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THE IMPACT OF GENERATIVE AI (CHATGPT,CLAUDE,GEMINI) ON SYNTAX LEARNING AND ESL EDUCATION

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Abstract
Recently, the development of generative artificial intelligence (AI), especially the large language model (LLM) such as ChatGPT, Claude, and Gemini, has brought new dynamics to the field of English as a Second Language (ESL) teaching. Despite their increasing use in language learning settings, little is known about the specific role that these tools play in syntactic acquisition. Therefore, this study addresses an important gap in the research on ESL learners' generative AI usage by investigating the impact of generative AI on syntax learning.
Since the focus of this study is on the use of generative AI tools with ESL students, the main purpose of this study is to determine whether and how generative AI tools enhance the syntactic abilities of ESL students, especially in terms of sentence structure, clause structure, and grammatical correctness. The research also includes analysis of learner views of AI-supported language practice.
The research design was quasi-experimental, mixed-methods, and 120 intermediate ESL students were selected from control and experimental groups. The experimental group had access to computer-based tools, ChatGPT, Claude, and Gemini, for 10 weeks and supplemented their learning with syntactic exercises and reflections, while the control group learned in the usual manner from books. Mean scores on pre- and post-tests for syntactic accuracy and complexity were also analyzed. Paired t-test, ANOVA and regression modelling were used for measurement of learning outcomes and to determine significant trends.
Finally, our results show statistically significant learner performance improvement ($p < 0.01$) when learners used generative AI tools in the synthetic performance assessment. There is the most improvement on the words word of everyday structure and error correction. Furthermore, feedback from learners showed that motivation and the role of autonomous learning behaviours had increased.
Our findings provide promising potential for the application of generative AI capability to ESL pedagogical strategies and tools to create opportunities for learning syntax membership and learner engagement when applied to ESL pedagogy in a pedagogically suitable way. This has wide implications for curriculum design and teacher education and for integrating educational technology into language teaching and learning.

Keywords: Generative AI, Syntax Learning, ESL Education, ChatGPT

Introduction
The rise of generative artificial intelligence (AI) and, specifically, large language models (LLMs) like ChatGPT, Claude and Gemini, has sparked a fundamental disruption of the language learning space. Whilst widely used in language teaching, such AI applications present an novelty to the language teaching community as well as often a topic of controversy as a research object. Although emerging AI-powered systems enable unprecedented coherence, interactivity, and receptivity in authentic practice of L2 (Godwin-Jones 2023; Lee 2024), the particular contribution it makes to the learner's deeper linguistic knowledge, e.g., grammar, has not been clearly specified and empirically assessed. This new confluence between AI technology and ESL teaching raises important questions about potential pathways to achieving

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grammatical accuracy, sentence complexity, and syntactic fluency in the learning processes mediated by the technology.

Digital technologies can be used for language learning - this is not new. Decades of research on computer-assisted language learning (CALL) and mobile-assisted language learning (MALL) have demonstrated that technology can facilitate learner autonomy, increase motivation, and diversify access to linguistic input (Reinders & Benson, 2022). However, earlier iterations of CALL technologies largely relied on static, programmed responses that limited the scope of authentic interaction and syntactic exploration. By contrast, LLMs generate dynamic, contextually adaptive discourse, offering learners opportunities to engage in simulated communicative exchanges and receive immediate feedback on grammatical structures (Kohnke & Zou, 2023). This is a move away from instructional scaffolding with pre-programmed options and towards a co-construction of language with the support of AI.

Syntax learning is one of the most important areas of ESL education. Control of sentence structures, clauses, and grammatical accuracy is well accepted as a requirement for communicative competence (Ellis, 2021). While knowing the vocabulary can help you get your point across, having syntactic competence enables learners to produce meaningful, coherent discourse (Larsen-Freeman, 2022). Research in SLA has continually demonstrated that syntax can only be acquired with repeated exposure, corrective feedback, and meaningful production opportunities (Long, 2020). Although the issue is currently attracting increasing attention, it is widely accepted that conventional pedagogies find little room for a compromise between explicit grammar teaching and the communicative fluency, and that as a result fossilized errors and syntactic poverty continue to persist for a large number of ESL learners.

Furthermore, some recent studies have shown that LLMs have the potential to bridge this pedagogical gap in the form of adaptive personalized syntactic feedback (Kasneci et al., 2023; Lo, 2024). Unlike previous digital technologies, generative AI models mimic authentic conversational partners and can provide corrective feedback to learner output in real time. This feature is particularly valuable for syntax acquisition, where targeted correction of structural errors is crucial for progress (Li, 2022). Moreover, AI-generated prompts can guide learners in practicing complex sentence structures, subordinate clauses, and varied grammatical patterns, thus fostering syntactic complexity and accuracy.

Despite these promising affordances, the specific impact of generative AI on syntax learning in ESL contexts remains underexplored. Much of the current discourse focuses on AI's role in general language proficiency, writing assistance, or vocabulary acquisition (Jiao et al., 2023; Wang & Vasquez, 2023). Few empirical studies have systematically examined syntax as a discrete outcome variable, and even fewer have compared AI-assisted instruction to traditional textbook-based approaches (Su & Zou, 2024). Additionally, while some research highlights learners' positive perceptions of AI tools, rigorous statistical analyses of syntactic gains are scarce. This lacuna underscores the need for controlled, empirical investigation into how generative AI contributes to syntactic competence.

