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The effect of AI-supported collaborative learning on EFL students' grammar achievement

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Abstract

The current research explores the role of collaborative learning mediated by Artificial Intelligence (AI) technology in enhancing English as a Foreign Language (EFL) grammar achievement at a university level. A quasi-experiment has been carried out at a Cypriot higher education institution where the sample involved 40 undergraduate participants classified as having intermediate proficiency in English. Two intact classes have been selected: one class served as a control group exposed to conventional teacher-centred instruction and another as an experimental one engaged in AI-mediated collaborative learning. The pre-test-post-test design was employed for data collection regarding the change in grammatical proficiency. Data were analysed using the following procedures: paired-samples t-test, independent-samples t-test, and ANCOVA which was performed with the use of IBM SPSS Statistics. Both groups showed progress; however, the latter group achieved significantly greater improvement. There was a significant difference between the pre-test and post-test means which corresponded to a very large effect size, thus, implying great practical significance of results. Cognitive load theory and the notion of entangled cognition have been used for the interpretation of data as the findings reflect how the introduction of AI reduced extraneous cognitive load and promoted deeper engagement via collaboration (Sweller, 1998; Clark & Chalmers, 1998). Learners received immediate personal feedback when co-creating grammatical concepts with the help of AI tools. Thus, under the conditions of this study, AI-supported collaborative learning appeared more effective than traditional grammar instruction for improving grammar achievement.

Introduction

Grammar competence has long remained one of the essential aspects of EFL proficiency, helping learners to create meaningful communicative acts. Although the significance of grammar is undeniable, there still exist difficulties in the process of teaching this language aspect to EFL learners, who frequently fail to acquire grammatical rules due to the lack of appropriate practice and the inability to employ them in actual communication. Traditional approaches to grammar acquisition based on the analysis of grammar rules and subsequent practice often fall short in fostering motivation and engagement of learners and providing them with opportunities to interact and receive relevant feedback. With advancements in modern technology, however, innovative solutions to the problem at hand have become available. Artificial intelligence (AI), in particular, has shown its effectiveness in the field of education, creating opportunities to improve processes of teaching and learning languages. AI-powered platforms such as ChatGPT offer prompt, personalised feedback on learners' errors, contributing to enhanced self-monitoring, correction, and improvement. As pointed out by Lee (2003), one of the main disadvantages of traditional grammar teaching lies in its inefficiency when it comes to delivering timely and detailed feedback. AI provides the missing component to facilitate effective instruction, as it helps learners to continually refine their grammar. Besides individual approaches to language learning, collaboration has proven to be an efficient strategy to promote language acquisition. Collaboration in EFL contexts encourages interaction and negotiation of meaning among participants, which positively affects learners' understanding of language structures. With regards to grammar, it is evident that group activities help learners discuss rules and analyse their mistakes, potentially facilitating greater awareness of grammatical forms. However, collaboration in language learning might lack accuracy-focused feedback, as learners' linguistic competencies might prevent them from effectively correcting their mistakes.

Collaboration supported by AI tools seems like an excellent way to fill the void. Combining the benefits of interaction provided through peer cooperation and accuracy-focused feedback provided by AI systems, such a technique creates a unique learning environment that fosters both collaboration and accuracy. From the perspective of contemporary views on learning that are based on distributed cognition and claim that knowledge is created through interactions between an individual and a cognitive agent (Clark & Chalmers, 1998), it is obvious that AI becomes such an agent, helping people learn and develop grammar. Although AI-assisted language learning has drawn increasing attention lately, most studies have addressed general language skills or writing achievements rather than grammar. Furthermore, there were cases in which AI had been used individually by students rather than incorporated into a collaborative approach to grammar learning. Thus, no conclusive findings on the impact of AI in collaborative environments on the development of learners' grammatical abilities can currently be provided. More specifically, limited research has examined AI-supported collaborative grammar learning in university EFL contexts. In light of this, the present study

will focus on the effect of AI-supported collaborative learning on EFL university students' grammar achievement in Cyprus. Comparing traditional grammar teaching with an innovative approach to learning based on the combination of peer collaboration and AI assistance, this paper will assess whether AI can be instrumental in enhancing EFL students' grammatical ability.

