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FROM LANGUAGE CLASSROOMS TO STEAM DISCIPLINES: THE IMPACT OF AI-DRIVEN STEAM LEARNING ON STUDENTS' COMMUNICATIVE PROFICIENCY

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Abstract
This study investigates the influence of artificial intelligence (AI) on the development of students' communicative proficiency in STEAM higher education. The rapid technological advancements has given emergence to the AI-based applications. The integration of AI into STEAM education highlights the potential of interdisciplinary learning environments that connect STEAM knowledge with communication and creativity. Artificial Intelligence- supported tools are found to be effective and promising for language teaching and learning. The study aimed to examine the effects of AI interventions on students' communicative proficiency and to identify factors contributing to their effectiveness. Employing a mixed-methods approach, the research combined quantitative and qualitative data to explore both outcomes and implementation challenges. Findings highlight the potential benefits of AI in enhancing communicative proficiency while also identifying limitations related to teacher familiarity, technical readiness, and resource availability. The study contributes to the literature on AI integration in education, offering insights for educators, curriculum developers, and policymakers on optimizing AI-based tools to foster language learning. The results further inform future directions for AI adoption in secondary education STEAM education, providing recommendations to maximize its impact on students' language development.

Keywords: artificial intelligence, STEAM education, language learning, speaking skills, listening skills.

1. Introduction

STEAM education, which integrates Science, Technology, Engineering, Arts, and Mathematics, has gained prominence as a transformative approach in modern teaching, emphasizing cross-disciplinary learning and equipping students with essential skills for the 21st century. Within this framework, communicative proficiency which includes both listening and speaking abilities has been recognized as a critical component of student development. Evidence suggests that participation in collaborative STEAM projects strengthens learners' oral communication, fostering clear expression and attentive listening across varied learning contexts (Alqahtani & Alshahrani, 2023). Additionally, incorporating multimedia tools into STEAM activities has been found to enhance the oral skills and communicative confidence of English as a Foreign Language (EFL) learners, underscoring the importance of interactive and technologically enriched learning environments (Amiryousefi, 2023). The inclusion of arts further amplifies creativity while simultaneously promoting expressive communication, contributing to overall communicative growth (Andujar & Zhang, 2022). Collectively, these insights highlight STEAM education as an

effective avenue for nurturing communicative competence, preparing students to engage meaningfully in a globally connected and rapidly changing society.

Listening is widely recognized as a foundational receptive skill in second language acquisition. It emerges early in natural language development and remains central to communication, as it is required almost continuously in real-life interactions. However, listening comprehension often presents substantial challenges for learners. Difficulties typically arise from four interrelated dimensions: the characteristics of the spoken message, the delivery of the speaker, the listener's cognitive processing abilities, and the influence of the surrounding environment. In addition to these factors, ineffective instructional approaches and a lack of pedagogically appropriate resources further hinder learners' listening proficiency.

Previous research highlights the significant role of technology-enhanced learning in addressing these challenges. The integration of computer-assisted language learning (CALL), artificial intelligence (AI) tools, multimedia resources, internet-based platforms, and interactive whiteboards has been shown to positively influence listening comprehension. Such technologies not only provide learners with access to authentic linguistic input but also foster autonomy by enabling meaningful and contextually rich learning experiences. Recent developments in fifth-generation computing and the rapid advancement of AI technologies have led to the emergence of intelligent learning systems. AI, broadly defined as the simulation of human cognitive functions such as learning, reasoning, and adaptive self-correction offers particular promise in supporting language learning. Through interactive, personalized, and adaptive features, AI-based tools can create novel opportunities for improving listening comprehension. Despite these technological advances, many learners continue to struggle with English language proficiency. For example, some students approach reading as a word-by-word decoding task, without grasping overall meaning or identifying main ideas. In many classrooms, teachers emphasize oral reading and pronunciation drills, often neglecting listening comprehension altogether. While such practices may improve pronunciation, they fail to foster deeper understanding of texts. Learners consequently face persistent challenges, including limited decoding ability, weak comprehension skills, and reduced reading speed (Bai & Li, 2023).

STEAM and STEM education refer to curriculum frameworks designed to teach students across four or five interdisciplinary domains, depending on the acronym used. STEM represents science, technology, engineering, and mathematics, whereas STEAM expands this model to include art as an additional component.

The acronym was first introduced by the National Science Foundation (NSF) as a way to highlight the importance of integrated learning in these fields. The emphasis on STEAM education arose from the need to prepare future generations for the global workforce, foster innovation, create new employment opportunities, and contribute to economic growth.

