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The Effect of Using an Artificial Intelligence-Enhanced Instructional Approach on Grammatical Knowledge and Motivation

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Abstract

This study examined the impact of an artificial intelligence (AI)-enhanced multimodal instructional approach on students' grammatical knowledge and motivation. Therefore, 70 Omani English as a Foreign Language (EFL) learners were divided into a control group (in-class training and feedback) and an experimental group (AI feedback), with 35 students in each group. The researcher used grammar tests and a motivation questionnaire adapted from Li et al. (2025) to collect data. After a five-week treatment period, the posttest findings showed that both groups increased their scores, but the experimental group performed significantly better than the control group. In the delayed posttest, the control group showed no progress, but the experimental group increased their scores and significantly outperformed the control group. Additionally, the experimental group was the only group in which the motivation questionnaire was administered, and it was found that their motivation levels were considerably positive. The findings of the study are helpful for teachers, syllabus designers, students, and policymakers by suggesting that integrating an AI-enhanced multimodal instructional approach into grammar teaching could be a viable method to improve educational outcomes, enhance student engagement, provide personalized feedback, and also inform subsequent curriculum planning and the implementation of educational strategies.

Keywords: Artificial intelligence, grammar, motivation.

Data Availability Statement: *All relevant data are within this paper.*

Introduction

Artificial intelligence (AI) has demonstrated significant potential in English language learning contexts. In a synthesis of 14 systematic reviews, it was revealed that direct AI-based instruction leads to meaningful benefits for L2 English language learners, including improved writing accuracy, cohesion, and revision with automated feedback systems, and increased speaking fluency, confidence, and willingness to communicate in dialogue-based instruction with chatbots (Jeon, 2025). In this regard, Wei (2023) found that EFL students' grammar, vocabulary, reading comprehension, and writing achievement increased when AI was used in instruction, along with increased motivation and self-regulated learning. Additionally, Kooti et al. (2025) showed that instruction using ChatGPT led to substantial improvements in speaking skills and motivation, as well as reduced speaking anxiety. In addition, chatbot-based AI support improved speaking fluency and learner autonomy, and AI-supported feedback fostered self-reflection, creativity, and emotional resilience in writing tasks while partially alleviating performance anxiety through corrective and motivational feedback strategies (He et al., 2025). AI-powered tools were also found to improve EFL learners' listening performance (Behforouz & Al Ghaithi, 2024a).

Grammar is the backbone of effective communication in English, and developing solid grammatical knowledge is essential for language learning (Alsakaker, 2025). Zhang (2009) argued that, since grammatical competence is a component of communicative competence, grammar instruction is necessary for learners to communicate successfully. Rossiter (2021) stated that grammar is important for students who want to go beyond basic communication and master written communication so their messages are immediately understandable, clear, and unambiguous. According to Syvak (2018), correct grammar is important for professional communication, helping students produce consistent, logical sentences and paragraphs. Furthermore, Ly (2020) stated that grammar education helps students accelerate their English learning and scaffolds it when taught correctly. Stevens (2025) and Tran (2026) claimed that AI helps students learn grammar by automatically correcting related mistakes, providing real-time assessment, and explicating grammar rules through contextualization. It was also found that AI-assisted grammar learning was considerably more effective than traditional methods for developing students' grammar skills. Elmotri et al. (2025) found that AI-based automated written corrective feedback can improve grammar and sentence-structure accuracy. Sharmithashini and Hashim (2025) found that AI grammar checkers improve grammatical accuracy through real-time corrective feedback. Setiawan and Alkhowarizmi (2025) noted that combining AI feedback with teacher and peer feedback can lead to optimal writing outcomes for students.

Artificial intelligence has also been shown to boost students' motivation to learn English (Behforouz et al., 2026). Wei (2023) found that students taught through AI-mediated language instruction had higher L2 motivation than those taught through customary instruction and used more self-regulated learning strategies. ChatGPT increased students' intrinsic motivation through personalization and instant feedback, thereby reducing learning anxiety (Al Ghaithi et al., 2026; Jayaputri, 2024). Xiaofan and Annamalai (2025) found that AI tools positively impacted motivation through interactive features, gamification, instant feedback, and personalized engagement. Aly et al. (2024) found that learners using AI-improved platforms are more motivated to learn because of individualized learning pathways and feedback in game formats.

Literature Review

Theoretical Framework

The study conceptualizes AI-supported learning and its influence on grammar learning and learner motivation through Self-Determination Theory, Sociocultural Theory, and Cognitive Load Theory.

Self-Determination Theory (SDT; Deci & Ryan, 2000) posits that autonomy, competence, and relatedness are environmental conditions that are positively correlated with student motivation and performance. In AI-supported learning, autonomy can increase when learners can set their own instructional pace, revisit explanations, and practice independently, while immediate, personalized feedback can boost learners' sense of competence. Sociocultural Theory conceptualizes learning as a mediated process in which tools, interaction, and scaffolding support learners' development (Vygotsky, 1978). From this viewpoint, AI tools and features can serve as resources for mediation in the learning process by providing guidance, explanations, corrective feedback, and second chances to practise grammatical structures. Such input may help the learner progress from partial to full understanding of grammar and use it more effectively and independently. Cognitive Load Theory (Paas et al., 2003; Sweller, 1988), in turn, suggests that instructional materials should reduce unnecessary cognitive demands and focus attention on essential information. Thus, suitable organization and multimodal representation may simplify learners' processing of grammatical rules, examples, and feedback. Practising the rules again may not only support the consolidation of grammatical knowledge but also facilitate its retrieval.

