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FLIPPING THE LANGUAGE CLASSROOM WITH AI: EFFECTS OF AI-ASSISTED FLIPPED LEARNING ON LANGUAGE ACQUISITION AND LEARNER OUTCOMES

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Abstract

The rapid integration of artificial intelligence (AI) into language education has created new possibilities for reconfiguring conventional instructional practices, particularly through AI-assisted flipped learning. This study examines the effects of an AI-enhanced flipped classroom model on students' second language acquisition and learning outcomes. Drawing on the flipped classroom approach and perspectives from second language acquisition, the study investigates how combining AI-supported pre-class learning with interactive, task-oriented in-class activities influences learners' language development, engagement, autonomy, and academic performance. The study adopts a quantitative quasi-experimental design involving university-level English as a Second Language (ESL) learners assigned to an AI-assisted flipped classroom and a conventional instruction group. Data are collected through pre- and post-language proficiency assessments, learner engagement measures, and academic performance indicators. The findings are expected to demonstrate whether AI-supported flipped instruction provides measurable advantages in language acquisition and broader learner outcomes compared with conventional classroom instruction. Particular attention is given to the role of AI tools in providing personalized practice, immediate feedback, adaptive learning support, and opportunities for learners to engage with English beyond classroom hours. The study contributes to the growing literature on AI-assisted language education by positioning the flipped classroom as a pedagogical framework through which AI can extend learning beyond traditional classroom boundaries. The findings may provide practical implications for ESL educators and higher education institutions seeking to integrate AI technologies into learner-centered language instruction while promoting active participation, autonomous learning, and sustained language development.

1.INTRODUCTION

The rapid advancement of artificial intelligence (AI) has begun to reshape educational practices by introducing increasingly sophisticated forms of personalized, adaptive, and interactive learning (Rana et al., 2023). Within second language (L2) education, the emergence of AI-powered applications has generated new opportunities for learners to access language input, practice communicative skills, receive

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immediate feedback, and regulate their learning beyond the temporal and spatial boundaries of the conventional classroom (Ramzan et al., 2023a). Technologies such as intelligent tutoring systems, conversational AI, automated writing evaluation, speech-recognition applications, adaptive language-learning platforms, and generative AI tools have consequently expanded the range of pedagogical resources available to language teachers and learners (Wah, 2025).This technological transformation is particularly significant in English as a Second Language (ESL) contexts, where limited classroom time, heterogeneous proficiency levels, large student populations, and restricted opportunities for authentic English interaction may constrain learners' exposure to meaningful language practice. Accordingly, the integration of AI into language pedagogy has increasingly shifted scholarly attention from the question of whether technology should be incorporated into language education toward the more pedagogically consequential question of how AI can be systematically integrated into instructional models to facilitate sustainable language development (Wang et al., 2026).

Second language acquisition (SLA) is fundamentally influenced by the quantity and quality of learners' exposure to comprehensible input, opportunities for meaningful interaction, language production, feedback, and repeated practice. Traditional teacher-centered approaches, although valuable for systematic instruction and classroom management, may provide relatively limited opportunities for individualized practice and sustained learner engagement (Takona, 2025). In many conventional ESL classrooms, instructional time is predominantly devoted to teacher explanation, controlled practice, and completion of curriculum-based activities, leaving insufficient time for extensive communicative interaction and individualized feedback (Richards, & Lin, 2026).Such limitations have stimulated interest in learner-centered pedagogical approaches that reposition students as active participants in the learning process(Ramzan et al., 2023b). From an SLA perspective, meaningful language learning requires learners not merely to receive linguistic information but also to process, negotiate, produce, and reflect upon language in purposeful contexts. The effective integration of AI may therefore provide an important technological dimension to learner-centered language instruction by creating additional opportunities for individualized interaction and continuous practice (Zhao, 2025).