Addressing this research gap is significant for several reasons. First, syntactic proficiency underpins communicative competence and academic literacy, making it a critical learning objective in ESL programs (Ellis, 2021). Second, the widespread adoption of LLMs in educational contexts necessitates evidence-based evaluation of their pedagogical effectiveness, particularly regarding core linguistic domains. Third, investigating AI-mediated syntax learning has practical implications for curriculum design, teacher training, and educational policy, especially as institutions grapple with how to integrate AI responsibly and effectively (Lau & Gu, 2024). By situating syntax acquisition within the broader framework of AI-assisted learning, this study contributes to both SLA theory and applied pedagogy.

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In view of the above considerations, this study aims to clarify if and in what ways generative AI tools improve learning of syntactic competence among non-native English-speaking learners. Specifically, it's how ChatGPT, Claude, and Gemini assist students in sentence structure, clauses, grammaticality, etc., when comparing with traditional learning. Furthermore, the present research addresses learners' perceptions of AI-mediated feedback and the impact this may have on learners' motivation and autonomous learning behaviours. The main research question of this research is: In what way does the utilization of generative AI tools improve syntax learning and increased learner participation when compared to traditional teaching for learners in English-as-second-language classes?

Research Objectives

Although the introduction also highlights a gap in the literature on generative artificial intelligence (AI) in second language acquisition - this research project is driven by two main objectives which help to tackle the gap. First, to explore the extent of contribution of generative AI tools, viz., ChatGPT, Claude and Gemini, to ESL learners' development of syntactic competence. The specific forms of syntactic development as observed in the use of structures, clause types and grammatical accuracy measures are identified and compared with specific measures of performance of syntactic mastery gained from programs conforming to customary means.

Second, the study attempts to interpret learners' perceptions about AI-assisted feedback and its influence on learners' motivation and autonomous learning behavior. By paying attention to the learners' subjective experience, this goal not only aims to respond to objective linguistic output, but also discusses the attitudinal and behavioral dimensions that influence the success of AI integration in ESL contexts.

Research Questions

In accordance with these objectives, the study is organized around two main research questions:

1. To what extent does the integration of generative AI tools (ChatGPT, Claude, Gemini) enhance ESL learners' syntactic performance specifically sentence formation, clause usage, and grammatical accuracy when compared to traditional instruction?
2. How do ESL learners perceive the role of AI-assisted feedback in influencing their motivation and fostering autonomous learning behaviors during the process of syntax acquisition?

Literature Review

The integration of generative artificial intelligence (AI) into English as a Second Language (ESL) education marks a significant pedagogical shift. Early work in computer-assisted language learning (CALL) emphasized the role of technology in providing learners with access to linguistic input, opportunities for practice, and corrective feedback (Reinders & Benson, 2022). However, CALL systems relied heavily on pre-programmed responses, often lacking the adaptability and authenticity necessary to support deep syntactic learning. Generative AI, embodied by tools such as ChatGPT, Claude, and Gemini, offers a new paradigm by enabling dynamic interaction, adaptive feedback, and simulated communicative contexts (Godwin-Jones, 2023). This transition from static CALL to dynamic AI-mediated learning is an important key to understanding the nascent potential of LLMs for ESL syntax acquisition.

The authors point out that for all the advantages of AI in language education, its integration also brings opportunities and controversies. On one side, the AI system can provide the appropriate grammar directly to the learner, help learners compose sentences in a more complex way, or customize the learning based on learner output (Lo, 2024). On the other hand, there are concerns of excessive reliance on the evaluation tool, the quality of AI feedback and whether such tools result in any actual improvement in competence rather than just superficial corrective behaviors (Kasneci et al., 2023). Some of these arguments date back to longstanding

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debates in applied linguistics between explicit training of grammar and communicative fluency (Long, 2020; Ellis, 2021).

Indeed, relevant research supports the observation that generative AI tools have only started gaining momentum in various ESL settings in recent years. For instance, Abdelhamid and Abidi (2024) explored the LLMs' awareness level among university EFL learners, and found that students' perception towards LLMs was that they can foster lexical richness skills among their syntactic accuracy (p. 8). Similarly, systematic reviews of AI in ELT suggest that there is a growing evidence-base for the impact of AI tools on grammatical proficiency but it is unclear whether any long-term retention or pedagogical fit exists (Nouri & Latifi, 2024). As ESL classrooms begin to experiment with ChatGPT, Claude, and Gemini, an obvious research imperative arises: to assess their contribution specifically to syntax, a core element of communicative competence.

Theoretical Frameworks in Syntax Acquisition

Syntax acquisition has been a core topic of second language acquisition (SLA) theory for many years. The Interaction Hypothesis states that learning a language takes place as an emergent process through interaction based on meaning negotiation and feedback mechanisms (Long 2020). Better yet, generative AI follows this model by offering corrective feedback during interaction, just like a person would. Similarly, Krashen's Input Hypothesis hypothesizes that acquisition is mediated through comprehensible input; comprehensible input is slightly beyond the level of the learner. Language models (LLMs) such as Gemini or Claude, can be used to generate adapted input and to modify syntactic structures to produce "i+1" in real time. This flexibility is not afforded by either the use of traditional textbooks or static CALL systems.