AI-Powered Tools in EFL Grammar Instruction

Ng et al. (2025) examined the impact of Gemini AI on grammar learning and student engagement among 75 Omani pre-intermediate EFL learners. The study involved three groups: a control group (traditional instruction), experimental group A (traditional instruction + in-class use of Gemini AI), and experimental group B (traditional instruction + out-of-class use of Gemini AI). The findings revealed that Group A performed significantly better than the other two groups in the tests. Group A also showed the highest engagement, followed by Group B. Strengths of the study included its quasi-experimental design and range of outcome measures; weaknesses included a small sample size, a single-institution study, and a short intervention period. Overall, the outcomes suggest that directly integrating AI into classroom learning may be more efficient than using AI for grammar coaching outside class. Nonetheless, the specific learning context and the brief treatment period suggest the need to investigate whether similar advantages emerge with other AI platforms and settings.

Similarly, Ali et al. (2025) examined how ChatGPT affected the grammatical development of 100 Saudi English as a Second Language (ESL) university students, divided into a control group (traditional instruction only) and an experimental group (traditional instruction supplemented with ChatGPT). The experimental group outperformed the control group on posttests with a large effect size, and students also rated ChatGPT's lexical support and personalized practice positively. Strengths of the study included its dual-methodology approach and controlled variables; weaknesses included its male-only sample, its focus on one country, and its short length. The results make it clear that AI can enhance grammar learning when used alongside teacher-led instruction. However, the study examined only short examinations and specific AI systems, highlighting the need to explore whether similar gains could be achieved with different AI platforms and learning affordances.

Consistent with these findings, Azwar and Sujarwati (2025) studied the effectiveness of ChatGPT-assisted instruction on 60 junior high school EFL students in Indonesia. The students were divided into two groups: a control group that used textbooks with instructor support and an experimental group that used ChatGPT as an additional grammar-learning resource. The findings revealed initial progress of both groups, but the experimental group performed significantly better. Strengths included the use of instrumentation and mixed-methods research. Limitations include its implementation in only one school setting, the lack of random assignment, and the short duration of the intervention. Taken together, the results and prior studies suggest that using AI in grammar classes is likely to yield more positive effects than traditional teaching alone. On the other hand, existing research has focused mainly on ChatGPT and on short interventions, so the effectiveness of other AI-based teaching has not been thoroughly evaluated.

Further evidence of AI effectiveness in grammar instruction comes from Behforouz and Al Ghaithi (2024b), who investigated the effect of ChatGPT on the grammatical accuracy of 60 intermediate EFL learners in Oman. Participants were randomly assigned to a control group, which was taught grammar through a standard instructional approach, and to two experimental groups that learned grammar through either in-class or fully online instruction, both supplemented with ChatGPT feedback. The study revealed that experimental group 1 performed considerably better than both the control group and experimental group 2. Gains were maintained in experimental group 1 but not in the control group or experimental group 2 on delayed testing. Strengths of this study included a strong design, retention assessment, and measures with known validity and reliability. Limitations include the small, single-institution sample, the five-week duration, and the focus on only two grammatical structures. The current findings carry an additional suggestion that the manner of integrating AI into a classroom can have a bearing on its success. For instance, compared to the free-form way of using AI, in-class structured integration likely comes out stronger. Further, these results would be more conclusive if different AI tools were tested in the study instead of just ChatGPT, as well as more grammar-learning contexts that are broader than just focusing on less grammatical structures.

Similarly, Kucuk (2024b) conducted a quasi-experimental study comparing the impact of integrating ChatGPT into grammar instruction with 60 Iraqi EFL university students. The participants were randomly divided into a control group that studied grammar the traditional way and an experimental group that studied grammar through ChatGPT. The experimental group experienced important gains in scores. Experimental group interview responses highlighted the appeal of immediate feedback and tailored responses from ChatGPT, but also expressed concern that reliance on technology could inhibit critical thinking. Strengths included a mixed-methods design and a large effect size; limitations included a small sample size at a single institution and selection bias. The findings show a generally positive contribution of AI-mediated feedback and personalization to grammar learning. Nevertheless, the prevalence of ChatGPT-based research also points to a clear need to examine whether newer source-grounded and multimodal AI tools, such as NotebookLM AI, provide the same benefits or different ones for EFL grammar development.

Although earlier investigations have established the supportive role of conversational AI programs, such as ChatGPT and Gemini, in grammar education, these systems primarily adopt a communicative language approach that is text-based and emphasizes conversation and corrective feedback. However, NotebookLM is a learning platform that is based on source-grounded learning. It allows students to develop their skills directly through the instructor's materials, using the program's multimodal features such as structured summaries, visual concept organization, question-and-answer sessions based on uploaded sources, and audio overviews. These learning tools may support grammar learning by presenting rules and examples in multiple complementary ways, aligning with the course content. Despite its strong educational potential, NotebookLM AI and its features have not yet been examined in EFL grammar teaching in relation to students' grammatical knowledge and motivation, which provides a strong rationale for the present study. Despite the existing literature, this paper exclusively focuses on the application of NotebookLM AI and its multimodal features in the Omani EFL context, an area that has been less explored in earlier investigations. Second, it examines both grammatical proficiency and student engagement, providing a more holistic view of AI's educational function. Third, it includes a pretest, posttest, and delayed posttest, allowing examination of immediate achievement and short-term retention of the material taught.

