617	1.334
	PreAnxiety	10	-.838	.687	-.561	1.334
	PostAnxiety	10	-.803	.687	-.576	1.334
Flipped	PreGrammar	10	.386	.687	-1.090	1.334
	PostGrammar	10	-.560	.687	-.951	1.334
	PreAnxiety	10	-.496	.687	-1.093	1.334
	PostAnxiety	10	.088	.687	-.739	1.334

Pre = Pretest, Post = Posttest, Grammar = Grammatical competence, and Anxiety = Foreign language anxiety

Reliability Estimates

Table 4 shows the descriptive statistics and KR-21 reliability indices for the pretests, and posttests of GC, and FLA. The reliability indices for pretest and posttest of GC were .70, and .82. Pretest and posttest of FLA enjoyed reliability indices of .75, and .88. These reliability indices can be considered as "appropriate" as noted by Fulcher & Davidson (2007), who believe that instruments should enjoyed KR-21 reliability index of at least .70.

Table 4
Descriptive statistics and KR-21 reliability indices

	N	Mean	Std. Deviation	Variance	KR-21
PreGrammar	20	19.05	5.586	31.208	0.70
PostGrammar	20	27.00	6.617	43.789	0.82
PreAnxiety	20	75.70	12.679	160.747	0.75
PostAnxiety	20	60.15	17.257	297.818	0.88

Exploring First Research Question

At the outset, it must be acknowledged that the small sample size in this study limits the generalizability of the findings. Readers are encouraged to interpret results with caution. To answer the first research question, a One-Way ANCOVA was conducted to compare the two groups' mean posttest scores on GC, while statistically controlling for pretest scores.

A brief explanation of One-Way ANCOVA is warranted. This analysis is suitable when comparing groups on a post-intervention measure, using a covariate (here, the GC pretest) to adjust for any baseline differences. By controlling for pretest performance, ANCOVA allows us to more accurately assess the effect of the intervention itself. As Harrison et al. (2021) observe, ANCOVA "removes the effect of the covariate by using the regression equation to measure its influence," making it more precise than comparing raw means.

Several assumptions must be satisfied for ANCOVA to be valid. These include normality, reliability, linearity, homogeneity of regression slopes, and homogeneity of variances. The covariate must be measured before the posttest, as in this study, and there should not be excessive correlation among covariates.

The assumption of linearity was evaluated and supported, as shown in Table 5. A significant result for linearity ($F(1, 19) = 10.70$, $p = .011$), with a large effect size (eta squared = .724), demonstrates a strong, linear relationship between pretest and posttest GC scores.

Table 5
Testing linearity of relationship between pretest and posttest of GC

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups (Combined)	602.167	11	54.742	1.905	.185
Linearity	307.495	1	307.495	10.703	.011
Deviation from Linearity	294.672	10	29.467	1.026	.495
Within Groups	229.833	8	28.729		
Total	832.000	19			
Eta Squared					.724

The next assumption, homogeneity of regression slopes, is detailed in Table 6. The interaction between group and pretest was not significant ($F(1, 16) = .174$, $p = .682$, partial eta squared = .011), indicating the relationship between pretest and posttest was similar across both groups.

Table 6
Testing homogeneity of regression slopes for posttest of gc by group with pretest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Group	37.371	1	37.371	2.388	.142	.130
PreGrammar	334.631	1	334.631	21.386	.000	.572
Group * PreGrammar	2.723	1	2.723	.174	.682	.011
Error	250.358	16	15.647			
Total	15412.000	20				

Although the assumption of homogeneity of variances was not met, this is less problematic because both groups had equal sample sizes, supporting the robustness of the analysis (Pallant, 2016; Tabachnick & Fidell, 2019; Field, 2024).

The main ANCOVA results are shown in Table 9 (renumbered as Table 7 here, following your instruction to skip removed tables). After controlling for pretest scores, the group difference was statistically significant ($F(1, 17) = 18.23$, $p = .001$, partial $\eta^2 = .517$), indicating a large effect size. The AI group outperformed the flipped group on GC at posttest, even when initial differences were accounted for.