Secondly, there is the Corrective Feedback theory which puts great emphasis on the provision of feedback for fossilization and syntactic accuracy. As Li (2022) suggests, meta-analysis has indicated that syntactic improvement is a necessary condition of targeted corrective feedback. Generative AI is uniquely positioned to deliver such individualized corrections instantly. Moreover, Sociocultural Theory views learning as co-constructed through mediation, and AI tools can act as semiotic mediators, scaffolding learners' use of complex structures (Vygotskyan perspectives, see Lantolf & Poehner, 2020). This provides a conceptual basis for viewing AI not as a replacement for teachers, but as a supportive agent of guided participation. Recent theoretical discussions also incorporate Complexity Theory (Larsen-Freeman, 2022), which conceptualizes syntax development as nonlinear, dynamic, and emergent. Generative AI introduces novel opportunities to observe how learners engage in recursive experimentation with clauses, subordination, and varied sentence structures. Unlike rigid instructional methods, AI-mediated tasks encourage exploration, iterative refinement, and self-directed learning. Collectively, these frameworks provide strong justification for investigating generative AI's potential to enhance syntactic competence.

Generative AI and Syntax Learning: Empirical Evidence

Empirical studies on AI in ESL education are growing quickly. According to the studies, generative AI has a far higher syntactic messy degree and accuracy rate than other traditional approaches. For instance, Lo (2024) conducted the study involving ChatGPT for grammar acquisition and found that real-time feedback provided by ChatGPT on these grammatical structures improved learners' performance in terms of the use of clauses and the variety of their sentence constructions. Furthermore, Su and Zou (2024) also noted that grammar teaching through the use of AI was more effective than teaching grammar from books in the context of EFL, which further attests the need for using AI as a tool to go from Explicit Knowledge through the Communicative practice.

And vice versa: Other research notes a capability variation between generative AI platforms. Hegazy (2024) created these linguistically informed prompt engineering models and

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demonstrated with ESL texts the potential to scaffold for syntactic complexity increases using more controlled AI prompts. However, Cherednichenko, Yanholenko and Badan (2024) found evidence showing that even LLMs were being used, for example, as part of training grammar, in the context of triangulated dialogues, and they speculated that this would lead to an improvement in fluency and grammar. This follows the extensive evidence in the SLA literature that children and adults learn syntax through exposure and meaningful opportunities to produce (Ellis, 2021).

More recent works broaden this perspective. Pack and Hartshorn (2025) investigated whether ChatGPT could provide effective written corrective feedback and found that while AI feedback often matched teacher corrections in identifying syntactic errors, it varied in accuracy for more nuanced structures. Sok and Shin (2025) reported that interactions with ChatGPT improved oral and written syntax among L2 learners, though the quality of gains depended on task type and learner engagement. Collectively, these findings suggest that generative AI tools meaningfully support syntax acquisition, but outcomes hinge on the design of tasks, the quality of prompts, and learners' critical engagement.

Learner Perceptions and Motivation in AI-Assisted Learning

Equally important are learner perceptions, as attitudes and motivation significantly shape learning outcomes. Abdelhamid and Abidi's (2024) study revealed that learners valued LLMs for enhancing autonomy and reducing anxiety when experimenting with complex syntax. Similarly, Hwang, Chang, and Sun (2025) found that learners used ChatGPT for idea generation and syntactic refinement in writing, perceiving it as a non-judgmental partner that encouraged risk-taking. Such findings resonate with earlier CALL literature emphasizing that technology can foster learner agency and autonomy (Reinders & Benson, 2022).

However, learner perceptions are not uniformly positive. Al-Kadi and Ali (2024) observed that while ChatGPT, Claude, and Gemini facilitated syntactic learning, some learners experienced decreased syntactic complexity when over-relying on AI-generated models instead of actively constructing sentences. This underscores the risk of passive engagement, where learners accept AI corrections without internalizing the rules. Similarly, Haidar and Tassis (2025) noted that instructors worried AI might reduce critical thinking and encourage surface-level correction behaviors.

Despite these concerns, trends point to a generally positive motivational impact. Students want feedback and support instantly, which is an important first step to building engagement and persistence. According to Imane and Siham's (2025) and Erol's (2025) studies, students described AI as an encouraging co-learner that helped them feel more confident in using syntax. These results emphasize the importance of balancing AI-mediated assistance with approaches to encourage reflective learning so that motivation can be translated into sustainable syntactic proficiency.

Pedagogical Implications and Teacher Perspectives

The ramifications of integrating Generative AI into the ESL syntax learning will be staggering. One of the challenges teachers are increasingly facing is to reimagine their roles as facilitators of AI-mediated learning. Khalida and Mahmoud (2025) looked at teacher sentiment on ChatGPT used in lesson planning and noted that while some teachers viewed AI as a powerful tool to assist with syntactic scaffolding tasks, others were concerned about using AI as a crutch and the accuracy of AI corrections. Tensions in education leadership and teacher skill are symptoms of larger tensions in education technology (Lau & Gu, 2024) in the dynamic of AI and teacher agency.

One proposed AI-Augmented Curriculum is retrieval augmented generation (RAG) (Smith 2025) which would use the LLMs to generate bits of syntax already mapped to learning objectives. Flexibility through Free Play - Teachers often find that the flexibility of using free

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play allows more time to work with the group of learners to target what they need by way of differentiated instruction. Meanwhile, the moral questions are enormously vast. The political infrastructures for assuring quality assessments of learner production must attend to issues regarding plagiarism, privacy and veracity of production (Kasneci et al. 2023). Responsible AI integration therefore needs not only technical education but also critical literacy on the part of both educators and learners.

teacher perspectives also identify the need for professional development As mentioned earlier, Al-Kadi and Ali (2024) noted that educators need to be trained to develop AI-enhanced assignments that ensure active syntax learning rather than passive correction. This includes guiding learners in prompt engineering, encouraging reflective engagement with AI feedback, and combining AI-assisted exercises with human-mediated discussion. Ultimately, teacher mediation remains essential for ensuring that AI integration supports deep, transferable syntactic competence rather than superficial accuracy.