AI Integration and L2 Motivation

Based on a study by Yuan and Liu (2025), AI, engagement, foreign language enjoyment (FLE), and motivation were positively related. The study compared 383 Chinese university EFL students in a

treatment group that received instruction using AI technology and a control group that received traditional instruction. The study found that the treatment group was more engaged, enjoyed learning a foreign language, and was more motivated than the control group. Strengths included the large sample size, the use of validated measures, and the quasi-experimental design. Limitations included its focus on one country and the absence of qualitative data. The key finding is that implementing AI in teaching increases motivation and positively affects learning. However, the findings are strongly influenced by the study's specific context, underscoring the need to examine whether the same motivational outcomes can be achieved with different AI technologies and in other EFL contexts.

In a later study, Jafari et al. (2025) examined the effects of ChatGPT-assisted writing on the accuracy and motivation of 40 Iranian intermediate EFL learners. The researchers divided students into experimental and control groups; the experimental group received ChatGPT-assisted writing instruction, while the control group received traditional instruction. The treatment group had greater accuracy and motivation in writing than the control group. Study strengths included a quantitative research design and controlled intervention. Limitations included the study's focus on two institutes in Tehran, time constraints, and the lack of qualitative data. These results point out that AI-supported instruction may increase both motivation and language performance. However, the evidence primarily focused on the mechanisms of conversational AI, such as ChatGPT, and specific language skills, leaving the motivational capacity of additional AI platforms and learning environments inadequately evaluated.

In another study, Afkarin and Asmara (2024) studied the effect of ChatGPT on motivation and academic performance. In a mixed-methods study of 35 students at an Indonesian university majoring in English education, 25 used ChatGPT to learn, and 10 did not. Those who used ChatGPT frequently had higher learning motivation and GPAs than those who did not. Thematic analysis identified the following benefits of ChatGPT: understanding, efficiency, academic motivation, reduced effort, better organization, improved feedback, and greater fluency. Strengths included its mixed-methods design and its use of Self-Determination Theory (SDT) as a theoretical framework. However, the small sample size and focus on descriptive data were weaknesses. This research shows a link between AI use and learner motivation. It also suggests that some features linked to motivation arise from feedback, process efficiency, and the support learners receive. Yet the small, non-experimental sample size, along with issues in selecting these research tools, underscores the need for more research using controlled designs and varied forms of AI-supported learning.

Jayaputri (2024) examined the effect of ChatGPT on the motivation of 40 Indonesian English language learners in class. In a one-group experimental design, participants attended six ChatGPT training sessions. The results showed that motivation and expertise scores increased, with motivation rising from low to high. Strengths of the study included incidental learning and the use of multiple data sources. Limitations included a small sample size, a single-institution focus, no control group, and a focus on reading and writing. Beyond the earlier studies, the results also justify incorporating AI into the learning process as a means of motivating learners. Nevertheless, ChatGPT was the most mentioned, the samples were limited, and only specific language skills were considered, suggesting the need for further research to determine whether the same motivational reactions occur when students use newer AI platforms such as NotebookLM AI, which are designed to operate in different EFL contexts.

The studies mentioned previously demonstrate that AI-supported language learning positively affects learners' motivation, engagement, and enjoyment across various EFL settings. However, current studies have mainly focused on conversational AI systems such as ChatGPT, and very little is known about the effects of source-grounded and multimodal AI platforms, such as NotebookLM AI, on learners' motivation. The gap is even wider in Omani EFL, where few studies exist, underscoring the importance of investigating students' interest in new AI innovations in this context.

Although AI applications are acknowledged for their capacity to improve language acquisition, most studies have failed to isolate grammar as a separate ability and have not employed objective metrics, such as grammar exam results, to assess their efficacy (Lalirea et al., 2024). Knowledge of the motivational factors influencing university students' use of AI in learning remains sparse (Chai et al., 2024; Guo et al., 2024); therefore, understanding students' desire to engage in AI-assisted learning is essential. This comprehension could facilitate the development of effective, engaging, and adaptive educational experiences that address students' needs, thereby improving learning outcomes (An et al., 2023). Although supportive settings and engagement are intrinsically linked to motivation (Wang et al., 2023), no comprehensive questionnaire assesses students' motivation to study with AI. Thus, it remains unclear how the educational environment influences different forms of motivation and how they affect students' participation in learning with AI (Li et al., 2025). This study explores the effects of an AI tool, systematically called NotebookLM AI, and its multimodal features on grammatical performance by scrutinizing objective grammar assessment data. It fills a methodological and contextual gap in Omani studies and contributes to the knowledge base by exploring the effects of NotebookLM's multimodal AI features on students' motivation to learn with AI. Beyond the grammar-based outputs of AI tools, understanding the motivational aspects of their use may help in Oman's EFL context, where persistence, engagement, and self-regulation in education are paramount. By providing research-informed insights, this study seeks to inform curriculum designers, policymakers, and educators in Oman on how to embrace and adapt AI tools to ensure educational and motivational appropriateness in accordance with local educational ideals. Ultimately, this research provides evidence for contextually appropriate adoption of sustainable AI in Omani language education to foster pedagogical and learner motivation. Although some previous studies have examined AI tools and motivation, this study examines the NotebookLM AI application and emphasizes the specific context of EFL in Oman, a relatively understudied area. Additionally, the research adopts a new perspective on student motivation and analyzes it alongside grammatical proficiency, thereby integrating emotional and performance-oriented aspects into a single framework. Finally, the research employs a controlled experimental design, allowing the researchers to measure direct, short-term improvements in learning and knowledge retention.

Therefore, the following research questions are addressed in this study:

1. Does using NotebookLM AI improve the grammatical knowledge of Omani pre-intermediate EFL learners?
2. Does using NotebookLM AI improve the motivation levels of Omani pre-intermediate EFL learners?