Table 7
Tests of between-subjects effects for posttest of GC by group with pretest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PreGrammar	333.920	1	333.920	22.430	.000	.569
Group	271.425	1	271.425	18.232	.001	.517
Error	253.080	17	14.887			
Total	15412.000	20				

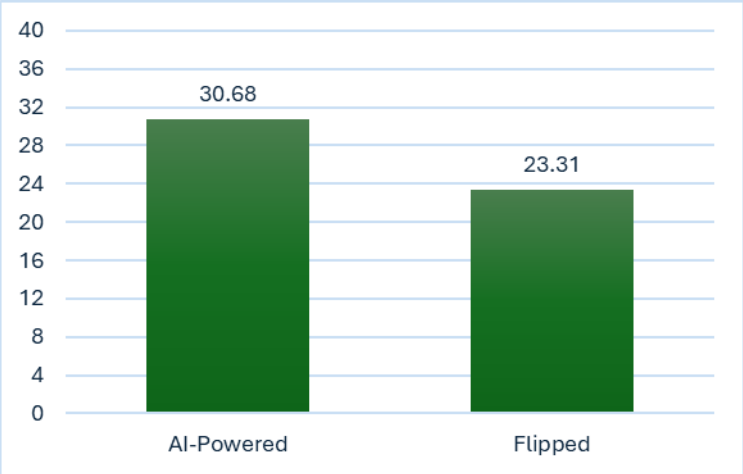

Figure 1
Means on Posttest of GC by Group with Pretest

These findings suggest that the AI-powered classroom approach led to higher GC scores than the flipped classroom, after adjusting for pre-existing differences. However, the small sample size means results should be interpreted with care.

Exploring Second Research Question

The second research question examined whether there was a significant difference in the effect of the AI-powered classroom and the flipped classroom on students' FLA. Again, a One-Way ANCOVA was conducted, comparing posttest anxiety scores while controlling for pretest anxiety.

The assumption of linearity was met, as shown in Table 8 (formerly Table 10). The significant result for linearity ($F(1, 19) = 7.775$, $p = .032$, eta squared = .825) demonstrates a strong, linear relationship between pretest and posttest anxiety scores.

Table 8
Testing linearity of relationship between pretest and posttest of FLA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups (Combined)	4668.050	13	359.081	2.175	.174
Linearity	1283.480	1	1283.480	7.775	.032
Deviation from Linearity	3384.570	12	282.048	1.709	.264
Within Groups	990.500	6	165.083		
Total	5658.550	19			
Eta Squared					.825

The homogeneity of regression slopes assumption was also supported, as indicated in Table 9 (formerly Table 11). The interaction term was not significant ($F(1, 16) = .698$, $p = .416$, partial eta squared = .042), meaning the relationship between pretest and posttest anxiety was consistent across both groups.

Table 9
Testing homogeneity of regression slopes for posttest of FLA by group with pretest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Group	241.440	1	241.440	3.121	.096	.163
PreAnxiety	753.325	1	753.325	9.737	.007	.378
Group * PreAnxiety	53.981	1	53.981	.698	.416	.042
Error	1237.870	16	77.367			
Total	78019.000	20				

The main ANCOVA results are shown in Table 10 (formerly Table 14). After adjusting for pretest scores, the group difference was significant ($F(1, 17) = 40.573$, $p < .001$, partial $\eta^2 = .705$), indicating a large effect size. The AI group had significantly lower posttest anxiety than the flipped classroom group.