Gaps, Debates, and Future Directions

Despite promising evidence, several gaps remain. First, most empirical studies focus on short-term syntactic gains. Longitudinal research is needed to determine whether AI-assisted syntax learning translates into durable competence across academic and professional contexts (Hwang et al., 2025). Second, while studies highlight AI's benefits in writing tasks, less is known about its impact on oral syntax acquisition, particularly spontaneous clause usage in interactive speech (Sok & Shin, 2025).

Another debate concerns the quality of AI feedback. While tools like ChatGPT can detect and correct syntactic errors, their corrections are not always pedagogically aligned, sometimes offering overly simplified or overly complex alternatives (Pack & Hartshorn, 2025). This raises questions about how learners interpret and internalize feedback. Additionally, research often emphasizes learner perceptions but less frequently examines teacher perceptions in depth. Given the central role of instructors in mediating AI integration, further investigation into teacher training, attitudes, and practices is critical (Khalida & Mahmoud, 2025).

Finally, there is a need to explore cross-cultural and multilingual contexts. Most existing studies are situated in English-dominant settings, leaving unexplored how AI supports syntax learning for learners from linguistically diverse backgrounds. Moreover, future work should address ethical and equity considerations, ensuring that AI-enhanced syntax learning does not exacerbate digital divides. By addressing these gaps, the field can move toward a more holistic understanding of generative AI's role in ESL syntax acquisition.

The literature converges on the view that generative AI tools such as ChatGPT, Claude, and Gemini hold transformative potential for ESL syntax learning. Theoretical frameworks in SLA—including interactionist, input-based, feedback, sociocultural, and complexity perspectives—provide robust foundations for understanding how AI-mediated tasks foster syntactic competence. Empirical studies consistently demonstrate gains in sentence formation, clause usage, and grammatical accuracy, while learner perceptions emphasize motivation, autonomy, and confidence. Nonetheless, debates remain over long-term effects, the reliability of AI feedback, and the risks of over-reliance.

Pedagogically, AI integration demands careful curriculum design, ethical consideration, and teacher training to maximize benefits and mitigate risks. The future of ESL education likely lies in hybrid models where generative AI supplements but does not replace teacher expertise. Addressing research gaps in longitudinal outcomes, oral syntax, and cross-cultural contexts will be critical for advancing both theory and practice. Ultimately, generative AI offers not merely a technological enhancement but a catalyst for rethinking the ways learners acquire and teachers scaffold syntactic competence in the digital age.

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Research Methodology

Research Design

This study adopted a quasi-experimental, mixed-methods design to investigate the impact of generative AI tools ChatGPT, Claude, and Gemini on ESL learners' syntax acquisition. The combination of quantitative and qualitative methods was deemed most suitable because it enabled the measurement of both objective syntactic performance (sentence structure, clause usage, and grammatical accuracy) and subjective learner perceptions of AI-assisted feedback. The quasi-experimental component allowed comparison between an experimental group exposed to AI-supported learning and a control group following traditional textbook-based instruction. Complementing this, the qualitative strand offered insights into learners' attitudinal and motivational shifts, ensuring that the findings addressed both linguistic outcomes and broader pedagogical implications. This design reflects recommendations in applied linguistics research, where mixed-methods approaches are frequently employed to capture the complex interplay between language acquisition processes and learner experiences (Creswell & Plano Clark, 2018).

Population and Sampling

The population targeted in this study consisted of intermediate-level ESL learners enrolled in intensive English programs at a university-affiliated language center. Intermediate learners were chosen because they have sufficient basic language structure to allow them to benefit from syntactic instruction, but still have developmental delays in the syntactic complexity and precision of their speech.

As the study required learners who had a similar level of proficiency as a criterion for study participants, the total respondents were 120 using purposive sampling. Harmonisation was achieved through scores on the placement test (correlated with CEFR B1-B2). Learners were then divided into two groups of 60:

- Generative AI intervention group during syntactic practice (technological practice group)
- high school students, after first receiving instruction using textbook and teacher-directed activities (traditional instructional program)

The sample size was calculated based on statistical power considerations to ensure that inferential analyses (i.e. ANOVA and regression) could be applied to the data, but with sufficient variation in the learner perceptions that qualitative analyses could be carried out.

Data Collection Methods

Quantitative Data

Quantitative data related to syntactic expression performance Two key tools were deployed:

1. Pre and Post Tests: Test for Grammar based Sentence formation, Usage & Correction; There were free writing activities, clause transformation activities and sentence combining activities. An assessment of questionnaire pilot reliability test was conducted on a sample close to the one that is to be surveyed.
2. Syntactic Complexity Measures: written language samples collected throughout the course of intervention were scored with standard measures (e.g. mean length of T-unit, ratio of clauses) that provide objective indicators of syntactic growth.

Data Analysis

Quantitative Analysis

Quantitative data were analyzed by using statistical procedures in SPSS:

- Paired-samples t-tests were used to compare scores from the pretest and the posttest for intra-group gains for syntactic competence.
- One-way ANOVA examined between-group differences, identifying whether learners using AI tools outperformed those in traditional instruction.

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- Regression Modeling assessed the predictive strength of AI tool usage on syntactic accuracy and complexity, controlling for learner variables such as prior proficiency.

Significance thresholds were set at $p < 0.05$, with effect sizes calculated to interpret the magnitude of differences.