Method

The current paper used a quasi-experimental research design. The study used pre-existing participant groups rather than randomly assigned conditions. This approach supports the classroom's natural arrangement and allows comparison of outcomes between the intervention and control groups in a real educational context. This section provides comprehensive information on the study population, the instruments used to collect data, the step-by-step procedures for implementing the treatment, and the quantitative data analysis using SPSS 27.0.

Participants

For the study, 70 students enrolled in the foundation program at a higher education institute in Oman were selected as the study sample. These learners were native Arabic speakers, and they were 18 to 19 years old. Additionally, the students were placed at the pre-intermediate level of English

proficiency based on the college's placement test results and final assessments. The students were divided into a control and an experimental group, with 35 students in each. Although both classes included both males and females, gender was not treated as a variable in this study. The control group followed the conventional teaching technique, receiving face-to-face instruction in the classroom, while the experimental group received in-class instruction and used the NotebookLM AI and its multimodal features as an additional facilitator during the treatment period. Additionally, within the official learning environment, the study population did not engage in any learning activities using NotebookLM AI.

In accordance with Oman's national curriculum, all students accepted into the university must spend one or two mandatory years in the Foundation Department. This department is a prerequisite for higher education departments and specializations, and it prepares learners through introductory courses in English, computing, mathematics, information technology, and science. Upon successful completion of this program, students are eligible to proceed to their specializations in the higher education departments.

Instruments

This section provides more information about the instruments researchers developed and used to collect the required data. In the current study, the researchers used two instruments: three researcher-made grammar tests and one motivation questionnaire.

Grammar Test Package

Because one of the main variables in this study was learners' grammatical knowledge, the researchers developed three grammar tests to administer as pretests, posttests, and delayed posttests to participants in both groups. All the tests had 20 items: 5 multiple-choice, 5 fill-in-the-blank, 5 error-correction, and 5 transformation questions. Each item was worth 1 point, and there was no penalty for incorrect answers. This study used two grammatical structures: the simple present and simple past tenses, selected based on the general English course delivery plan. Table 1 shows two samples of each section from the pretest.

To ensure the tests' efficiency, reliability, and validity, we conducted a pilot study with 30 students from the foundation program at the same institution, all with the same English proficiency level.

Table 1 *Sample Items from the Pretest*

Part A. Multiple Choice (5 items)	**Part B. Fill in the Blank (5 items)**
Choose the correct answer.	**Write the correct form of the verb in brackets.**
1. My brother usually _____ to school by bus. a) go b) goes c) went	6. Salma _____ English at university. (study)
2. They _____ football yesterday afternoon. a) play b) plays c) played	7. We _____ our grandparents last Friday. (visit)
Part C. Error Correction	**Part D. Rewrite the sentence as instructed.**
Each sentence has one grammar mistake. Rewrite the sentence correctly.	16. He plays tennis every Friday. Change into negative.
11. He go to the gym every day.	17. They visited Nizwa yesterday. Change into a question.
12. They was happy after the exam.	

These students were not among the participants of the control and experimental groups. The results showed a reliability index of 0.862, which could be associated with high test reliability. Additionally, two Omani PhD holders in Applied Linguistics with 15 years of teaching English in the same context and institution approved the usability and suitability of the test statements.

Motivation Questionnaire

The questionnaire used in this study to measure students' motivation in the experimental group was adapted from the AI Motivation Scale (AIMS) by Li et al. (2025). This questionnaire was based on SDT, which posits that individuals who experience autonomy, competence, and relatedness are, in turn, more motivated and more committed to the activities involved. Based on this hypothesis, intrinsic motivation and self-determined extrinsic motivation are associated with positive learning conditions, and perseverance and engagement in the educational context (Ryan & Deci, 2020). The original AIMS had five subclasses: intrinsic motivation, identified regulation, introjected regulation, external regulation, and amotivation. The Cronbach's alphas for these subsections were 0.88, 0.84, 0.84, 0.87, and 0.90, respectively, indicating high reliability of the questionnaire items. However, to make it suitable for the current study, only three sections, including Intrinsic Motivation, Identified Regulation, and Amotivation, with a total of 11 statements, were selected (see Table 6). The statements used a 5-point Likert scale: 1 (*Strongly Disagree)*, 2 (*Disagree*), 3 (*Neutral*), 4 (*Agree*), and 5 (*Strongly Agree*). This questionnaire was translated into Arabic, and the statements were presented in both Arabic and English.

Since the original questionnaire was shortened and translated into Arabic, it was necessary to test the new questionnaire's reliability. As shown in Table 2, we calculated Cronbach's alpha for three retained AIMS subscale composite variables: Intrinsic Motivation, Identified Regulation, and Amotivation. All individual questionnaire statements for each subscale were combined to obtain the final subscale score. Thus, the reliability analysis used three composite items instead of 11 individual statements. The derived value of .799 for Cronbach's alpha indicates acceptable internal consistency in the adapted questionnaire across the three motivational dimensions. Additionally, an Omani bilingual with a PhD in English-Arabic Translation completed the translation. Moreover, to ensure the final version's validity, two Omani PhD holders in Applied Linguistics with 15 years of experience teaching English in Oman reviewed the statements for cultural and contextual appropriateness.