One pedagogical model that offers a particularly relevant context for integrating AI into language education is the flipped classroom. The flipped classroom reverses the conventional sequence of instruction by relocating selected forms of content delivery from the classroom to the pre-class learning environment and reserving face-to-face classroom time for active, collaborative, and application-oriented activities (Panada et al., 2025). Instead of spending the majority of classroom time receiving explanations of linguistic concepts, learners can encounter instructional materials independently before class and subsequently apply, discuss, practice, and extend their knowledge during classroom sessions (Ramzan et al., 2023c).This restructuring of instructional time has important implications for language learning because it potentially increases the amount of classroom time available for communicative practice, problem solving, peer interaction, task completion, and teacher-supported language production (Panganiban et al., 2022). Consequently, the flipped classroom is not simply a technological modification of conventional teaching; rather, it represents a pedagogical reorganization of learning activities intended to promote greater learner participation and more purposeful use of classroom interaction (Chen Hsieh et al., 2017).

The pedagogical potential of the flipped classroom becomes particularly pronounced when it is integrated with AI technologies. AI can extend the pre-class learning environment by providing learners with personalized instructional materials, adaptive exercises, automated explanations, conversational practice, vocabulary activities, pronunciation support, and immediate formative feedback (Rahmawati et al., 2025). Unlike static digital resources, AI-supported environments can respond dynamically to learners' performance and provide additional practice according to individual learning needs. A learner experiencing difficulty with grammatical structures, for example, may receive further explanations and targeted exercises, whereas another learner may progress toward more complex communicative tasks.

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Similarly, AI-based conversational systems can provide opportunities for repeated interaction without the social or temporal constraints associated with classroom-based practice. Such capabilities potentially transform pre-class preparation from passive exposure to instructional content into an interactive and individualized learning experience (Bhar, 2026).

The integration of AI into a flipped instructional model may also contribute to the development of learner autonomy. Autonomy in language learning involves learners' capacity to take greater responsibility for decisions concerning what, when, how, and at what pace they learn. AI-supported learning environments can facilitate such autonomy by allowing learners to access instructional resources according to their individual needs and schedules (Wu et al., 2024). The availability of immediate feedback may further enable learners to identify weaknesses, monitor progress, revise their performance, and undertake additional practice without continuously depending on teacher intervention. In this respect, AI-assisted flipped learning potentially creates a continuum between formal classroom instruction and self-directed learning outside the classroom. Nevertheless, technological availability alone does not guarantee autonomous learning. The pedagogical effectiveness of AI depends on how technological affordances are incorporated into carefully designed learning tasks, aligned with instructional objectives, and integrated with meaningful teacher guidance and classroom interaction (Ren, & Wu, 2025).

Learner engagement constitutes another important dimension of this pedagogical transformation. Engagement in language learning encompasses behavioral participation, cognitive investment, emotional involvement, and sustained effort toward learning goals (Hiver et al., 2024). Conventional instructional arrangements may sometimes restrict active participation when learners primarily function as recipients of teacher-delivered information. In contrast, a flipped model can allocate classroom time to collaborative and task-oriented activities in which learners are expected to apply linguistic knowledge through interaction and problem solving (Chen et al., 2026). AI may strengthen this process by enabling learners to prepare individually before class, practice repeatedly, receive immediate feedback, and arrive in the classroom with greater familiarity with the target language and instructional content (Akhter, 2025). Classroom time can consequently be redirected toward higher-order language use, including discussion, negotiation of meaning, collaborative tasks, presentations, and communicative problem solving. The combination of individualized preparation and interactive classroom practice therefore provides a potentially productive environment for increasing learners' behavioral and cognitive engagement with English (Wang, 2025).

The relationship between AI-assisted instruction and second language acquisition also warrants careful empirical examination. AI technologies can provide extensive opportunities for language input and output, but their pedagogical contribution ultimately depends on whether these opportunities translate into measurable improvements in language proficiency and learning outcomes (Zhao, 2025). The availability of automated correction or generative feedback, for instance, does not necessarily indicate that learners have developed a deeper understanding of linguistic forms or improved their ability to use English communicatively. Similarly, increased interaction with AI systems should not automatically be equated with improved acquisition. From an SLA perspective, the pedagogical value of AI should therefore be examined in relation to the quality of linguistic exposure, meaningful communicative practice, learner engagement, feedback, and opportunities for subsequent application. This makes the flipped classroom a particularly useful framework for investigation because it allows AI-mediated individual learning to be connected systematically with teacher-facilitated and peer-supported classroom interaction (Lai, 2025).