Literature review

Recently, artificial intelligence has been introduced in English as a Foreign Language teaching. The emergence of AI-assisted tools, including automatic writing systems such as ChatGPT and writing generators, provides learners with feedback on their grammatical mistakes almost instantly. As a result, these advancements can help learners improve their grammatical achievements due to an increased level of interaction, personalisation, and adaptation (Asadi et al., 2025; Su et al., 2023). Numerous empirical studies prove that AI-based technology greatly contributes to learners' grammatical growth by providing them with feedback and corrections. Specifically, learners gain an opportunity to fix grammatical mistakes on their own, developing self-regulated behaviours and fostering their independence. AI applications positively influence learners' grammatical accuracy and sentence formation because learners get feedback throughout the whole writing process. Thanks to natural language processing systems embedded in AI, learners get precise grammar correction and relevant language input (Mammadova, 2019; Fitria et al., 2024). Besides, by allowing learners to avoid dealing with low-level cognitive activities, such as grammar and vocabulary, AI tools facilitate the process of idea generation and organization. Namely, AI helps learners apply their grammatical knowledge repeatedly and, consequently, retain grammatical rules (Gayed et al., 2022; Hwang et al., 2023; Clark & Yu, 2022). Thus, these tools create a possibility for deep and meaningful engagement with grammatical forms.

Traditional grammar education still faces numerous limitations, especially in case of large class sizes that make it impossible to provide individual feedback. In turn, AI solves this issue and facilitates teacher work by providing constant feedback on learners' grammatical mistakes (Richards & Schmidt, 2013). Empirical studies confirm that AI tools not only enhance grammatical accuracy but also boost learners' self-efficacy and increase their engagement in language learning activities (Huang & Tan, 2023; Liu et al., 2023). At present, researchers increasingly pay attention to using AI technology in collaborative learning settings, demonstrating that combining peer and AI-based feedback improves learners' understanding of grammatical concepts. Namely, discussing and negotiating meaning with other learners helps learners develop grammatical knowledge. At the same time, most of the existing studies are devoted to AI-supported individual learning rather than collaborative

learning environment and specifically its role in fostering grammatical achievement (Song & Song, 2023).

Considering that AI technology is used in language learning, it plays a vital role in facilitating grammar education by reducing extraneous load. According to cognitive load theory, minimising cognitive demands makes it possible for learners to devote attention to important aspects of language (Sweller, 1998). As a result, thanks to the provision of feedback and structure, AI tools allow learners to concentrate on meaningful language use (Chen & Chang, 2024; Feng, 2024). Moreover, using AI systems contributes to the development of metacognitive strategies and enables learners to evaluate their grammatical performance and apply appropriate learning strategies (Yang & Xia, 2023). Another perspective on how AI influences grammar learning is the concept of entangled cognition. According to this theory, cognitive processes occur not only within individuals but also between them and technological tools that are used by them to perform specific activities (Clark & Chalmers, 1998; Morais, 2023). Thus, in the case of grammar learning, learners use AI to identify grammatical errors and construct correct forms (Chen & Yadollahpour, 2024; Zhai et al., 2024; Kejriwal et al., 2024). Although this cooperation improves learners' ability to perform certain actions, it might lead to dependence on AI and a lack of independent grammatical skills (Shanmugasundaram & Tamilarasu, 2023). Despite the fact that AI has a great impact on learners' grammatical development, some problems emerge in regard to this technology. First, the reliability of AI-generated feedback might pose a problem in the context of grammar learning (Crompton et al., 2024; Hockly, 2023; Gupta, 2023). Second, there is a risk of overdependence on AI technology. Lastly, current AI cannot provide feedback concerning the complex grammatical and discourse-level aspects (Rüdian et al., 2022; Rahmi et al., 2024).