Table 2 *Results of the Reliability Index for the AIMS Questionnaire*

Cronbach's Alpha	*N* of Items
.799	3

Procedure

The study was conducted in the first semester of the 2025–2026 academic year. Students were told that participation was voluntary, and they signed a consent form before the main study. The study lasted 5 weeks and included a pretest, 4 weeks of treatment, a posttest, and a delayed posttest. Before the treatment weeks, all students completed a grammar pretest, and the experimental group also completed an extra motivation questionnaire. In the same week, the treatment group underwent three days of training on learning and practising grammar using NotebookLM AI, during which the researchers discussed the tool's basic technical aspects and presented its three main features: a video overview, an infographic, and a quiz (see Figure 1). To support collaborative learning and share feedback on learning progress during class tasks, students in the experimental group were divided into seven smaller groups of five,

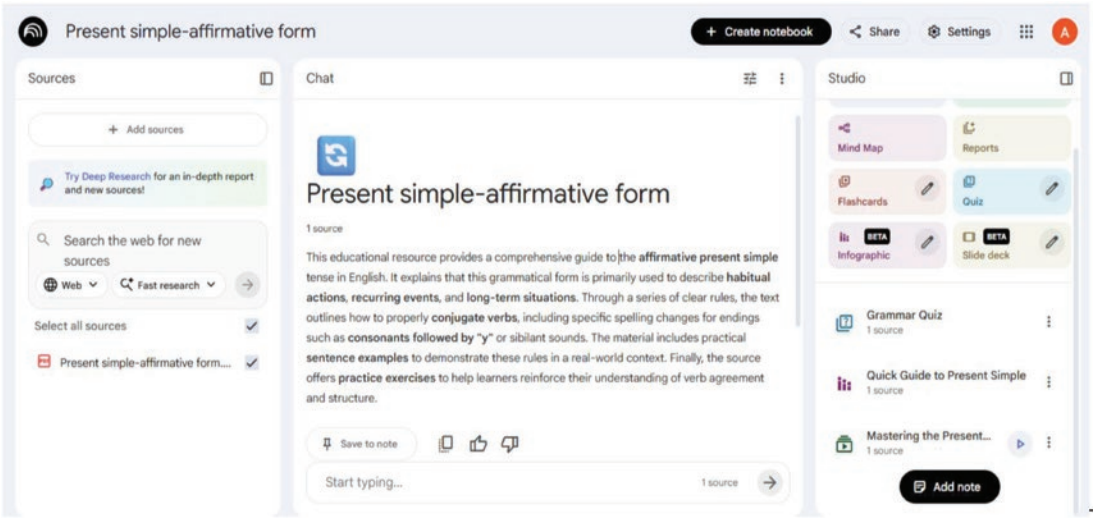

Figure 1 *A Sample Screenshot from the NotebookLM AI Learning Environment*

and NotebookLM AI accounts were registered for each experimental subgroup. Microsoft Teams was customized and used to share lesson files.

The experimental group received grammar instruction via NotebookLM AI, integrated into existing class instruction. Each week contained a different number of daily sessions on each grammatical tense. In week 2, students were taught the present simple tense, focusing on the affirmative, negative, and interrogative forms, and each session lasted 70 minutes. The teacher sent the PDF lesson on the affirmative present simple in Microsoft Teams. Then, students spent 30 minutes in groups working with NotebookLM AI. First, students used the video overview feature to convert the file into an interactive video; then they watched an automatically generated video of the grammar lesson and discussed and took notes while watching. Second, students used the infographic feature to convert the files into an interactive visual to summarize the content. After that, students discussed the affirmative present simple in more detail, linking their discussion and notes from the video for further clarification. Finally, students used the quiz feature to answer automatically generated practice items on the target structure. Also, students used NotebookLM AI's chat feature to request clarification about the uploaded grammar material. After this activity, the teacher discussed the affirmative present simple with the whole class for 20 minutes to clarify any unclear points. Later, the teacher used NotebookLM AI's flashcards feature, projected on the board, to practice and review the affirmative present simple. In the final 20 minutes, groups completed a grammar exercise on paper (15 minutes), followed by teacher feedback (5 minutes). Students received homework exercises to complete. They would discuss those exercises in the following lesson. Days 2 and 3 featured a 10-minute homework review using NotebookLM AI's flashcard feature. This review ensured students understood the corrections. The remaining 60 minutes of the lessons were used to teach negative and question forms, respectively. For Days 4 and 5, students practised all three forms of the present simple verb using NotebookLM AI. Teachers then sent practice exercises and activities via Microsoft Forms, and students downloaded them and practised them in NotebookLM AI for 30 minutes in their assigned groups, followed by 20 minutes of teacher-led feedback on their answers. The teachers then taught the past simple tense in the same way during week 3 (affirmative, negative, and interrogative forms on days 1, 2, and 3, respectively, with teacher-created exercises and activities on days 4 and 5). In week 4, the students practised the two tenses for 5 days using teacher-created activities in NotebookLM AI for 30 minutes, received teacher-led feedback on their work for 20 minutes, and took the grammar and motivation questionnaire posttest at the end of the week.

The control group received traditional face-to-face grammar instruction, without any AI tools. They were divided into groups of five students each to match the treatment group's classroom structure. The control group was taught the same grammatical tenses at the same time as the treatment group. During week 2, the control group was taught the affirmative present simple. Each lesson lasted 70 minutes. Explicit grammar instruction lasted 30 minutes and included direct teacher explanations, written models of the grammar rule posted on the board, and the teacher demonstrating proper use. This was followed by a 20-minute teacher-led discussion, during which the teacher answered students' questions, corrected misconceptions, and asked for additional examples. In the last 20 minutes, students completed a written grammar task in pairs or groups, followed by teacher-provided error feedback and correction. Each lesson ended with textbook homework, which was reviewed in the following lesson. On days 2 and 3, the first 10 minutes were used for a homework check, during which the teacher reviewed the answers and wrote them on the board. This was followed by the remaining 70 minutes of the intervention. On days 4 and 5, students completed 30 minutes of teacher-prepared activities and workbooks on all three types of the present simple tense in their groups, followed by 20 minutes of teacher-led class discussion and answer review on the present simple tense. Week 3 included the simple past, covering the affirmative, negative, and interrogative forms, as well as past simple practice. Week 4 included 30 minutes of teacher-prepared grammar practice covering all tenses, with teacher-generated exercises and textbook activities, as one session. Teacher feedback on answers and exercises lasted 20 minutes. The grammar posttest was administered to the control group at the end of week 5.