Table 10
Tests of between-subjects effects for posttest of FLA by group with pretest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PreAnxiety	1064.249	1	1064.249	14.005	.002	.452
Group	3083.219	1	3083.219	40.573	.000	.705
Error	1291.851	17	75.991			
Total	78019.000	20				

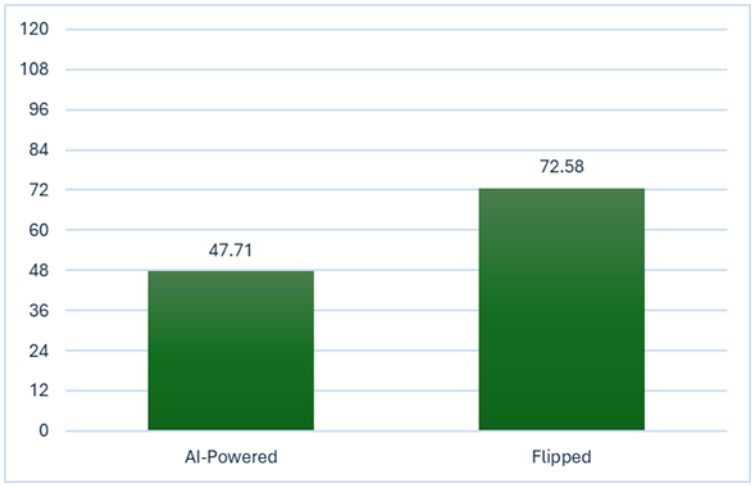

Figure 2
Means on posttest of FLA by group with pretest

In summary, the ANCOVA results indicate that the AI-powered classroom led to greater GC and lower FLA compared to the flipped classroom, after accounting for pre-existing differences. However, these findings should be considered preliminary due to the limited sample size.

DISCUSSION & CONCLUSION

This study provides clear and compelling evidence that the AI-driven flipped classroom leads to significant improvements in students' GC, and these results speak directly to the research questions posed at the outset. In contrast to some previous accounts that have emphasized only the theoretical merits of the flipped model, the present findings offer tangible data demonstrating how constructivist learning theories translate into measurable gains when paired with adaptive technology. The results not only reaffirm the well-documented benefits of the flipped classroom—namely, its capacity to foster active, student-centered learning through collaborative in-class activities (Nasrah, 2024; Binoy, 2024)—but also reveal that the integration of AI fundamentally enhances the efficacy of this approach.

One of the most frequently cited limitations of traditional flipped classrooms is their reliance on students' intrinsic motivation and ability to engage independently with pre-class materials. Such reliance can be problematic, as some students may struggle with self-regulation, limiting their ability to fully benefit from in-class collaborative learning experiences (Lo & Hew, 2017). The current study extends the literature by demonstrating that the incorporation of AI into the flipped classroom addresses this limitation directly. Adaptive AI platforms provide personalized, interactive pre-class learning experiences that respond to each learner's unique strengths and needs. Immediate and individualized feedback, as well as scaffolded instruction, help ensure that students not only complete pre-class assignments but also develop a deeper understanding of grammatical structures prior to class. This, in turn, increases their confidence and effectiveness during classroom activities, supporting the observed improvements in GC. Such personalization, highlighted by Dung (2024), emerges as a key mechanism behind the enhanced learning outcomes reported here.

Another major contribution of this study lies in its detailed analysis of how AI-driven environments can deliver multimodal and gamified input, further supporting learners with varied preferences and needs. Building on Krashen's (1982) input hypothesis—which stresses the importance of providing input that is both comprehensible and slightly beyond a learner's current abilities—this study shows that AI tools can present language content in diverse formats, including text, audio, and video. This variety not only accommodates different learning styles but also increases engagement and motivation. Prior research by López-Villanueva et al. (2024) and Sung and Hwang (2013) underscores the value of gamification in language learning, and the present findings corroborate these claims. By integrating gamified elements within the AI-driven flipped classroom, grammar practice becomes more enjoyable and less repetitive, which helps to mitigate the tedium often associated with traditional drills. Furthermore, the study's results suggest that this active, multimodal engagement does not merely enhance short-term performance but also supports the long-term retention of

grammatical rules. Thus, the integration of AI into flipped classrooms represents a meaningful advancement, both in terms of pedagogical theory and classroom practice.