The existing literature confirms the potential of AI in improving learners' grammatical achievement. Nevertheless, despite numerous empirical studies, there are gaps related to this topic. Namely, little attention is paid to investigating how learners' grammar can be improved by using AI in collaboration with peers. Specifically, most studies focus on the use of AI in individualised setting and in regard to language competence in general.

Research Questions

Q1. Does AI-supported collaborative learning significantly improve EFL university students' grammar achievement compared with traditional grammar instruction?

Q2. To what extent are AI engagement and perceptions of collaborative learning associated with grammar achievement within the experimental group?

Methodology

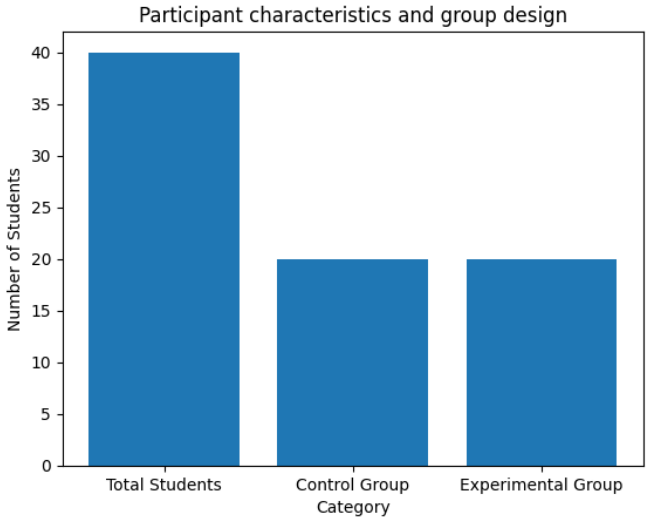
Research design

A quasi-experimental research design was used in this study to examine the effects of AI-assisted collaborative learning on the grammar performance of EFL students at a university in Cyprus. It was possible to compare the control and experimental groups, as there were two existing intact groups. Specifically, the control group received conventional instruction in grammar, while the experimental group participated in AI-assisted collaborative learning activities. A pre-test and post-test design was adopted to evaluate grammar achievement changes over time and to determine the academic gains of integrating artificial intelligence in collaborative learning situations. Quasi-experimental research is preferred in such situations when random grouping cannot be used for various practical reasons.

Participants

The study involved 40 undergraduate university students taking the English as a Foreign Language course at the Cyprus University. All students participating in the research were intermediate-level learners, based on the results of placement tests used at the institution. These students constituted two intact classes with twenty individuals in each. The control group was taught grammar in a traditional way while the experimental group undertook AI-assisted collaborative learning activities. Since quasi-experimental design required intact groups, Figure 1, it was impossible to conduct the random allocation of students to the two conditions. The participant group comprised male and female students. While studying a variety of majors, all participants had one feature in common – being EFL learners. Although the participants varied slightly in terms of experience in speaking English, there were no major differences among them. Baseline equivalence between groups was examined using pre-test scores and no substantial initial differences were observed. Apart from grammar test data, information on AI usage in the experimental group was also collected. Engagement with AI-supported activities was categorised descriptively into low, medium, and high participation levels for exploratory analysis. Collaborative learning perceptions were evaluated by the means of Likert scale ratings. Convenience sampling was used to recruit the participants of the study, selecting from the researcher's teaching context. All participants gave voluntary consent to take part in the investigation.

Figure 1
Participant characteristics and group distribution



Materials

Materials were created to be consistent with the two learning conditions used in the study, as well as capture learning outcomes and other significant process variables. A grammar achievement test was devised to serve as the pre- and post-test. The test contained multiple choice questions, as well as sentence transformations and editing tasks aimed at evaluating grammar knowledge. Expert review by EFL teachers was conducted in order to establish the validity of the test content. The grammar achievement test underwent pilot testing to evaluate clarity and administration procedures; however, reliability coefficients were not retained and therefore are not reported. Additional data on the perception of collaborative learning was gathered by means of a collaborative learning scale with Likert-scale ratings from 1 to 5 assessing students' interactions with peers. The collaborative learning scale was piloted prior to implementation; however, internal consistency coefficients were not retained and are therefore not reported. The experimental group was offered AI-assisted tools in collaborative learning activities, receiving immediate feedback regarding grammatical correctness, suggested correction options, and language explanation from the AI system. Working in small groups, the students carried out tasks with grammar problems, making use of AI. Engagement with AI was assessed in terms of low, medium, and high usage frequency. Collaborative tasks in the experimental condition were facilitated by means of worksheets and prompts to ensure that all students interacted with the same grammatical material. At the same time, AI tools were available only to the experimental group to facilitate collaboration.