The delayed grammar posttests were conducted at the end of week 5 to measure grammatical knowledge retention in both groups.

Data Analysis

This section thoroughly analyses the data collected from the grammar tests and AIMS questionnaire using SPSS 27.0. The first part of this section concerns the analysis of pretests, posttests, and delayed posttests of grammar among participants in both groups. Before running any statistical tests, we needed to determine the data distribution to choose the appropriate comparison test. Table 3 below shows the results of the Kolmogorov-Smirnov Normality test.

As shown in Table 3, the control group showed a normal distribution of data in the pretest (p = .092) and the delayed posttest (p = .068), whereas the posttest showed a non-normal distribution (p = .026). In the experimental group, data were normally distributed at the posttest (p = .055), whereas normality was violated at the pretest (p = .018) and the delayed posttest (p = .011). Because normality was inconsistent across tests within each group, nonparametric statistical analysis was used for subsequent comparisons. Initially, a Wilcoxon Signed Rank Test was conducted to assess participants' performance within their respective groups. Table 4 below shows the results for students in both groups across all tests.

Table 3 *Results of Normal Distribution of Data in all Sets of Tests in Both Groups*

Test phase	Group	Statistic	*df*	Sig.
Pretest	Control	.138	35	.092
Pretest	Experimental	.164	35	.018
Posttest	Control	.159	35	.026
Posttest	Experimental	.147	35	.055
Delayed posttest	Control	.143	35	.068
Delayed posttest	Experimental	.171	35	.011

Table 4 *Comparison of the Performance of Participants in all Tests within Groups*

Groups	posttest – pretest	delayed posttest – posttest
Control		
Z	–3.005	–.712
Asymp. Sig. (2-tailed)	.003	.476
Experiment		
Z	–5.101	–1.635
Asymp. Sig. (2-tailed)	< .001	.012

Table 4 shows that the control group improved significantly from pretest to posttest ($Z = –3.005$, $p = .003$), but this change was not significant from posttest to delayed posttest ($Z = –0.712$, $p = .476$). In contrast, the experimental group showed significant improvements from pretest to posttest and from posttest to delayed posttest ($Z = –1.635$, $p = .012$). Next, a comparative statistical analysis was conducted to assess performance between the two groups. Table 5 below presents the analysis of data between the two groups using a Mann-Whitney U Test.

Table 5 shows that at the pretest, there was no statistically significant difference between the groups ($Z = –1.166$, $p = .244$), and the effect size was negligible ($\eta^2 = .005$), indicating similar knowledge of grammar among students. However, the analysis of the posttest reveals significant differences between both groups showing the outperformance of the experimental group over the control one ($Z = –6.115$, $p < .001$) following by a large effect size ($\eta^2 = .54$). The pattern continued in the delayed posttest, with the experimental group showing better performance ($Z = –5.671$, $p < .001$) and a large effect size ($\eta^2 = .46$), which means that the effects of the intervention lasted over time. Therefore, using NotebookLM AI as a learning facilitator might help learners achieve better results by improving their grammatical knowledge.

Table 5 *Comparison of Both Groups in all Sets of Tests*

	pretest	posttest	delayed posttest
Mann-Whitney U	515.000	96.000	134.500
Wilcoxon W	1145.000	726.000	764.500
Z	–1.166	–6.115	–5.671
Asymp. Sig. (2-tailed)	.244	< .001	< .001
η^2	0.005	0.54	0.46

The second part of this analysis involves a thorough investigation of the AIMS questionnaire within the experimental group only. To select the appropriate inferential test to compare both groups, the normality of the data was assessed using the Shapiro-Wilk Normality Test, and the results are shown in Table 6 below.

Table 6 *Results of Normal Distribution of Data in Pretest and Posttest of Motivation Questionnaire*

	Shapiro-Wilk		
	Statistic	*df*	Sig.
Pre total	.972	35	.500
Post total	.970	35	.452

Table 6 shows that the pretest and posttest were normally distributed. In pretest, $W(35) = .972$, $p = .500$, and posttest, $W(35) = .970$, $p = .452$. So, the normality assumption was fulfilled. Therefore, a Paired-Samples *t*-Test was conducted to compare the experimental group's performance on the pretest and posttest, and the results are shown in Table 7 below.

Table 7 *Results of Experimental Group Motivation in Pretest and Posttest*

	Paired Differences					*t*	*df*	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
pretotal – posttotal	–3.514	1.482	.250	–4.023	–3.004	–14.023	34	< .001

Table 7 shows a statistically significant difference between the pretest and posttest. This comparison showed a mean difference of –3.51 (*SD* = 1.48), with a 95% confidence interval of –4.02 to –3.00. A significant difference $t(34) = -14.02$, $p < .001$, was observed, indicating that learners' performance on the posttest was higher than on the pretest. This difference suggests that NotebookLM AI and its multimodal features positively affected the experimental group's motivation levels. Additionally, the AIMS statements were analyzed, and Table 8 below presents the investigation of the collected data.