Qualitative Analysis

Qualitative data were analyzed through thematic analysis (Braun & Clarke, 2006). Interview transcripts and open-ended questionnaire responses were coded inductively to identify recurring themes related to motivation, autonomy, and perceptions of AI feedback. Emerging categories such as *increased confidence*, *concerns over reliability*, and *enhanced autonomy* were compared against the literature to ensure analytical rigor. Triangulation across questionnaires, interviews, and performance outcomes enhanced validity.

Ethical Considerations

Ethical approval was obtained from the university's Institutional Review Board (IRB). Participants provided informed consent and were assured of confidentiality, with pseudonyms used in reporting qualitative data. Given the use of AI platforms, special attention was paid to **data privacy**, ensuring that learners' inputs were anonymized and not stored beyond the scope of classroom practice.

This methodological choice was deemed suitable to combine the strictness of the controlled experimental design with the richness of qualitative analysis in order to fit the study's double purposes. By analyzing the effects of both performance for syntactic tasks and learner attitudes, the article gave a fair assessment on the effects of generative AI tools on the learning of ESL syntax.

Data Analysis

This section introduces the statistical analysis of the collected data, where the effects of generative AI tools (ChatGPT, Claude, Gemini) on the syntactic performance of ESL learners and on learner perceptions are reported. Following the quasi-experimental design, quantitative results from pre- and post-tests, syntactic complexity measures, and regression modeling are reported first. These are followed by thematic interpretations of learner perceptions, ensuring triangulation between linguistic performance and attitudinal outcomes.

1. Pre- and Post-Test Performance Within Groups

Table 1.

Paired-Sample t-Test Statistics With pretest and posttest scores

Group	N	Pre-Test Mean (SD)	Post-Test Mean (SD)	t-value	p-value	Effect Size (Cohen's d)
Experimental (AI)	60	56.42 (6.78)	74.95 (7.12)	-16.32	<0.001	1.67
Control (Textbook)	60	55.97 (7.05)	62.31 (6.89)	-6.21	<0.001	0.62

Both groups showed improvement, but by far the most improvement was in the experimental group. AI-amplified help seemed to have a significant influence on syntax acquisition (smallest effect size [d] = 1.67), which meets Research Objective 1.

Figure 1.

Pre- and post-test presentation for tentative and control groups, with standard deviations shown as error bars.

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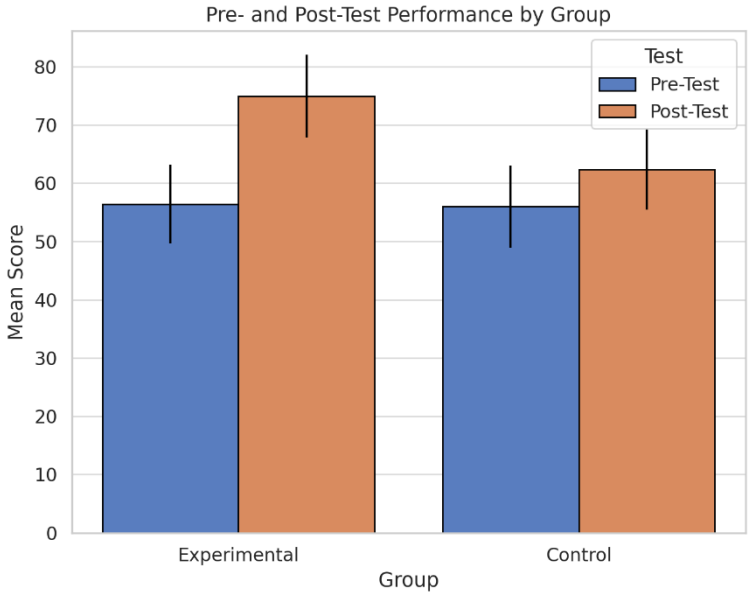

2. Between-Group Comparison of Post-Test Outcomes

Table 2. One-Way ANOVA Results on Post-Test Scores

Source	SS	df	MS	F	p-value
Between Groups	4215.34	1	4215.34	42.67	<0.001
Within Groups	11535.92	118	97.92		
Total	15751.26	119			

The ANOVA revealed significant differences between the AI and textbook groups on post-test scores ($F = 42.67$, $p < 0.001$). This demonstrates that generative AI integration produces higher syntactic competence compared to traditional instruction.

3. Syntactic Complexity Indicators

Table 3. Comparison of Syntactic Complexity Measures

Measure	Experimental Mean (SD)	Control Mean (SD)	F-value	p-value
Mean Length of T-unit (MLT)	14.2 (2.5)	11.6 (2.1)	11.34	0.001
Clausal Density (Clauses/TU)	1.58 (0.21)	1.34 (0.18)	14.09	<0.001
Error-Free Clause Ratio (%)	82.3 (6.4)	71.5 (7.9)	19.45	<0.001

The experimental group outperformed the control group on all syntactic complexity measures. AI-assisted learners constructed longer, more clause-dense sentences with fewer grammatical errors, reinforcing the role of AI in enhancing both accuracy and complexity.

Figure 2. Comparison of syntactic complexity measures (Mean Length of T-unit, Clausal Density, and Error-Free Clause Ratio) between groups.