After considering the improvements in GC, it is equally important to note the marked reduction in FLA observed among students participating in the AI-driven flipped classroom. The findings here directly address a core research question, demonstrating that the reduction in FLA is not a mere byproduct of improved competence but a critical outcome in its own right. Previous literature has established that FLA can severely hinder a learner's willingness to communicate, process linguistic input, and participate in classroom activities (Horwitz et al., 1986; MacIntyre & Gardner, 1994). While the flipped classroom model generally alleviates anxiety by emphasizing peer collaboration and minimizing teacher-centered instruction (Xu, 2024), the present study reveals that AI integration further amplifies these benefits. Specifically, AI tools create a low-stakes, judgment-free environment where learners can practice and receive feedback anonymously, thereby reducing the performance pressure that often accompanies language learning. This finding is consistent with Binoy's (2024) assertion that AI reduces the fear of making mistakes in front of peers or teachers, ultimately increasing student confidence and willingness to participate.

It is particularly noteworthy that the results from this research challenge some existing concerns in the literature. For instance, Lin and Chen (2024) have suggested that the impersonal nature of AI might exacerbate student anxiety. However, the evidence in this study points in the opposite direction: the adaptive and personalized feedback offered by AI systems appears to foster a greater sense of control and self-efficacy among learners. By tracking individual progress and providing tailored guidance, AI tools reinforce students' perceptions of their own improvement, which in turn mitigates the fear of failure—a common barrier in language classrooms. Furthermore, the combination of AI-driven individual support and in-class collaborative activities creates a balanced environment that simultaneously addresses both academic and emotional needs, supporting a holistic approach to language learning.

The implications of these findings extend beyond immediate classroom outcomes, raising important questions about the evolving roles of teachers and learners in technology-enhanced education. In traditional flipped classrooms, teachers primarily facilitate collaborative tasks and offer individualized support as needed. With the integration of AI, however, much of the routine scaffolding and feedback is handled by technology, which allows teachers to focus on more complex and creative aspects of instruction, such as fostering critical thinking, nurturing literary analysis, and supporting student autonomy. This shift aligns with Packer and Keates's (2023) argument that AI can simulate the benefits of one-on-one tutoring, long recognized as a gold standard in educational practice. The division of labor between AI systems and teachers thus represents a potentially transformative development in language education.

Nevertheless, growing dependence on AI-driven instruction raises important ethical and practical considerations. Issues such as data privacy, digital literacy, and equitable access to technology must be carefully considered to prevent the exacerbation of

existing educational inequalities. The risk of over-reliance on AI should not be underestimated, as it could lead to the marginalization of essential humanistic elements in language learning, such as empathy, cultural exchange, and nuanced interpersonal communication. To address these concerns, it is vital to adopt a blended approach that leverages the strengths of both AI and human interaction. For example, pairing AI-driven pre-class activities with teacher-led discussions and peer collaboration ensures a dynamic and inclusive learning environment that promotes both academic achievement and social-emotional growth.

In conclusion, the central findings of this study can be summarized as follows: AI-driven flipped classrooms not only improve GC and reduce FLA, but they do so by offering personalized, engaging, and supportive learning experiences that directly address the research questions. The integration of AI transforms the pedagogical process and the roles of both teachers and students, while simultaneously presenting new challenges related to ethics and equity.

Despite these clear advantages, several limitations must be acknowledged to provide a balanced and critical perspective. First, the study focused primarily on short-term outcomes, leaving the long-term effects of AI-driven flipped classrooms on language retention and transferability unexplored. Second, the research did not systematically investigate the influence of individual learner variables, such as digital literacy, attitudes toward AI, or cultural background, which may moderate the effectiveness of this instructional model. Third, while the study documented the positive impact of AI integration in general, it did not isolate the effects of specific AI features—such as gamification, conversational chatbots, or adaptive assessments—which could have different influences on learning outcomes. Finally, qualitative data on students' and teachers' perceptions were not collected, limiting the depth of insight into the emotional, cognitive, and social dimensions of the AI-driven flipped classroom experience.