Procedure

An eight-week experimental design with the same duration of two instructional sessions per week (90 minutes each) was utilised to investigate the effect of AI-assisted collaborative learning on grammar achievement of the participants. Ethical approval and informed consent were granted by the relevant authority. Participation was declared voluntary, and subjects were advised that they could leave the study anytime without penalty. Moreover, it was communicated to participants that collected data would be confidentially used only for research purposes. Before applying treatment and conducting the experiment, participants took a standardised grammar achievement pre-test. The objective of the pre-test was to ensure that there were no significant initial differences between two groups with respect to their grammar proficiency level. Identical testing environment, instructions, time, and procedures were applied to both classes. Scores on pre-tests were carefully analysed by the researcher to confirm the equivalence of grammar competences between two groups. Subsequently, the two intact groups were subjected to different instructional methods in terms of grammar learning and acquisition.

Control group

The control group received grammar instruction through teacher-centred activities. It included explanation of grammar rules, examples, practice exercises, and correction by the instructor. Classroom interaction was teacher-led, and peer discussions were minimised. Students practiced individual tasks and received feedback from the instructor. Presentation of the material followed by practice was the strategy used by the instructor to provide students with adequate instruction and cover grammar structures systematically.

Experimental group

In turn, members of the experimental group worked primarily in collaborative groups consisting of three to four learners to gain knowledge about grammar. Small groups consisted of three to four learners who had to discuss grammar tasks and resolve issues collectively. Before the treatment process started, participants took part in a special orientation session to learn more about collaborative learning activities and appropriate use of the AI system. Collaboration was supported by the usage of an advanced AI system which helped learners to work together effectively and develop necessary skills. Collaboration involved generating examples, checking grammatical accuracy, requesting explanations of rules, comparing different forms of language units, etc. The AI system was used according to instructions developed by the researcher. It meant that collaboration with the AI system was

performed in accordance with structured prompts and specific tasks developed by the researcher. The instructor had the role of observer who monitored interaction and encouraged students to engage in productive discussion, reflection, and evaluation of generated content rather than accept suggestions given by the AI system.

Fidelity check and treatment implementation

Treatment implementation followed a standardised plan and fidelity was monitored through observation checklists. In order to facilitate fidelity checks, lesson plans, instructional materials, and tasks for collaborative learning were standardised. The researcher conducted observations and completion checklists to guarantee proper implementation of the treatment. Besides, learners' engagement with AI-assisted activities was also monitored. Specifically, it involved collecting frequencies and categories (low, medium, high) of interactions with the AI system.

Post-test

At the end of the intervention, participants took another standardised grammar achievement test as post-test. Test conditions were equivalent for all subjects, and assessment procedures were identical in terms of timing and instructions. Post-test scores reflected improvement in grammar achievement as well as the influence of the treatment procedure.

Ethical considerations

Prior to conducting the experiment, the approval was received from the relevant institutional review board at the Cyprus University. All participants were informed of the goals and procedure of the study and were provided with details of their rights. Voluntary participation was ensured as participants received informed consent form. The anonymity of participants was maintained by coding all responses and omitting identifying information from the data analysis. Participants were informed that their willingness to take part in the experiment or withdrawal from it will not have an effect on their grade results. In addition, precautions were undertaken to avoid discrimination based on AI tool usage. The experimental group received necessary training to use the tool effectively.