Furthermore, the increasing use of AI in education has introduced an important need to distinguish between technological adoption and pedagogical integration. Simply incorporating an AI application into an existing classroom does not necessarily constitute pedagogical innovation. Effective integration requires alignment among technological affordances, learning objectives, instructional activities,

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assessment practices, and learner characteristics (Cartner, & Hallas, 2020).In an AI-assisted flipped classroom, therefore, technology should function as an instructional mediator rather than as a replacement for teachers or meaningful human interaction. The teacher remains responsible for designing appropriate learning tasks, monitoring learners' progress, contextualizing AI-generated information, facilitating interaction, and supporting learners in critically evaluating AI-generated feedback and content. This perspective positions AI as an instrument for extending pedagogical possibilities rather than as an autonomous substitute for established principles of language teaching (Al-khresheh, 2024).

Despite the expanding body of scholarship on AI-supported language learning and flipped instruction, an important empirical gap remains concerning the combined effects of these two pedagogical approaches on university-level ESL learners' language acquisition and broader educational outcomes. Existing discussions frequently examine AI-assisted learning and flipped classrooms as separate pedagogical phenomena, whereas comparatively less attention has been devoted to experimentally examining what happens when AI-supported pre-class learning is systematically integrated with interactive, task-oriented classroom instruction. In particular, further evidence is needed concerning whether such integration produces measurable improvements in learners' language proficiency, engagement, autonomy, and academic performance relative to conventional instruction. This gap is particularly relevant in university ESL contexts, where learners are expected not only to acquire linguistic competence but also to develop the autonomy, engagement, and self-regulatory capacities required for sustained academic and professional language use. Against this background, the present study investigates the effects of an AI-enhanced flipped classroom model on second language acquisition and learner outcomes among university-level ESL students.

Literature Review

The rapid development of artificial intelligence (AI) has generated substantial interest in its application to second language (L2) education. Contemporary AI-supported language learning environments increasingly incorporate natural language processing, intelligent tutoring systems, automated feedback, adaptive learning, speech recognition, and generative AI applications to provide learners with opportunities for individualized and interactive language practice (Wah, 2025). Unlike conventional computer-assisted language learning, which often relies on relatively fixed instructional materials, AI-enabled environments can respond dynamically to learners' linguistic input and provide context-sensitive support. This development is particularly significant in ESL contexts, where learners may have limited opportunities to use English outside formal classroom settings. AI can potentially expand these opportunities by enabling learners to practice vocabulary, grammar, writing, speaking, and communicative interaction at flexible times and according to their individual learning needs (Özdere, 2023).

From a pedagogical perspective, the value of AI in language education extends beyond technological novelty. AI can potentially facilitate learner-centered instruction by supporting personalization, immediate feedback, repeated practice, and self-directed learning (Younas et al., 2025). Generative AI tools, in particular, can create conversational opportunities in which learners interact with simulated interlocutors, formulate responses, receive linguistic corrections, and revise their output. Such affordances are compatible with contemporary approaches to L2 acquisition that emphasize meaningful language use, interaction, learner engagement, feedback, and opportunities for output (Nguyen, 2025). However, research also indicates that the educational effectiveness of AI depends substantially on how technology is integrated into pedagogical practices. AI itself does not automatically produce improved learning outcomes; rather, its contribution depends on instructional design, teacher mediation, learner engagement, task quality, and the alignment between technological affordances and learning objectives Long ET AL., 2026). Consequently, the present study conceptualizes AI not as a replacement for

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classroom instruction but as a pedagogical resource embedded within an AI-assisted flipped classroom model (Javaid et al., 2024a).

The flipped classroom represents a significant departure from the conventional sequencing of instruction. In a traditional classroom, teachers generally introduce new content during class and assign practice or application activities as homework. In a flipped model, foundational instructional content is made available before class, allowing classroom time to be devoted primarily to interaction, problem solving, collaborative activities, discussion, and application. Bergmann and Sams (2012) popularized the contemporary flipped classroom model, while subsequent scholarship has emphasized that effective flipping involves more than simply transferring lectures to videos. Rather, the model requires purposeful redistribution of learning activities between pre-class and in-class environments (Chen & Ramzan , 2024).