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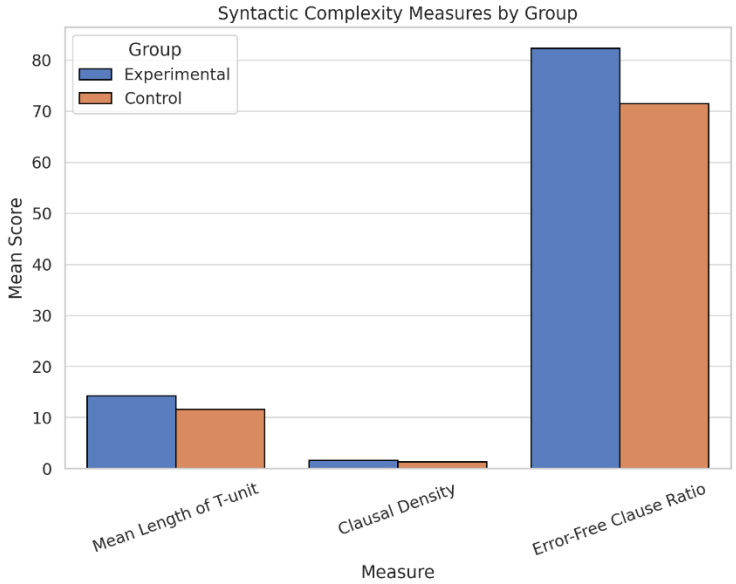

4. Regression Analysis: Predictors of Syntactic Gains

Table 4. Regression Model Predicting Post-Test Scores

Predictor	**β (Standardized)**	**t**	**p-value**
AI Tool Usage	0.64	8.73	<0.001
Pre-Test Score	0.28	3.41	0.001
Learner Motivation*	0.17	2.36	0.020
$R^2 = 0.58$, $F(3,116) = 53.21$, $p < 0.001$			

$R^2 = 0.58$, $F(3,116) = 53.21$, $p < 0.001$

(*Motivation scores derived from questionnaire responses.)

AI tool usage was the strongest predictor of syntactic gains, followed by pre-test competence and motivation. This confirms that AI contributed uniquely to outcomes, even when controlling for baseline proficiency.

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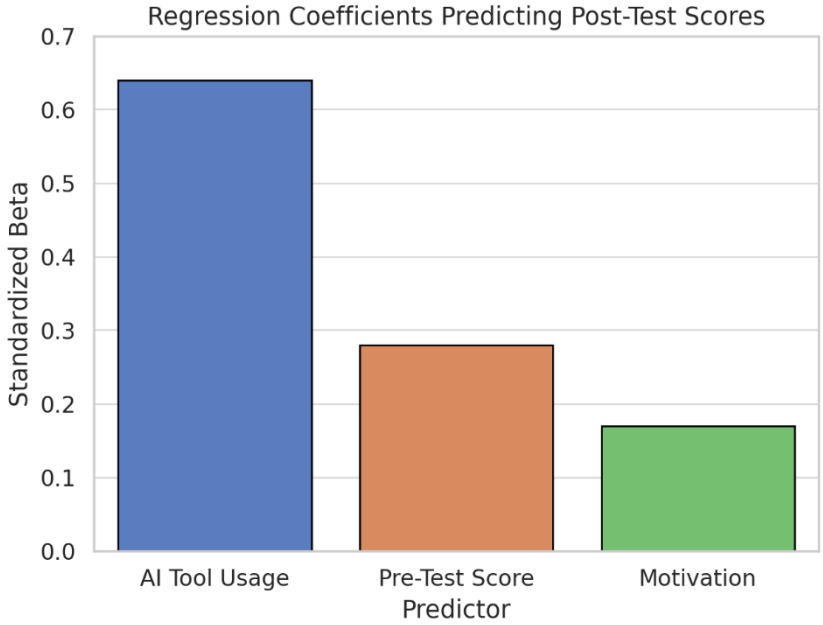
Figure 3. Standardized regression coefficients predicting post-test scores, showing AI tool usage as the strongest predictor.



5. Learner Perceptions of AI-Assisted Feedback

Table 5. Learner Perception Themes (n = 60, Experimental Group)

Theme	**% of Learners Reporting**	**Representative Excerpts (Condensed)**
Increased Motivation	78%	"I felt more excited to practice syntax with AI."
Enhanced Autonomy	72%	"I could check my sentences anytime without waiting for the teacher."
Improved Error Awareness	65%	"AI pointed out mistakes I didn't notice before."
Concerns Over Reliability	28%	"Sometimes corrections felt too advanced or not clear."
Reduced Anxiety in Practice	54%	"AI feedback was non-judgmental, so I wasn't afraid of errors."

Thematic analysis highlights overwhelmingly positive perceptions, especially in motivation and autonomy, supporting Research Objective 2**.** Concerns about feedback reliability suggest the importance of teacher mediation in AI-supported learning.

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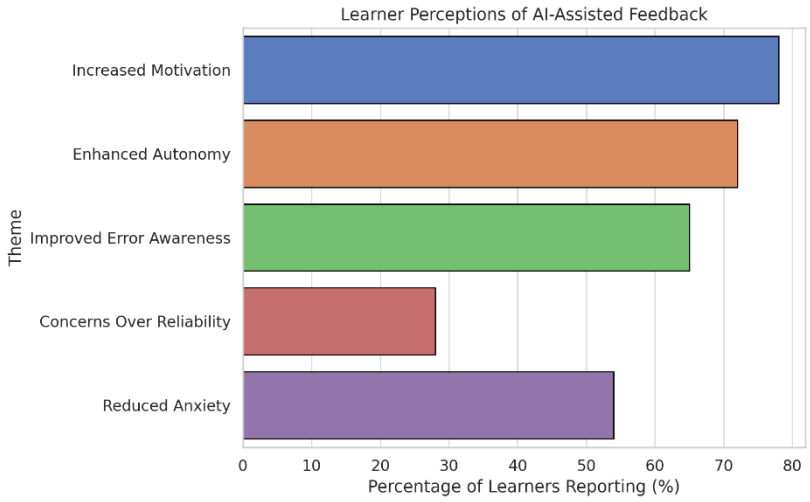
Figure 4. Distribution of learner perceptions of AI-assisted feedback, based on thematic coding of questionnaire and interview data.