Data analysis

The data were analysed using IBM SPSS Statistics to examine the effect of AI-supported collaborative learning on students' grammar achievement. Descriptive statistics were first calculated, followed by assumption testing for normality and homogeneity of variance to ensure the suitability of parametric tests. To evaluate within-group improvement, paired-samples t-tests were conducted for both groups. To compare differences between groups, an independent-samples t-test on gain scores was performed. Furthermore, an ANCOVA was conducted to control for pre-test differences and provide a more

precise estimate of the instructional effect. Finally, exploratory association analyses were conducted within the experimental group to examine relationships between AI engagement indicators, collaborative learning perceptions, and grammar achievement.

Table 1.
Overall descriptive statistics for pre-test and post-test scores

	N	Minimum	Maximum	Mean	Std. Deviation
PreTest	40	48	60	53.67	3.198
PostTest	40	53	75	64.33	6.411
Valid N (listwise)	40				

The descriptive data Table 1 reveal that students' mean scores increased from 53.67 in the pre-test to 64.33 in the post-test, indicating an overall improvement in grammar performance. The higher standard deviation in the post-test (6.411) suggests greater variability in students' outcomes after the intervention.

Table 2.
Group-wise descriptive statistics for pre-test and post-test scores

Report

Group		PreTest	PostTest
1	Mean	54.30	58.90
	N	20	20
	Std. Deviation	3.629	3.447
2	Mean	53.05	69.75
	N	20	20
	Std. Deviation	2.645	3.242
Total	Mean	53.67	64.33
	N	40	40
	Std. Deviation	3.198	6.411

The group comparison Table 2 reveal that both groups improved; however, the experimental group showed a substantially larger gain. While the control group improved modestly from 54.30 to 58.90, the experimental group increased markedly from 53.05 to 69.75. This suggests that AI-supported collaborative learning was more effective than traditional instruction.

Table 3.
Paired-samples t-test for pre-test and post-test scores

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PreTest - PostTest	-10.650	6.196	.980	-12.631	-8.669	-10.871	39	.000

The paired samples results in Table 3 indicate an overall statistically significant difference between pre-test and post-test scores across all participants, $t(39) = -10.871$, $p < .001$. The negative mean difference indicates that post-test scores were significantly higher than pre-test scores, confirming that students' grammar performance improved over time.

Table 4.
Effect sizes for pre-test and post-test differences

				95% Confidence Interval	
		Standardiser[a]	Point Estimate	Lower	Upper
Pair 1	PreTest - PostTest Cohen's d	6.196	-1.719	-2.205	-1.224
	Hedges' correction	6.256	-1.702	-2.183	-1.212

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation of the mean difference.
Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.

The effect size results Table 4 reveal a very large effect of the intervention. Both Cohen's d (-1.719) and Hedges' correction (-1.702) indicate a strong practical significance, suggesting that the observed improvement is not only statistically significant but also educationally meaningful. This indicates a large overall improvement across measurement occasions; however, interpretation of instructional effects should rely primarily on between-group comparisons.

Discussion

Results of the present research demonstrate significant improvements in performance on tests of grammar among both experimental and control groups; however, gains differed considerably depending on the instructional conditions. Learners who engaged in collaborative activities, enhanced by access to artificial intelligence, demonstrated much better gains compared to students in the control group with a very large effect size. The present findings should be viewed not only as evidence for AI effectiveness in promoting language development but also as a starting point for exploring reasons for the success of the discussed treatment modality. First of all, one should discuss the nature of feedback in the two conditions of the study. The participants in the control group received grammar instruction using the conventional instructional pattern – rule presentation by a teacher, individual practice, and instructor-led feedback. Although this led to positive results, it seems that the

conventional format limited learners' opportunities to get timely, frequent, and individualised feedback on their performance. As pointed out by Lee (2003), feedback provided by instructors tends to be delayed and generalised, thus failing to effectively address learners' specific problems. By contrast, learners in the AI-supported condition had greater access to immediate feedback opportunities that allowed them to find and correct mistakes while actually performing tasks. According to the claims made by Rahimi and Fathi (2022) and Shatri (2020), the availability of AI tools allows receiving personalised feedback in a timely fashion, as suggested by the present results. However, in collaborative activities, learners not only obtain feedback on their mistakes but engage in dialogue with peers and AI and try to understand the reasons for their mistakes and ways of correcting them. As emphasised by Rahimi and Fathi (2022), in a collaborative setting, learners can not only obtain information from instructors but interact and communicate, thus negotiating the meanings and sharing experiences. Hence, the effectiveness of the experimental treatment can be associated with learners' ability to interact with both peers and AI and gain deep insights into grammatical rules during problem-solving activities.