Table 8 *Descriptive Analysis of the AIMS Questionnaire*

	N	Minimum	Maximum	Mean	Std. Deviation
Intrinsic Motivation					
I enjoy learning with AI very much.	35	3.00	5.00	4.34	.683
Learning with AI is fun for me.	35	3.00	5.00	4.40	.694
I feel satisfied through learning with AI.	35	3.00	5.00	4.34	.725
Exploring knowledge with AI is fascinating to me.	35	3.00	5.00	4.49	.562
Identified Regulation					
Learning with AI could enhance my effectiveness.	35	3.00	5.00	4.14	.809
Learning with AI is important for my academic performance.	35	3.00	5.00	4.29	.710
Learning with AI is important in helping me deal with future challenges.	35	3.00	5.00	4.23	.770
Amotivation					
Learning with AI is meaningless.	35	1.00	4.00	2.49	.919
I cannot see why I need to learn with AI.	35	1.00	4.00	2.71	.859
I don't know what I am getting out of learning with AI.	35	1.00	4.00	2.66	.872
Learning with AI is a waste of my time.	35	1.00	4.00	2.57	.814
Valid *N* (listwise)	35				

Table 8 shows that the fourth statement, "exploring knowledge with AI is fascinating to me," has the highest mean score (M = 4.49). This score shows that using NotebookLM AI could foster exploratory learning, leading to students' active engagement in the learning process and increasing a sense of fascination and intellectual stimulation. Second, the statement "learning with AI is fun for me" had a mean score of M = 4.40 and ranked second among all statements. It could be implied that using NotebookLM AI created an enjoyable learning environment. Additionally, the two other statements, including "I enjoy learning with AI very much" and "I feel satisfied through learning with AI," received similar mean scores of M = 4.34. This score shows that using AI not only increases enjoyment but also creates a feeling of satisfaction. The other item, "learning with AI is important for my academic performance" received a mean score of M = 4.29. This shows that students believe AI tools can meaningfully improve their educational achievements.

The other two statements, "learning with AI is important in helping me deal with future challenges" (M = 4.23) and "learning with AI could enhance my effectiveness" (M = 4.14), show that students have a positive attitude toward the practical use of AI tools in the future. The other statement, "I cannot see why I need to learn with AI," received a mean score of M = 2.71, indicating some uncertainty among students about using AI, despite the positive outcomes the AI tools showed during the treatment period. The other remaining items, such as "I don't know what I am getting out of learning with AI" (M = 2.66), "learning with AI is a waste of my time` (M = 2.57), and "learning with AI is meaningless" (M = 2.49), received the lowest mean scores among all. These mean scores indicated that using AI as a treatment decreased feelings of inefficiency, irrelevance, and lack of purpose, and increased students' motivation in the learning process. Overall, the findings showed that the largest increase was in Intrinsic Motivation, which could be associated with the enjoyment, interest, and satisfaction derived from using AI tools in learning. The second-largest category was Identified Regulation, indicating that students strongly recognized the values and effectiveness of AI tools. Finally, Amotivation ranked last, indicating that learners' negative perceptions of AI use in the learning process decreased significantly during the treatment period.

Discussion

The current study attempted to measure the impact of using AI, NotebookLM AI and its multimodal features on the grammatical knowledge of Omani EFL learners. Simultaneously, the study sought to investigate the experimental group's motivation to use such AI tools in language learning. The study's findings for the first goal initially showed an increase in learners' grammar posttest scores, which may be related to the face-to-face instruction both groups received from their instructors. However, a deeper analysis of the posttests showed that the experimental group outperformed the control group, and some of this outperformance might be attributable to the AI-enhanced multimodal instructional approach used during the treatment period. In addition, the delayed posttests revealed that the experimental group performed better than the control group. Therefore, it can be concluded that using an AI-enhanced multimodal instructional approach as a mediator of learning could help learners gain more grammatical knowledge. Additionally, the AIMS questionnaire indicated that an AI-enhanced multimodal instructional approach improved students' motivation in the experimental group. The questionnaire analysis showed that students in the experimental group found using AI tools and their multimodal features enjoyable, motivating, and fun, which could foster learning and make educational environments more engaging. Learners also claimed that the AI-enhanced multimodal instructional approach could shape the future of learning. Finally, the study found that using AI tools reduced students' negative feelings and learning barriers by providing immediate, personalized feedback and explanations.

The experimental group's better grammar scores may be attributed, in part, to NotebookLM AI and its multimodal features, which increased motivation and improved grammar scores. Moreover,

the experimental group's improvement on the delayed assessment indicates some retention of knowledge that lasted longer in the AI-enhanced multimodal instructional environment. In contrast, the control group benefited from face-to-face teaching, which might explain the improvement in posttest scores, as the instruction was grammar-focused and did not include any AI tools. However, the delayed posttest showed no improvement; conventional teaching methods may not be sufficient for long-term retention. NotebookLM AI and its multimodal features may have driven the experimental group's strong motivation.