Future research should address these limitations by exploring the long-term effects of AI-driven flipped classrooms, particularly regarding the retention and real-world application of grammatical knowledge. Investigations into how digital literacy, learner attitudes, and cultural factors influence the efficacy of AI-based approaches will also be essential for understanding their adaptability across diverse populations. Comparative studies across different proficiency levels and age groups can provide further insights into the generalizability of this model. Additionally, research that isolates and examines the impact of specific AI tools or features will help identify the components most beneficial to learning. Finally, qualitative studies capturing the perspectives of both students and teachers are needed to provide a richer understanding of how AI-driven flipped classrooms affect emotional well-being, classroom dynamics, and overall educational experience.

Overall, this study offers strong evidence that the AI-driven flipped classroom represents a promising direction for language education. By combining adaptive technology with collaborative pedagogy, educators can create more personalized, inclusive, and effective learning environments that meet the diverse needs of language

learners. Ongoing attention to ethical, practical, and humanistic considerations will be crucial in ensuring that these innovations serve all students equitably and holistically.

REFERENCES

Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. *Higher Education Research & Development, 34*(1), 1–14. https://doi.org/10.1080/07294360.2014.934336

Almarzouqi, A., Aburayya, A., Alfaisal, R., Elbadawi, M., Salloum, S. (2024). Ethical implications of using ChatGPT in educational environments: A comprehensive review. In A. Al-Marzouqi, S. Salloum, M. Al-Saidat, A. Aburayya & B. Gupta, (Eds.), *Artificial intelligence in education: The power and dangers of ChatGPT in the classroom* (pp. 185–199). Springer. https://doi.org/10.1007/978-3-031-52280-2_13

Alshammari, M. E. (2025). Promoting emotional and psychological well-being in students through a self-help ChatGPT intervention: Artificial intelligence powered support. *International Journal of Instruction, 18(3), 511-530.*

Amini, M., Roohani, A., & Jafarpour, A. (2022). Effect of flipped learning on Iranian high school students' L2 grammar achievement and their foreign language anxiety. *Teaching English Language, 16*(2), 169–201. https://doi.org/10.22132/tel.2022.158977

Bachman, L. F. (2005). *Statistical analysis for language assessment* (2nd ed.). Cambridge University Press.

Bae, J., & Bachman, L. F. (2010). An investigation of four writing traits and two tasks across two languages. *Language Testing, 27*, 213–221. https://doi.org/10.1177/0265532209349470

Bergmann, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. Eugene, OR: International Society for Technology in Education.

Bilgin, A. A., & Lin, H. (2024). Comparison of student engagement in a large first-year statistics course between flipped and face-to-face instruction. *Creative Education, 15*(8), 1569–1592. https://doi.org/10.4236/ce.2024.158095

Binoy, S. (2024). Transforming education: Enhancing student performance and satisfaction through the flipped classroom method. *American Journal of Education and Technology, 3*(1), 35–45. https://doi.org/10.54536/ajet.v3i1.2121

Bloom, B. S. (1984). The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. *Educational Researcher, 13*(6), 4–16. https://doi.org/10.3102/0013189X013006004

Boumediene, A., & Hamazaoui-Elachachi, H. (2017). The effects of formative assessment on Algerian secondary school pupils' text comprehension. *Arab World English Journal (AWEJ), 8*(3), 1–10. https://dx.doi.org/10.24093/awej/vol8no3.12

Canale, M., & Swain, M. (1980). Theoretical bases of communicative approaches to second language teaching and testing. *Applied Linguistics, 1*(1), 1–47. https://sid.ir/paper/534264/en

Chang, D. H., Lin, M. P. C., Hajian, S., & Wang, Q. Q. (2023). Educational design principles of using AI chatbot that supports self-regulated learning in education: Goal setting, feedback, and personalization. *Sustainability, 15*(17), 1-15. https://doi.org/10.3390/su151712921

Cresswell, J. W., & Cresswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.