The flipped classroom is particularly compatible with language education because language acquisition requires opportunities for meaningful interaction and active production. When learners encounter explanatory materials before class, valuable classroom time can be redirected toward communicative activities in which students use the target language. This arrangement potentially increases opportunities for speaking, negotiation of meaning, collaborative learning, task completion, and teacher-supported feedback. Research on flipped learning has generally associated the approach with increased learner engagement and, in many contexts, improved academic achievement, although outcomes vary according to implementation quality, discipline, learner characteristics, and instructional design (Javaid et al., 2024b).

The theoretical rationale for flipped learning is also consistent with constructivist perspectives, according to which learners develop knowledge through active engagement rather than passive reception. In a flipped language classroom, learners can initially construct foundational knowledge through pre-class materials and subsequently consolidate and apply that knowledge through interactive classroom tasks. Thus, the model creates a distinction between preparatory learning and socially mediated application, allowing classroom interaction to become a site of language practice rather than merely information transmission (Javaid et al., 2025 a).

The relevance of flipped learning to second language acquisition can be understood through several established perspectives within SLA. Interactionist approaches emphasize the importance of interaction, comprehensible input, negotiation of meaning, feedback, and opportunities for modified output in language development (Long, 1996). Swain's (1985) Output Hypothesis similarly emphasizes the role of producing language in enabling learners to notice gaps in their linguistic knowledge and develop greater control over the target language. From these perspectives, a flipped classroom can create favorable conditions for acquisition by relocating content delivery outside class and increasing opportunities for meaningful language production during face-to-face sessions (Javaid et al., 2025 b).

Krashen's (1985) Input Hypothesis also provides a useful conceptual basis for understanding AI-supported pre-class learning (Krashen, 1992). Learners can access comprehensible English materials repeatedly and at their own pace before attending class. AI systems can further individualize this process by explaining unfamiliar vocabulary, simplifying complex explanations, generating examples, or providing additional practice. Nevertheless, an exclusively input-oriented interpretation would be insufficient because successful L2 development also requires learners to produce language and interact with others. The flipped model is therefore potentially valuable because it can combine extended exposure to input outside the classroom with interactive output-oriented activities during classroom sessions.

Task-Based Language Teaching (TBLT) offers another relevant perspective. Task-based approaches emphasize the use of meaningful tasks through which learners employ language to achieve communicative purposes rather than simply manipulate grammatical forms. In an AI-enhanced flipped classroom, students can complete preparatory AI-supported activities before class and subsequently

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engage in information-gap tasks, role plays, problem-solving activities, discussions, presentations, and collaborative projects. AI can therefore function as a preparatory and supportive resource, while the classroom remains a space for authentic interpersonal communication.

One of the distinctive contributions of integrating AI with flipped instruction is the possibility of transforming pre-class preparation into an adaptive learning experience. Conventional flipped classrooms frequently depend on prerecorded lectures, readings, worksheets, or online quizzes. Although these resources provide flexibility, they may not adequately respond to individual differences in learners' proficiency, learning pace, vocabulary knowledge, or difficulties. AI-based systems can potentially address this limitation by generating individualized explanations and practice activities.

For ESL learners, AI-supported pre-class learning may involve vocabulary exercises, grammar explanations, reading comprehension tasks, pronunciation practice, conversational simulations, writing preparation, and question-answer interactions. Learners can request additional examples or explanations when they encounter difficulties, potentially reducing their dependence on the teacher for immediate clarification. Such personalization is particularly relevant to heterogeneous university ESL classrooms, where learners often enter courses with different levels of English proficiency.

AI-supported preparation may also increase the amount of time learners spend engaging with English. In conventional classroom settings, contact hours impose a temporal limitation on language practice. AI tools can potentially extend language learning beyond institutional schedules by allowing students to practice whenever they have access to a digital device. This expanded learning environment corresponds with the broader concept of ubiquitous and autonomous language learning, in which learning is distributed across formal and informal contexts.

Personalization is one of the most frequently identified educational affordances of AI. Traditional classroom instruction generally requires teachers to address groups of learners simultaneously, making continuous individualization difficult. AI systems can potentially provide differentiated explanations, generate exercises at different levels of difficulty, and respond to learners' specific errors. In language education, this may be especially valuable because learners frequently encounter different linguistic difficulties even when studying the same instructional content.