Furthermore, one can refer to the concept of cognitive load and analyse reasons for better learning in the experimental condition in terms of this theory. Grammar learning requires considerable cognitive effort from learners because they need to remember rules and apply them in different situations. When learning is not facilitated by the instructor, learners tend to overload working memory with low-level processing related to remembering rules and applying them, which interferes with deeper processing and prevents knowledge acquisition. As claimed by Chen and Chang (2024) and Feng (2024), AI tools can help learners cope with unnecessary cognitive load by performing low-level processing tasks such as checking the text for mistakes. Thus, in the experimental condition, learners did not need to concentrate on checking errors and instead engaged in the process of understanding and discussing rules, which facilitated knowledge acquisition. Collaboration among learners can also be seen as a means of distributing cognitive load in the course of performing complex tasks. Moreover, the idea of entangled cognition (Clark & Chalmers, 1998; Morais, 2023) provides another way to explain the present results. Unlike conventional approaches to language acquisition, which assume that cognitive processes occur only within an individual learner, this approach states that these processes can be distributed among people and even artificial agents. Within the experimental condition of the current study, the learners not only used AI to identify their mistakes and correct them; they actually integrated the external agent into their cognitive system to perform tasks together. For example, if learners disagreed with each other or were unable to come up with solutions to the task, they could ask for assistance from AI, which helped to resolve the issue. This approach is similar to using peers to perform tasks, and according to Chen and Yadollahpour (2024)

and Zhai et al. (2024), AI can be perceived as an external resource that helps learners complete complex cognitive operations. This explains why the participants in the experimental condition showed substantial gains on the test of grammar performance.

Collaboration can also be regarded as a factor explaining the findings. Interaction with peers is recognised as an important factor facilitating language learning because it helps students articulate their reasoning and negotiate rules and meaning (Asadi & Taheri, 2024). However, learners in the control condition were probably not able to engage in discussion with peers because their knowledge of grammatical rules was rather poor, and they were unable to help others to learn or correct mistakes. Within the experimental condition, this limitation was compensated for due to the use of AI, which allowed participants to cross-check their understanding and opinions with suggestions generated by an external program. Descriptive observations suggested a possible positive association between AI engagement, collaborative participation, and grammar achievement; however, these relationships should be interpreted cautiously because detailed correlation outputs were not rep Thus, learners who actively collaborated with peers and AI achieved better results than those who did not participate in active group discussions.

In addition, the nature of the grammar test used deserves mention. As already mentioned, it contained a range of tasks involving not only recognising correct sentences and transformations but also transforming sentences and identifying errors. It required learners to recall the grammatical rules learned and use them to perform tasks, which is rather challenging. As seen in the findings, learners who participated in AI-enhanced collaborative activities obtained significantly higher scores on tasks of this type compared to students in the control condition, thus indicating that they were able to use grammatical knowledge gained in the learning process to produce text according to the rules. This result can be viewed as a refutation of concerns about possible superficial learning with AI as reported by Shanmugasundaram and Tamilarasu (2023). Indeed, as shown in the findings, AI can promote genuine knowledge gain if used along with teacher instructions and guidance to encourage learners to engage in analytical tasks. Finally, the fact that learners in the control condition also obtained positive results deserves mentioning. As can be seen from the findings, traditional methods of grammar instruction can lead to the development of grammatical competence although at a lower level compared to AI-assisted learning. This result is consistent with the existing literature on language learning, which emphasises the positive role of collaboration in this process. At the same time, it shows that the implementation of the discussed intervention provided a considerable additional benefit compared to traditional methods applied in the same timeframe.