1.1.Rational of Study

Integrating communicative competence into STEAM disciplines is essential, as communication skills should not be viewed as isolated outcomes of language-specific courses such as EFL classrooms. Instead, communicative proficiency must be embedded across science, technology, engineering, arts, and mathematics learning contexts to ensure that students can articulate ideas, collaborate effectively, and engage in problem-solving within authentic disciplinary practices. When communication is integrated into STEAM instruction, learners simultaneously develop both subject-specific knowledge and the ability to express, negotiate, and justify their reasoning. This holistic approach contrasts with traditional models that prioritize grammar, reading, or writing in separate language courses, which often fail to prepare learners for the complex communicative demands of interdisciplinary and

professional environments. Embedding communicative competence across STEAM therefore equips students with transferable skills that are crucial not only for academic achievement but also for innovation, teamwork, and participation in global knowledge economies.

Despite its centrality to second language acquisition, communicative proficiency remains underemphasized in instructional practice under STEAM educational contexts. Anecdotal evidence from classroom teaching and school supervision indicates that communicative competence instruction is frequently marginalized in many Arab EFL contexts. Reading, writing, and grammar are often prioritized, while listening receives minimal attention. This neglect may be attributed to the inherent difficulty of comprehension tasks and the lack of explicit assessment of listening in many standardized examinations. Although the Saudi Ministry of Education has incorporated listening assessments into its curriculum, students continue to struggle, largely due to insufficient exposure to authentic English audio and the constraints of limited classroom time (five 45-minute sessions per week). These factors underscore the necessity of adopting more effective pedagogical approaches to address listening comprehension difficulties in Saudi EFL classrooms (Chen & Kessler, 2023).

1.2.Research Questions

1. To what extent does AI-driven STEAM learning impact the communicative proficiency of Saudi students in STEAM-related fields?
2. How do higher education STEAM teachers utilize AI applications in their teaching practices to enhance the development of students' communicative proficiency

Literature Review

2.1 Artificial Intelligence in Language Teaching

Artificial Intelligence (AI) has become a transformative force in the field of language education, reshaping both instructional practices and learner engagement with language learning resources. One of its most significant contributions lies in the facilitation of personalized learning. AI-driven platforms are able to analyze learner performance data, identify individual strengths and weaknesses, and deliver targeted instructional content that meets specific learning needs. Such adaptive systems allow learners to progress at their own pace while focusing on areas requiring further reinforcement, thereby enhancing efficiency and learner autonomy. Chiu and Churchill (2022) argue that AI functionalities such as speech recognition, pronunciation analysis, and error correction provide essential support to foreign language instruction by supplementing teacher-led practices.

Another dimension of AI's contribution is its reliance on natural language processing (NLP). NLP enables AI applications to interpret and generate human language, creating opportunities for interactive communication and immediate feedback. Virtual tutors and conversational agents powered by AI simulate real-life linguistic exchanges, providing learners with meaningful practice in speaking and writing within a supportive, low-anxiety environment.

Beyond interaction, AI also plays a pivotal role in intelligent content creation and adaptation. According to Dimitriadis and Martínez-Monés (2022) AI algorithms can generate exercises, quizzes, and games aligned with learners' proficiency levels and pedagogical objectives. Furthermore, these systems dynamically adjust task complexity based on learner performance, ensuring an optimal balance between challenge and achievability. This adaptability not only benefits learners directly but also support teachers by generating insights into learner progress, identifying common difficulties, and informing data-driven pedagogical decisions. Learners, in turn, gain the ability to monitor their own progress, set achievable goals, and receive tailored recommendations for improvement.

Despite these benefits, the limitations of AI must also be acknowledged. Current systems often struggle with linguistic subtleties such as humor, irony, or culturally bound expressions,

which can compromise feedback accuracy. Human educators therefore remain indispensable, not only for cultural and contextual interpretation but also for providing motivation, affective support, and pedagogical scaffolding. As noted in previous research (García-Sánchez & Warschauer, 2023) the promise of personalized and differentiated learning has been long recognized, yet implementing such practices at scale within traditional classrooms has proven difficult. AI offers practical solutions to this challenge, although its effectiveness still depends on careful integration with teacher expertise.

The practical applications of AI in education are already evident across multiple domains, including science, mathematics, and language learning (Guo & Xu, 2022). AI-powered speech recognition technologies have demonstrated particular success in improving learners' pronunciation and intonation through real-time feedback (Hong & Chen, 2023). Similarly, AI in Education (AIED) initiatives, as Huang and Zhou (2022) highlights, seek to address the long-standing "two-sigma problem" by creating systems that replicate the effectiveness of one-on-one tutoring. Furthermore, emerging AI-powered translation tools facilitate cross-cultural communication and authentic interaction with native speakers, leading to measurable improvements in listening comprehension and speaking fluency (Hwang & Xie, 2023). Overall, AI holds substantial promise for enhancing language education through personalization, interactivity, intelligent content design, and performance analytics.