Culpepper, S. A. (2024). Introduction to the JEBS special section on artificial intelligence in educational statistics. *Journal of Educational and Behavioral Statistics, 49*(5), 691–693. https://doi.org/10.3102/10769986241276424

Dung, L. (2024). The effectiveness of the integration of ChatGPT into flipped classrooms from teachers' and learners' perspectives. *English Language Teaching, 17*(7), 38–47. https://doi.org/10.5539/elt.v17n7p38

Ellis, R. (2006). Current issues in the teaching of grammar: An SLA perspective. *TESOL Quarterly, 40*(1), 83–107. https://doi.org/10.2307/40264512

Ersoy, M., Eren, E., Avci, Z. Y., & Kandemir, C. M. (2023). Development of the Perception Scale for Flipped Learning Model. *Anatolian Journal of Education, 8(1), 63-78*. https://doi.org/10.29333/aje.2023.815a

Field, A. (2024). *Discovering statistics using IBM SPSS statistics*. Sage Publications.

Fulcher, G., & Davidson, F. (2007). *Language testing and assessment*. Routledge.

Gautam, S. (2024). *The learning code: Designing AI-driven adaptive learning systems for social learning* (Publication No. 31631275) [Doctoral dissertation, The Pennsylvania State University]. ProQuest Dissertations & Theses Global.

George, D., & Mallery, P. (2020). *IBM SPSS statistics 26 step by step: A simple guide and reference*. Routledge.

Gok, D., Bozoğlan, H., & Bozoğlan, B. (2023). Effects of online flipped classroom on foreign language classroom anxiety and reading anxiety. *Computer Assisted Language Learning, 36*(4), 840–860. https://doi.org/10.1080/09588221.2021.1950191

Gray, C. D., & Kinnear, P. R. (2012). *IBM SPSS statistics 19 made simple*. Psychology Press.

Harrison, V., Kemp, R., Brace, N., & Snelgar, R. (2021). *SPSS for psychologists*. Bloomsbury Publishing.

Helal, E. A. (2023). The impact of a proposed flipped learning program on promoting Egyptian EFL engineering students' grammatical achievement and competence. *CDELT Occasional Papers in the Development of English Education, 83*(1), 353–431. https://doi.org/10.21608/opde.2023.325341

Hongxia, H., & Razali, A. B. (2025). Impact of ChatGPT on English academic writing ability and engagement of Chinese EFL undergraduates. *International Journal of Instruction, 18(2), 323-346*. https://doi.org/10.29333/iji.2025.18218a

Horwitz, E. K., Horwitz, M. B., & Cope, J. (1986). Foreign language classroom anxiety. *The Modern Language Journal, 70*(2), 125–132. https://doi.org/10.1111/j.1540-4781.1986.tb05256.x

Hosseini, S. A., Rajabi, P., & Mahmoodi, K. (2021). Flipped classroom model and its impact on Iranian EFL learners' classroom anxiety and listening performance. *Computer-Assisted Language Learning Electronic Journal, 22*(3), 1–16. https://callej.org/index.php/journal/article/view/347

Hung, H. T. (2015). Flipping the classroom for English language learners to foster active learning. *Computer Assisted Language Learning, 28*(1), 81–96. https://doi.org/10.1080/09588221.2014.967701

Iqbal, M. (2023). AI in education: Personalized learning and adaptive assessment. *Cosmic Bulletin of Business Management, 2*(1), 280–297. https://www.researchgate.net/profile/Falsk-Raza/publication/375722799_AI_in_Education_Personalized_Learning_and_Adaptive_Assessment/links/65586587ce88b87031f25a8f/AI-in-Education-Personalized-Learning and-Adaptive Assessment.pdf

Kline, R. B. (2015). *Principles and practice of structural equation modeling* (4th ed.). Guilford Publications.

Korkmaz, S., & Mirici, İ. H. (2023). Converting a conventional flipped class into a synchronous online flipped class during COVID-19: University students' self-regulation skills and anxiety. *Interactive Learning Environments, 31*(9), 5746–5758. https://doi.org/10.1080/10494820.2021.2018615

Krashen, S. D. (1982). *Principles and practice in second language acquisition*. Pergamon Press.