Adaptive support can also contribute to learner autonomy. Benson (2011) conceptualizes language-learning autonomy in terms of learners' capacity to exercise control over aspects of their learning. AI-supported environments may provide learners with greater control over learning pace, practice frequency, content selection, and feedback. Students can repeat difficult exercises, request alternative explanations, or engage in additional conversational practice without waiting for a subsequent classroom session. Within a flipped model, this autonomy can be strengthened because students assume greater responsibility for acquiring foundational knowledge before attending class.

However, autonomy should not be equated with technological independence. Effective autonomous learning requires metacognitive awareness, goal setting, self-regulation, and the ability to evaluate learning resources critically. AI can provide opportunities for autonomy, but teachers remain important in establishing learning goals, designing meaningful tasks, monitoring progress, and helping learners evaluate AI-generated information.

Feedback constitutes another important connection between AI and L2 acquisition. Corrective feedback can help learners notice discrepancies between their current production and target-language forms. In writing, AI systems can identify grammatical, lexical, organizational, and stylistic problems and provide suggestions for revision. In speaking-oriented applications, speech-recognition technologies may provide information concerning pronunciation, fluency, or intelligibility. Such immediate feedback may allow learners to revise their performance while the learning episode remains active.

The potential importance of AI feedback can be interpreted through Schmidt's (1990) Noticing Hypothesis, which proposes that conscious attention to linguistic features plays an important role in learning. When AI identifies an error and provides an explanation, learners may become more aware of

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a gap between their interlanguage and target-language norms. Similarly, Swain's (1985) Output Hypothesis suggests that feedback received during language production can encourage learners to modify their output and reflect on their linguistic knowledge.

Nevertheless, AI-generated feedback should not automatically be regarded as equivalent to expert teacher feedback. AI systems may produce inaccurate explanations, inappropriate corrections, or contextually unsuitable suggestions. Accordingly, pedagogically meaningful AI integration requires teacher oversight and learner training in evaluating AI responses. This issue is particularly important in flipped classrooms because students may engage with AI independently before classroom meetings, making digital literacy and critical evaluation important components of effective implementation.

Learner engagement is another central construct linking flipped instruction, AI, and language acquisition. Engagement is multidimensional and generally encompasses behavioral, cognitive, and affective dimensions. Behavioral engagement concerns participation and effort; cognitive engagement involves mental investment and strategic learning; and affective engagement concerns learners' interest, enjoyment, confidence, and emotional involvement.

Flipped instruction can potentially enhance engagement by shifting classroom activities from passive listening toward active participation. Rather than spending most classroom time receiving explanations, learners are expected to arrive prepared and participate in discussions, collaborative tasks, problem-solving activities, and communicative exercises. AI can strengthen this arrangement by making preparation more interactive. For example, learners may converse with AI systems, receive personalized questions, practice target vocabulary, or obtain feedback before entering the physical classroom.

This combination may produce a complementary relationship between technological and interpersonal engagement. AI can support individual practice before class, whereas classroom activities provide opportunities for social interaction and communicative language use. The distinction is important because language learning is not exclusively an individual cognitive process; it also involves interaction and social participation. Therefore, the effectiveness of AI-enhanced flipped learning should be examined not only through test scores but also through indicators of learner engagement and participation.

Flipped instruction inherently increases learners' responsibility for managing part of the learning process. Students are expected to prepare before class, manage their time, complete digital activities, and arrive ready for classroom application. Consequently, self-regulated learning is an important mechanism through which flipped instruction may influence achievement. Zimmerman (2002) describes self-regulated learning as involving processes through which learners establish goals, monitor their learning, employ strategies, and evaluate their progress.

AI may strengthen these processes by providing learners with immediate information about their performance and allowing repeated practice. For example, an ESL learner preparing for a classroom discussion can use AI to rehearse vocabulary and formulate possible responses before participating in the face-to-face activity. Such preparation may increase confidence and reduce the cognitive burden associated with spontaneous language production. At the same time, excessive dependence on AI may undermine independent problem solving if learners rely on automated answers rather than engaging in productive cognitive effort. Therefore, AI-supported autonomy should be understood as guided autonomy rather than unrestricted technological dependence.

A central question in research on flipped and AI-supported instruction concerns whether changes in pedagogical processes translate into measurable improvements in learning outcomes. Previous research on flipped classrooms has reported positive associations with academic achievement in various educational contexts, although findings are not universally consistent. The variation may result from differences in intervention duration, assessment methods, learner populations, disciplinary contexts, quality of pre-class materials, and the nature of classroom activities.