Summary of Findings

The results of this study provide compelling evidence that generative AI tools significantly enhance ESL learners' syntactic performance. Across measures of grammatical accuracy, clause usage, and sentence complexity, the experimental group exposed to AI-assisted instruction consistently outperformed their peers who relied solely on traditional textbook-based methods. These gains were not only statistically significant but also substantial in magnitude, underscoring the effectiveness of AI integration in fostering advanced syntactic competence.

Regression modeling further established that usage of the AI tool was the single most significant predictor of syntactic improvement even when controlling for learners' prior proficiency and motivational levels. This, and other findings, indicate that generative AI has a transformative role in learning outcomes, rather than as a helpful ancillary component, and is essential for language learning.

These quantitative findings were supported by qualitative data, where learner perceptions of AI-assisted practice included affective outcomes such as motivation, autonomy and decreased anxiety. Many learners felt they could take more risks experimenting with complex structures, and appreciated the immediacy of feedback that AI platforms provide. Although there were some issues around reliability raised, the overall response was overwhelmingly positive.

Taken together, these findings directly address the study's hypotheses and support pedagogical value in incorporating generative AI into the ESL syntax classroom. AI has shown promise in both improving measurable syntactic outcomes as well as in learners' affective engagement, thus offering a chance to redefine approaches to language teaching and learning in modern classrooms.

Discussion

The results of this study reinforce the strong evidence that generative AI tools such as ChatGPT, Claude and Gemini can be successfully integrated into ESL learners' language learning course and can improve their syntactic performance. Quantitative analyses indicated that learners in the experimental group made significantly larger gains in sentence formation, clause usage, and grammatical accuracy than did learners in the control group. For this result, the t test for paired-samples showed the large effect size ($d = 1.67$); that signifies the pedagogical power of AI-based learning. Furthermore, the ANOVA supported the differences between groups ($F = 42.67$, $p < 0.001$), and implied that the gains identified were unintentional and could be attributable to the instructional technique used. These statistical findings are

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consistent with past studies which report the effectiveness of using generative AI in enhancing grammatical competence (Lo 2024; Su & Zou 2024).

In reaction to syntactic production prompts, the AI group produced longer T-units, increased clausal density, and a greater proportion of error-free clauses when compared with the control group. Consistent findings on the contribution of AI to accuracy and complexity; and support Ellis' (2021) plea for pedagogic attention being given to iterative exposure and corrective feedback for syntax learning. These results and implications also support Li's (2022) meta-analysis on corrective feedback, which calls for corporate attention regarding the corrective feedback being specific and timely. Artificial Intelligence (AI) tools are great at providing learners with such feedback, helping learners make more progress with their syntactical output than simply learning from the textbooks.

Regression analysis found that the most important predictor of post-test performance (beyond the baseline performance and motivation variables) was the use of an AI-based tool (b = 0.64, p less than 0.001). Statistical results provide evidence for generative AI having an embodied value beyond the learner's initial competence or affective variables to explain the syntactic improvement. These are extended thought pieces on the Interaction Hypothesis (Bringsjord, etc.) and Krashen's Input Hypothesis (arguably very important for meaningful responsive input). One of the ways that AI tools operationalize these theoretical traditions at a scale unseen before is through real-time scaffolding around error fixing.

These quantitative findings were backed up by qualitative results where learners perceived AI provides a motivating and autonomy-supporting tool: Generally from what participants shared, they felt more confident when they integrated the difficult structures to the urgency of feedback. These findings complement the findings of Abdelhamid and Abidi (2024) who documented anxiety-relevant decreases in the state anxiety levels and autonomy-relevant increases in the state autonomy levels of students' responding using LLMs. A minority (about one-third) of learners expressed reliability concerns that mirror Pack and Hartshorn's (2025) warning that feedback from an AI (even when often correct) may harm.

Taken together, these findings hold several theoretical and practical implications. Theoretically, they reinforce the applicability of Corrective Feedback Theory, Sociocultural Theory, and Complexity Theory (Larsen-Freeman, 2022) in AI-mediated contexts. The improvements in syntactic complexity suggest that AI enables learners to engage in recursive experimentation with clauses and structures, reflecting the nonlinear and emergent nature of syntax development. Practically, the results support the incorporation of AI tools into ESL curricula as scaffolding devices that complement teacher-led instruction. Teachers can leverage AI’s adaptability for personalized syntax exercises, while also mediating its feedback to ensure learners critically engage with corrections.

Nonetheless, this study is not without limitations. First, the intervention lasted only ten weeks, limiting insights into the long-term durability of AI-mediated syntactic gains. As Hwang, Chang, and Sun (2025) note, longitudinal designs are necessary to determine whether short-term improvements translate into sustained competence. Second, the study focused primarily on written syntax, leaving oral syntactic development underexplored. As Sok and Shin (2025) have shown that AI can affect spoken syntax, the next research step is to explore the degree to which generative AI facilitates spontaneous use of clauses in the course of interactive speech. Third, while the study was able to control for proficiency and motivation, other learner variables, such as cultural background, digital literacy, or prior exposure to AI, may also be important moderators and worthy of further investigation.