Lin, H., & Chen, Q. (2024). Artificial intelligence (AI)-integrated educational applications and college students' creativity and academic emotions: Students and teachers' perceptions and attitudes. *BMC Psychology, 12*(1), 1-16. https://doi.org/10.1186/s40359-024-01979-0

Liu, L. (2022). The contribution of the flipped learning environment to value perception and controllability of classroom activities as antecedents of learners' anxiety: A control-value approach. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.1000710

Lo, C. K., & Hew, K. F. (2017). A critical review of flipped classroom challenges in K-12 education: Possible solutions and recommendations for future research. *Research and Practice in Technology Enhanced Learning, 12*(1), 1–22. https://doi.org/10.1186/s41039-016-0044-2

López-Villanueva, D., Santiago, R., & Palau, R. (2024). Flipped learning and artificial intelligence. *Electronics, 13*(17), Article 1–19. https://doi.org/10.3390/electronics13173424

Lubis, A. H., & Rahmawati, E. (2022, February). Incorporating flipped learning in teaching English grammar for EFL students across proficiency levels. In *67th TEFLIN International Virtual Conference & the 9th ICOELT 2021 (TEFLIN ICOELT 2021)* (pp. 68–73). Atlantis Press. https://doi.org/10.2991/assehr.k.220201.012

Mertens, D. M. (2019). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods* (5th ed.). Sage Publications.

Muthmainnah, M., Cardoso, L., Alsbbagh, Y. A. M. R., Al Yakin, A., & Apriani, E. (2024, June). Advancing sustainable learning by boosting student self-regulated learning and feedback through AI-driven personalized in EFL education. In *International Conference on Explainable Artificial Intelligence in the Digital Sustainability* (pp. 36–54). Springer Nature Switzerland.

Naderi, S. (2018). EFL Learners' Grammar Knowledge Development through Explicit and Implicit Feedback: Social Networks in Focus. *Anatolian Journal of Education, 3(1), 31-38*. https://doi.org/10.29333/aje.2018.313a

Nasrah, N., Malago, J., & Saman, A. (2024). Designing a learning model with a contextual teaching learning approach based on the flipped classroom to improve science understanding. *Asian Journal of Education and Social Studies, 50*(3), 60–70. https://doi.org/10.9734/ajess/2024/v50i31280

Packer, B., & Keates, S. (2023, July). Designing AI writing workflow UX for reduced cognitive loads. In *International Conference on Human-Computer Interaction* (pp. 306–325). Springer Nature Switzerland.

Pallant, J. (2016). *SPSS survival manual* (6th ed.). Allen & Unwin.

Pan, H., Xia, F., Kumar, T., Li, X., & Shamsy, A. (2022). Massive open online course versus flipped instruction: Impacts on foreign language speaking anxiety, foreign language learning motivation, and learning attitude. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.833616

Parvaneh, H., Zoghi, M., & Asadi, N. (2022). Effect of the flipped classroom approach and language proficiency on learner autonomy and foreign language anxiety. *International Journal of Foreign Language Teaching and Research, 10*(41), 77–88. https://doi.org/10.30495/jfl.2022.689316

Patton, M. Q. (2015). *Qualitative research and evaluation methods* (4th ed.). Sage Publications.

Ponte, D. C. (2024). The application of artificial intelligence in EFL learning and teaching: Considerations, challenges and practical examples for educators. In *English Linguistics Meets the 21st Century* (pp. 118–137). Dykinson.