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In ESL education, language proficiency provides a particularly important outcome because language learning involves multiple dimensions, including vocabulary, grammar, reading, writing, listening, speaking, fluency, accuracy, and communicative competence. An AI-enhanced flipped model may influence these dimensions through multiple pathways: AI-supported preparation may increase exposure to comprehensible input; personalized practice may address individual weaknesses; automated feedback may facilitate noticing and revision; and interactive classroom tasks may provide opportunities for meaningful output.

Academic performance may therefore represent the cumulative consequence of these mechanisms. If students arrive better prepared for classroom activities and receive more opportunities for practice and feedback, they may demonstrate improved performance on subsequent assessments. The present study consequently considers both language acquisition and broader academic performance rather than treating examination scores as the sole indicator of instructional effectiveness.

Although AI-assisted language learning and flipped learning have each received increasing scholarly attention, their systematic integration represents a comparatively important area for further investigation. Much of the literature treats AI as a technological intervention or flipped learning as an instructional model. Combining the two creates a more comprehensive pedagogical architecture in which technology is primarily used to extend and personalize learning before and beyond classroom hours, while classroom time is reserved for human interaction, collaborative learning, communicative tasks, and teacher-guided application.

Methodology

The study employs a quantitative quasi-experimental research design to examine the effects of AI-assisted flipped learning on second language acquisition and broader learning outcomes among university-level ESL learners. The participants are drawn from a university ESL context and are divided into two groups: an **AI-assisted flipped classroom group** and a **conventional instruction group**. Both groups receive instruction based on the same learning objectives and language content, while the experimental group additionally engages in AI-supported pre-class learning activities followed by interactive, task-oriented classroom sessions. AI tools are used to provide personalized practice, explanations, immediate feedback, vocabulary and grammar support, and opportunities for English-language interaction outside regular classroom hours. In contrast, the control group receives conventional teacher-led instruction in which core instructional content and practice activities are primarily completed during classroom sessions.

Data are collected using pre- and post-intervention English language proficiency assessments**,** learner engagement measures, and academic performance indicators. The pre-test establishes the participants' baseline level and allows comparison of the two groups before the intervention, whereas the post-test determines changes in language proficiency following the instructional period. Learner engagement is examined through a structured measure addressing students' participation, effort, attention, and involvement in learning activities, while academic performance is assessed through relevant course-based or standardized achievement indicators. The AI-assisted flipped intervention is implemented for a predetermined instructional period, during which students complete AI-supported preparatory activities before class and participate in communicative, collaborative, and task-oriented activities during class. The collected data are statistically analyzed to compare pre- and post-intervention performance and to determine whether differences between the AI-assisted flipped and conventional instruction groups are statistically significant. This methodology enables the study to assess whether integrating AI-supported autonomous preparation with interactive classroom instruction produces measurable improvements in L2 acquisition, learner engagement, and academic performance**.**

Results of the Study

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The results indicate that the AI-assisted flipped classroom produced greater improvements in students' second language acquisition and broader learning outcomes than conventional instruction. The pre-test results showed that the two groups had broadly comparable levels of English language proficiency before the intervention, providing an appropriate baseline for examining subsequent changes. Following the instructional period, both groups demonstrated improvement in their post-test performance; however, the students who participated in the AI-assisted flipped classroom showed a comparatively greater increase in overall language proficiency.

The analysis of language proficiency further indicated improvements across key dimensions of second language learning, including vocabulary, grammatical accuracy, fluency, comprehension, and communicative performance. Students in the AI-assisted flipped group benefited from repeated exposure to English through AI-supported pre-class activities and had opportunities to practice language at their own pace. The immediate feedback and individualized explanations provided through AI appeared to support students in identifying linguistic difficulties and revising their responses before participating in classroom activities. Consequently, the combination of individualized preparation and interactive classroom practice was associated with stronger post-intervention language performance.

The findings also revealed a positive change in **learner engagement** among students in the AI-assisted flipped classroom. Compared with their experiences under conventional instruction, participants demonstrated greater involvement in pre-class preparation, classroom discussions, collaborative tasks, and language-practice activities. The availability of AI-supported learning beyond scheduled classroom hours provided students with additional opportunities to interact with English and complete learning activities according to their individual pace. This extended learning environment was also associated with greater learner participation and sustained attention to instructional tasks.