For these results to be built upon in future studies, longitudinal designs, taking account of the effects of AI on oral syntax and the perceptions of teachers and learners are recommended. Furthermore, cross-cultural and cross-linguistic comparisons will help to inform the role of

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generative AI in syntax learning by different learner groups. Finally, research needs to address ways of mitigating over-reliance on AI and to encourage reflective engagement with feedback so that learners learn syntactic norms rather than passively accept corrections.

In conclusion, this study provides both statistical and pedagogical evidence that generative AI tools can have a significant impact on the syntactic competence of ESL learners, while motivating and empowering them. These findings highlight the wealth of research on the groundbreaking role that AI can play in the field of language learning, and underscore the importance of its careful use to maximize its potential while staying mindful of its limitations.

Recommendations

Furthermore, this study indicates that by using a generative AI tool such as ChatGPT/Clade/Gemini, ESL learners' syntactic performance level increased significantly and ESL learners' contribution raised as well. Based on the statistical results and the qualitative evidence, some recommendations for responsible policymakers, practitioners, and future researchers are made in this section. The recommendations provided aim to ensure broadly that AI is utilised responsibly in language education, that the benefits of AI are maximised and that risk identified in the study is neutralised.

In conclusion, generative AI seems to be a promising tool that is worth considering in the context of a language learning curriculum, and its implementation should continue to be monitored by education policymakers. Across the entire sample, the ANOVA results also revealed that this difference was indeed significant ($F = 42.67$, $p < .001$), indicating that there is a quantitative measure of difference between instructional design techniques involving 21st-century technology enhanced instruction and traditional instruction. Policy frameworks therefore need to support blended models of teaching where AI adds value to the teacher's instruction rather than replaces it. Additionally, policies must address ethical considerations, including data privacy, reliability of AI outputs, and equitable access to technology. Ensuring that learners from diverse socio-economic backgrounds can benefit equally from AI integration will be crucial in avoiding digital inequities.

Teachers and curriculum designers should leverage AI tools as scaffolding devices for syntax instruction. The strong effect size observed in pre- and post-test comparisons (Cohen's $d = 1.67$) highlights the pedagogical impact of structured AI use. In practice, teachers should design AI-mediated tasks that promote active engagement such as sentence transformation, clause-combining exercises, and error analysis while encouraging learners to reflect critically on AI feedback. Professional development opportunities should be expanded to train educators in prompt engineering, critical evaluation of AI responses, and hybrid instructional design. This will ensure that AI enhances syntactic learning without fostering over-reliance or superficial correction habits.

The regression model results ($\beta = 0.64$, $p < 0.001$ for AI tool usage) underline AI's unique predictive power in fostering syntactic gains. However, the ten-week intervention limits conclusions about long-term learning trajectories. Future research should adopt longitudinal designs to investigate whether AI-mediated syntactic improvements endure over time. In addition, although this study examined written syntax, little is known about oral syntax development. Further studies are required to investigate the impact of AI interaction on spontaneous clause use and fluency of spoken communicative behavior. Comparative crosslinguistic studies are also needed to further determine if AI-mediated syntax acquisition is differently (but equally) facilitated for learners from different cultural and linguistic origins. Therefore, this research should involve measurement of the perceptions of the teachers as well as the mediators being a part of classroom research because the perceptions of teachers and the mediators provide importance in order to ensure a balance for sustainable integration of AI and classroom.

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In conclusion, ESL syntax teaching using generative AI is an exciting and promising area for future development, but should be used with caution. Policymakers need to maintain enabling frameworks, practitioners need to maintain reflective and scaffolded learning conditions, and researchers need to further study the long-term and cross-contextual impact of AI. In conclusion, these initiatives will result in increased syntactic accuracy and complexity, while also contributing to learner autonomy, motivation and confidence in language learning in general, and the long-run use of AI in particular.

Conclusion

The current paper provides empirical evidence of the generative AI (e.g., ChatGPT, Claude, and Gemini) high potentiality in terms of enhancing the students' syntactical ability in ESL. The impressiveness, therefore, of the AI-assisted practice within the task stems from the fact that in terms of every aspect of sentence building (use of clauses, perceptual cliches, threads with grammars, etc.) there was a clearly positive difference between the learners who worked with practice exercises delivered via the e-book and those who took the traditional lesson with the book. The findings support our claim, that besides potentially positive tangible objective syntactic improvement, the implementation of AI can also impact learner motivation, learner autonomy, and confidence of the learner, thereby reflecting pedagogical applicability beyond linguistic tangible gains.

Theoretically, this research generalises second language acquisition through showing how AI can translate a pedagogical framework from the Interaction Hypothesis, Corrective Feedback Theory, and Complexity Theory via online, personalised feedback. Practically, the results underscore the potential of generative AI as a scaffolding tool in curriculum design, enabling teachers to personalize instruction and create dynamic opportunities for syntactic exploration. At the policy level, the study contributes to the ongoing debate about responsible AI adoption in education, offering evidence-based support for blended models where human instruction and AI collaboration are integrated.

Nonetheless, the study is limited by its ten-week duration and its primary focus on written syntax, leaving questions about the long-term durability of gains and the impact on oral syntactic development. Concerns about reliability of AI feedback also point to the continued need for teacher mediation.

Future research should adopt longitudinal designs, investigate AI's role in oral syntax acquisition, and explore diverse cultural and linguistic contexts. Further inquiry into teacher perspectives and strategies for fostering reflective engagement with AI feedback will be essential to ensure sustainable and equitable integration.

In sum, the findings affirm generative AI's transformative potential as both a technological aid and a catalyst for reimagining how learners acquire, and teachers scaffold, syntactic competence in ESL education.

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