The study's findings may align with well-established theories. First, the experimental group's performance in both grammar acquisition and motivation could be explained by SDT, which claims that learners who study in an environment that promotes autonomy, competence, and relatedness tend to improve their performance (Deci & Ryan, 2000). In this research, NotebookLM AI might have enabled students to review forms and explanations and improve their answers faster than in traditional classroom settings. The tool allowed students to interact with grammatical structures at their own pace and to review explanations as needed. This may have given students more control over the learning process, which could explain their increased motivation. Viewed from a sociocultural perspective, the outcomes of this study also support the idea that mediated learning through guided contact and cultural tools is a key factor (Vygotsky, 1978). For example, by giving students extra opportunities to manipulate language forms, test their hypotheses, and better understand the material through repeated use, NotebookLM AI acted as a mediational artefact, creating space for learning grammar alongside teacher instruction. Cognitive Load Theory can also explain the results: learning is better when a person can focus more on what is needed and less on irrelevant material (Paas et al., 2003; Sweller, 1988). In this case, students might have been able to focus more on recognizing grammar patterns, understanding the rules, and applying them in context by using NotebookLM AI and its easily accessible multimodal features. Altogether, these perspectives suggest that the advancements seen in the experimental group were not merely the result of using a new technology instrument but rather of participating in a learning approach that was more adaptive, supportive, and cognitively manageable; therefore, both the intervention and the technology effectively fostered grammar learning and promoted long-term motivation.

The first aim's findings align with those of Ali et al. (2025), who studied the impact of an interactive AI-powered tool on classroom grammar learning among Omani EFL learners. The study found that AI-generated classroom feedback significantly improved grammar knowledge. Similarly, El-Said (2024) examined the possible role of AI in grammar learning among Egyptian preparatory school students. The study found that AI usage in the classroom led to gains in grammatical knowledge for the experimental group. These findings also align with those of Lalira et al. (2024), who found that AI tools effectively improved Indonesian university students' grammar accuracy in the short term but struggled to reduce over-reliance on AI tools, which could obstruct students' development of independent grammar skills and critical thinking. Kucuk (2024a) found similar results among Iraqi university students. The study found that AI-assisted instruction, by providing access to interactive tools and real-time feedback, can improve grammar outcomes in the immediate context of students' abilities but can also lead to surface learning without guidance.

In addition, the findings for the second aim were consistent with those of previous studies. Ahmed et al. (2025) conducted a systematic literature review on the influence of AI learning tools on ESL students' motivation. The study concluded that using AI learning tools, such as ChatGPT and Grammarly, increased students' motivation, and that features such as immediate feedback, personalized content, and gamification enhanced both intrinsic and extrinsic motivation. Anjum et al. (2024) studied the effect of an AI tool on second language (L2) learners' motivation and engagement among university students in India and Iraq and found statistically meaningful differences in motivation, along with positive learning experiences and perceived progress from engagement with the AI tool. This aligns

with Yang (2024), who conducted a meta-analysis of AI's influence on English language learning motivation, encompassing 24 experimental studies. The impact of AI technology was reported as a strong motivator for learners, especially in middle school and university contexts, by providing personalization, instant feedback, and dynamically adapting content to learners' needs. This finding also aligned with Aly et al. (2024), who studied 66 Indonesian university students studying English for Specific Purposes (ESP) and found that AI-enhanced platforms strongly increased learner motivation through personalization and instant feedback.

Conclusion

The current study aimed to implement advanced technologies such as AI and its multimodal features in the grammar learning process and showed that learners performed well on the post-assessment and that using AI tools could increase learners' motivation. The study's findings could be helpful to various stakeholders.

First, this study's findings can be useful for EFL instructors, who can leverage AI technologies such as NotebookLM AI and its multimodal features to improve grammar instruction. Secondly, the study may provide syllabus designers with information that they can use to make meaningful use of AI-enabled EFL grammar exercises. In addition, it may support EFL learners in similar situations by showing how AI tools can raise learner motivation. Furthermore, this study outlines how the findings can help education policymakers and administrators decide whether including AI in learning environments is worth their time, and how researchers in applied linguistics and educational technology can understand the multiplicative influence AI use can have on language performance and learner motivation.

Despite these findings, this study had several limitations. Because the present study was conducted at one higher education institution in Oman with pre-intermediate foundation students, the findings may not generalize to other settings with different language levels. Although intact classes were quasi-experimental and may have been similar at baseline, pre-existing differences could affect the results. Given the short duration of the treatment, the lack of statistically significant results in the delayed posttest should be treated cautiously regarding whether grammatical structures are retained in the long run. Additionally, researchers assessed motivation using self-report questionnaire data, which may be affected by social desirability bias. In addition, because the study examined only two grammatical structures, it contributed limited information to the field of grammatical development. The other limitation was the lack of focus on students' recognition of gender and age, which could yield different findings. Another limitation of the study is that the training workshop, with its new approach in intervention, was conducted using various multimodal materials and included collaborative subgroup work, which are potential factors for the noticeable improvement observed; thus, it becomes difficult to assign the NotebookLM AI's feedback features as the only factor for the gains. Finally, a limitation of this study is the motivation questionnaire results. This questionnaire was administered only to the experimental group, and the results could not be generalized to the control group.

Future research could use larger samples of students from different universities and competence levels, and longitudinal designs with longer exposure periods and previously untested time lags between training and testing to examine how long the results last. It could also examine the effects of AI tools on other language skills and subskills, such as writing accuracy, speaking fluency, and vocabulary development, and combine quantitative data with qualitative data, such as interviews or learning diaries, to explore learners' perceptions, attitudes, and experiences in using AI tools for language learning. Comparing different AI tools or instructional frameworks will reveal which aspects of AI best support language learning and motivation. Additionally, analyzing the findings by age and gender could provide more comprehensive insights into AI's usefulness in the learning context. Future studies should

consider the novelty factor, collect data from students on the training received and the multimodal support provided, and include process evidence such as usage logs, interaction records, and feedback frequency data to identify which element primarily influences learners' motivation and achievement. Finally, further research could be conducted to compare a control and an experimental group based on their motivation for using AI tools.

Declaration on Generative AI

The authors confirm that Grammarly AI and Paperpal AI were run on the final version of the manuscript solely for proofreading.

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