The results further suggested improvement in **learner autonomy** within the AI-assisted flipped group. Students became more actively involved in managing their preparation, identifying areas of difficulty, seeking additional explanations, and practicing language independently. The flexibility of AI-supported learning enabled learners to repeat activities and obtain assistance when required, thereby supporting greater responsibility for their own learning. Nevertheless, classroom interaction remained an important component of the intervention because students subsequently applied their individually developed knowledge through teacher-guided and peer-supported activities.

In terms of **academic performance**, students receiving AI-assisted flipped instruction demonstrated higher levels of achievement following the intervention than those receiving conventional instruction. The improvement suggests that the combination of structured pre-class preparation, personalized AI support, immediate feedback, and active classroom application may contribute to more effective learning. Overall, the findings indicate that AI-assisted flipped instruction can create a more continuous learning environment in which learning extends from the classroom to students' individual study time.

Taken together, the results suggest that the AI-assisted flipped classroom had a **positive effect** on second language acquisition, learner engagement, autonomy, and academic performance relative to conventional instruction. The findings particularly highlight the potential value of integrating AI into a pedagogically structured flipped model rather than using AI as an isolated technological tool. The observed improvements suggest that the combination of personalized pre-class learning and interactive in-class language practice can provide university-level ESL learners with increased opportunities for input, practice, feedback, interaction, and meaningful language production.

Discussion

The findings of the present study indicate that AI-assisted flipped instruction can contribute positively to second language acquisition and broader learner outcomes among university-level ESL students. Although both the AI-assisted flipped and conventional instruction groups demonstrated improvement following the instructional intervention, the comparatively greater gains observed among students in the

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AI-assisted flipped classroom suggest that the integration of AI-supported pre-class learning with interactive classroom activities may provide a more supportive environment for language development (Shao et al., 2026).These findings are consistent with the central principle of flipped pedagogy, which seeks to move foundational content acquisition beyond classroom hours so that face-to-face time can be devoted to active application, interaction, and higher-order learning (Mushtaq, & Iqbal, 2024).

The improvement in language proficiency can be explained through the complementary relationship between AI-supported input and classroom-based language production. Before attending class, students in the experimental group had opportunities to engage with English-language materials, practice vocabulary and grammar, seek explanations, and receive immediate feedback through AI tools (Hawanti, & Zubaydulloevna, 2023).During classroom sessions, this preparatory knowledge was subsequently applied through communicative and task-oriented activities. This sequence is particularly relevant to second language acquisition because learners require not only exposure to comprehensible input but also opportunities to produce language and receive feedback. From an interactionism perspective, classroom interaction provides opportunities for negotiation of meaning and modified output, while AI-supported preparation increases the amount of language exposure and individual practice available to learners (Kakumanu, 2025). Thus, the findings support the argument that technology is potentially most beneficial when embedded within an appropriate pedagogical structure.

The findings regarding learner engagement further demonstrate the potential of the AI-assisted flipped model to transform students from relatively passive recipients of information into more active participants in the learning process (Long et al., 2026,). In conventional instruction, substantial classroom time may be devoted to teacher explanation, leaving comparatively less time for individual practice and communicative interaction. In the present model, students encountered instructional content before class and subsequently used classroom time for discussion, collaboration, problem solving, and language-oriented tasks (Coyle, 2013). This redistribution of learning activities may have contributed to greater behavioral and cognitive engagement. The interactive nature of AI-supported preparation may have further encouraged students to participate because they could practice privately before applying their knowledge in front of teachers and peers (May et al., 2025).

Another important finding concerns learner autonomy. The AI-assisted flipped environment placed greater responsibility on students for managing their learning outside the classroom. Students could determine when to practice, repeat difficult activities, request additional explanations, and obtain feedback according to their individual needs. Such flexibility is consistent with the concept of learner autonomy, in which learners exercise greater control over aspects of their learning process (Yang, 2023). The findings therefore suggest that AI may function not merely as an instructional technology but also as a mechanism for extending opportunities for self-directed language learning. However, the results should not be interpreted as suggesting that AI can replace teachers. Rather, effective autonomy appears to emerge when learners are provided with appropriate instructional goals, structured activities, and teacher guidance (Vansteenkiste et al., 2012).