Qiu, Y., & Luo, W. (2022). Investigation of the effect of flipped listening instruction on the listening performance and listening anxiety of Chinese EFL students. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.1043004

Rajesh, E., Subramaniam, S., Pasupathy, P., Suresh, T., & Gopichandran, V. (2024). Lived experiences of medical students of online learning: Lessons for adopting virtual learning in medical education. *BMC Medical Education, 24*(1), 1-10. https://doi.org/10.1186/s12909-024-05953-7

Ray, S., & Sikdar, D. P. (2024). AI-Driven flipped classroom: Revolutionizing education through digital pedagogy. *British Journal of Education, Learning and Development Psychology*, *7*(2), 169-179. https://doi.org/10.52589/bjeldp-ltdjflih

Reyna, J., Cabal, H., Resentes, G., Mejorada, R., Arcamo, F. E., Naparan, G. B., & Alayon, M. F. (2023). Exploring the Relationship Between English Language Anxiety and Students' Grammatical Competence. *Canadian Journal of Educational and Social Studies*, *3*(4), 63-74. https://doi.org/10.53103/cjess.v3i4.149

Salami, O. (2024). A flipped classroom applied: Undergraduate students' perception in mathematics. *Mathematics Education Journal, 8*(1), 11-20. https://doi.org/10.22219/mej.v8i1.29636

Shams, M. (2024). A study on foreign language learning anxiety among English major students in online environments. *Sprin Journal of Arts Humanities and Social Sciences, 3*(5), 98-102. https://doi.org/10.55559/sjahss.v3i5.331

Strielkowski, W., Grebennikova, V., Lisovskiy, A., Rakhimova, G., & Vasileva, T. (2024). AI-driven adaptive learning for sustainable educational transformation. *Sustainable Development*, 1-27. https://doi.org/10.1002/sd.3221

Sun, J. (2024). An empirical study on flipped classroom in college physical education theory courses. *Creative Education, 15*(2), 153-163. https://doi.org/10.4236/ce.2024.152008

Tabachnick, B. G., & Fidell, L. S. (2019). *Using multivariate statistics* (7th ed.). Pearson.

Tiongson, H., Florencondia, N., & Pascual, L. (2024). Assessment of the implementation of flipped classroom setup in difequations at Holy Angel University – School of Engineering and Architecture. *Engineering and Technology Journal, 9*(5), 4100-4106. https://doi.org/10.47191/etj/v9i05.27

Watkins, M. W. (2021). *A step-by-step guide to exploratory factor analysis with SPSS*. Routledge.

Xu, Q., Xiong, X., & Xu, X. (2024, January). Research on building an open assessment and evaluation system for smart classroom teaching based on computer aided technology. In *Proceedings of the 3rd International Conference on New Media Development and Modernized Education, NMDME 2023, October 13–15, 2023, Xi'an, China*. https://doi.org/10.4108/eai.13-10-2023.2341337

Yuliyatno, Mustaji, & Sitompul, N. C. (2019). Exploring the Implementation of Weblog-Based Flipped Classroom in Teaching Civics: Is It Feasible and Effective?. *International Journal of Instruction, 12(4), 239-250*. https://doi.org/10.29333/iji.2019.12415a

Yusufoglu, S., & Kaya, F. B. (2024). The effect of flipped classroom model on Turkish as a foreign language learners' speaking anxiety and speaking skill achievement. *Base for Electronic Educational Sciences, 5*(2), 213–227. https://doi.org/10.29329/bedu.2024.1064.12

Zarinfard, S., Rahimi, M., & Mohseni, A. (2021). The impact of flipped classroom on learning outcome in a general English course: Grammar and vocabulary gains in focus. *International Journal of Foreign Language Teaching and Research, 9*(38), 65–80. https://doi.org/10.52547/jfl.9.38.65

Zhong, L. (2024). The enhancement of student learning engagement in EFL speaking flipped classrooms. *Transactions on Social Science, Education and Humanities Research (TSSEHR), 6*, 343–349. https://doi.org/10.62051/p2bgj445

Zhu, X., Raquel, M., & Aryadoust, V. (2019). Structural equation modeling to predict performance in English proficiency tests. In V. Aryadoust & M. Raquel (Eds.), *Quantitative data analysis for language assessment volume II* (pp. 101–126). Routledge.