Pedagogical Implications

Based on the findings, several suggestions regarding future actions can be made. First, university instructors dealing with EFL students can introduce the discussed method into the learning process and design grammar tasks involving collaborative work and AI-assistance in the classroom. Second, educators should promote students' AI literacy, which will enable them to use AI tools productively. Third, the role of the educator in this process can change: instead of explaining rules, the instructor can become a mediator and guide learners in evaluating AI feedback and negotiating grammatical rules.

Study limitations

Like any other research, the current project has several limitations that should be considered when interpreting results. The sample consisted of forty learners across two intact classes within one institution. Moreover, the design of the current study involved quasi-experimental manipulation instead of random assignment of learners. Future research should replicate these results with larger, more diverse samples and in other educational settings. Also, the experimental treatment lasted for eight weeks, and its duration was rather limited. Future research should focus on long-term consequences and effects of this treatment. Another possible direction is the examination of individual differences in participants' willingness to collaborate or trust AI. Additionally, measurements of AI engagement and collaborative perceptions were based primarily on self-report measures and observational categorisation. These measures are useful but rather subjective, and more objective measurements would provide a better picture of processes occurring during collaboration and using AI tools. For example, screen recordings of students' sessions could be analysed to examine actual interactions with technology and their impact on learning. Furthermore, it is possible to conduct longitudinal research aimed at tracing students' attitudes to collaborating with peers and AI after engaging in the experimental treatment. As discussed above, some authors report a risk of AI generating inaccurate or misleading suggestions. Crompton et al. (2024) and Rahmi et al. (2024) highlight the possibility that artificial intelligence might make mistakes, leading learners to adopt false beliefs about grammar. In the present study, this limitation might be mitigated by the presence of the teacher who assisted learners in assessing AI's suggestions. Future studies should focus on the effect of teacher's mediation on the efficiency of AI-assisted learning and suggest effective practices for promoting critical AI literacy in learners.

Conclusion

The findings of the current study suggest that using AI-supported collaborative tasks appeared more effective under the conditions of this study in promoting the development of grammatical competence in EFL university students compared to traditional methods of instruction. The large effect

size suggests the practical significance of the discussed method as it enables to obtain tangible learning gains within a relatively short period. Moreover, in the AI-assisted condition, learners were able to not only recognise grammatically correct sentences but also actively apply grammar rules. These results show the benefits of this strategy since many conventional teaching methods do not allow learners to use grammar successfully. From a theoretical perspective, results obtained in the current study can be explained by referring to concepts such as cognitive load and entangled cognition. In terms of cognitive load theory, grammar learning involves complex cognitive operations which place substantial demands on working memory and cause learners' failure. By reducing extraneous load, AI-enabled collaboration helps to decrease the cognitive load related to grammar learning, thus optimising germane cognitive load and making this task easier for learners. In this regard, the use of the AI tools allowed to optimise the distribution of cognitive load between the computer and the student. Moreover, the notion of entangled cognition shows that the participants were not only using the tools provided by AI but also collaborated with each other and externalised part of the cognitive process to the AI system. Thus, in AI-assisted learning, a collective cognitive system composed of learners and artificial intelligence is formed. Finally, the current study makes a significant contribution to the existing literature because it examines collaborative learning in the context of using AI in a classroom. Most researchers consider AI as a means to facilitate individual learning, whereas in reality, language learning is always a social process. The current study suggests that combining collaboration and AI may support stronger learning outcomes than traditional instruction alone. The teacher's role in this process is not diminished and remains vital because educators need to ensure that learners actively engage with AI.

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AI acknowledgment

This study involved the use of artificial intelligence tools to assist in generating instructional ideas and improving the clarity of the manuscript, consisted with COPE guidelines. All AI-assisted outputs were carefully reviewed, edited, and validated by the author to ensure academic integrity and accuracy.

Conflict of interest

The author declares that there is no conflict of interest regarding the publication of this paper.

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