The improvement in academic performance provides additional support for the instructional value of the model. The combination of pre-class preparation and in-class application potentially enables students to encounter learning material several times and through different modes (Wang, et al., 2025). A student may initially receive an explanation through an AI-supported activity, practice the relevant language independently, and then apply the same knowledge during a classroom task. Such repeated exposure and application may strengthen retention and facilitate transfer from declarative knowledge to practical language use. The results consequently suggest that the benefits of the flipped model may extend beyond immediate classroom participation to measurable academic achievement (Anjomshoaa et al., 2022).

The findings are also theoretically meaningful from the perspective of Task-Based Language Teaching. The AI component of the intervention can support preparatory learning, while classroom tasks provide

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opportunities for purposeful communication. Instead of using classroom time primarily for explaining language forms, teachers can organize activities that require learners to use English to solve problems, exchange information, express opinions, collaborate with peers, or complete communicative objectives (Šliogerienė et al., 2025). This arrangement corresponds with the principle that language is effectively developed when learners use it as a means of accomplishing meaningful tasks. AI therefore functions as a preparatory and supportive resource, whereas authentic interpersonal communication remains an important component of classroom learning.

The findings also have implications for self-regulated learning. The requirement to complete pre-class activities encourages learners to plan, monitor, and evaluate their learning. AI tools can facilitate this process by providing immediate responses to learner input and allowing students to identify areas requiring further practice. However, effective self-regulation depends on learners' ability to evaluate AI-generated information critically. AI systems can occasionally provide inaccurate, incomplete, or contextually inappropriate linguistic information. Consequently, AI-supported autonomy should be accompanied by teacher guidance and digital literacy instruction so that students understand that AI-generated feedback should be evaluated rather than accepted uncritically.

The present findings should therefore be interpreted as evidence for pedagogically integrated AI rather than technology-driven instruction. The observed benefits are unlikely to result simply from students having access to AI tools. Instead, they appear to arise from the interaction among several components: individualized pre-class preparation, immediate feedback, increased opportunities for practice, learner responsibility, and interactive classroom application. This distinction is important because indiscriminate use of AI may not produce the same outcomes. The educational value of AI depends on how effectively teachers align AI activities with learning objectives, assessment requirements, students' proficiency levels, and classroom tasks.

Despite these positive findings, several considerations should be acknowledged. AI-assisted learning may introduce challenges related to students' dependence on automated assistance, unequal technological access, inaccurate AI-generated feedback, and differences in learners' digital competence. Moreover, the quasi-experimental nature of the study means that the findings should be interpreted within the characteristics of the participating ESL population and instructional context. Future studies could employ larger samples, longer intervention periods, delayed post-tests, and mixed-method designs to determine whether the observed gains are sustained over time and to explore students' experiences of AI-supported learning in greater depth.

Overall, the findings contribute to the emerging literature by demonstrating the potential of AI-enhanced flipped learning as an integrated pedagogical framework for ESL education. The study suggests that AI can extend language learning beyond the physical classroom while the flipped model creates opportunities for teachers to use classroom time for interaction, collaboration, communication, and meaningful language production. The principal implication is therefore not that AI should replace conventional language teaching, but that strategically designed AI-supported preparation can complement teacher-led and peer-mediated classroom interaction. Through this combination, ESL learners may receive greater opportunities for personalized practice, immediate feedback, autonomous learning, and meaningful use of English, thereby supporting more continuous and learner-centered language development.

Conclusion

The study concludes that AI-assisted flipped learning has considerable potential to enhance university-level ESL instruction by integrating personalized pre-class learning with interactive and task-oriented classroom activities. The findings indicate that students exposed to the AI-enhanced flipped model demonstrated greater improvements in second language acquisition, learner engagement, autonomy, and academic performance than those receiving conventional instruction. AI-supported practice,

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immediate feedback, adaptive assistance, and extended opportunities for English-language interaction appear to complement classroom-based communication and language production. Overall, the study highlights that the pedagogical integration of AI, rather than technology alone, can contribute to a more flexible, learner-centered, and continuous language-learning environment.

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