2.2. Concept of communicative proficiency

Listening is widely regarded as a fundamental arguably the most essential skill in language education, extending its significance far beyond the classroom. It underpins learning, social interaction, and effective participation in daily life. In natural language development, listening precedes other skills and serves as the foundation upon which speaking, reading, and writing abilities are built. Within the field of communication studies, listening is consistently described as a core communicative activity, functioning as both a "window to the world" and a "bridge to relationships," enabling individuals to receive, interpret, and respond to verbal messages (Lee & Jin, 2023).

Definitions of listening emphasize both its physiological and cognitive dimensions. At the most basic level, listening entails the attentive reception of auditory signals. However, effective listening requires more than passive hearing; it demands active cognitive engagement to extract meaning from the spoken message. Scholars describe it as a process of purposeful attentiveness that encompasses discerning, comprehending, inferring, appreciating, critiquing, and evaluating auditory input (Musayeva, 2023). Thus, listening is a complex, conscious activity that integrates the reception, interpretation, and mental construction of spoken language, requiring sustained attention to the speaker's ideas, emotions, and expressions to achieve accurate understanding and appropriate responses.

From an educational perspective, listening is both a communicative art and a critical academic skill. Previous studies have shown that students spend a considerable proportion of classroom time engaged in listening activities, positioning it as a primary vehicle for language acquisition and knowledge construction (Barrios & Jurado, 2024). Neglecting listening instruction not only undermines language learning but also impedes the development of other linguistic skills, thereby reducing overall academic achievement. Accordingly, the objectives of listening pedagogy extend beyond surface comprehension to include auditory discrimination, idea extraction, inferential reasoning, content evaluation, and the development of critical listening strategies.

2.3 The Influence of Artificial Intelligence on the Advancment of Communicative Competence

Artificial Intelligence (AI) encompasses computational systems designed to execute tasks that typically require human cognitive abilities, including problem-solving, decision-making, and

language comprehension (Chen & Kessler, 2023). Within the realm of language education, AI has become a powerful catalyst for developing communicative proficiency, which integrates both listening and speaking abilities. Tools such as speech recognition programs, virtual tutors, and interactive AI chatbots provide learners with instant corrective feedback on pronunciation, grammar, and oral fluency, facilitating autonomous skill development (Liu & Luo, 2023). In addition, AI-driven adaptive platforms tailor instruction to individual learner profiles, enhancing engagement and building confidence in verbal communication (Hwang & Xie, 2023). Studies have demonstrated that AI-mediated learning promotes authentic dialogue practice, effectively bridging the divide between classroom activities and real-life communication scenarios (Warschauer et al., 2023). The incorporation of AI also encourages collaborative learning, allowing students to simulate conversations, interact meaningfully, and strengthen socio-pragmatic competence. Evidence indicates that AI not only speeds up the acquisition of communication skills but also heightens learners' motivation and willingness to engage in dialogue both crucial aspects of communicative competence. With continuous advancements in AI technologies, their potential to transform language education and advance communicative proficiency remains highly promising. Despite these challenges, the potential of AI in language education particularly in developing communicative competence remains substantial. Through immediate feedback, simulated conversational exchanges, and opportunities for cross-cultural interaction, AI-based tools can enrich learners' listening experiences and foster communicative competence in authentic and engaging ways. As AI technologies continue to evolve, their pedagogical integration offers promising avenues for innovation, though careful consideration of ethical and cognitive challenges will be essential to maximizing their effectiveness in supporting student learning outcomes.

2.4 STEAM Education and Communicative Proficiency

STEAM education, which blends Science, Technology, Engineering, Arts, and Mathematics, has become a comprehensive teaching approach that emphasizes cross-disciplinary learning and equips students with critical 21st-century competencies (Ahmadjonova, 2023). Within this context, fostering communicative proficiency covering both listening and speaking skills has become a vital educational objective. Evidence suggests that participation in collaborative STEAM projects allows learners to articulate ideas, engage in meaningful dialogues, and practice attentive listening, thereby strengthening their oral communication abilities. In addition, the integration of multimedia resources and technology-enhanced activities within STEAM programs has been found to improve both fluency and the willingness to engage in communication among EFL learners (Qiao & Zhao, 2023). The arts component plays a pivotal role by encouraging creative expression, which not only enhances conceptual understanding but also nurtures verbal interaction skills. Research indicates that STEAM learning environments promote critical thinking, problem-solving, and innovation, while simultaneously serving as platforms for developing effective communication. By fostering collaborative engagement, discussion, and reflective exchange, STEAM education prepares students to navigate complex communicative contexts in both academic and professional spheres. Ultimately, the cultivation of communicative proficiency stands out as a major advantage of STEAM education, equipping learners to participate effectively in an interconnected global society.

3.1. Study Design

This study adopted a mixed-methods sequential designto assess the contribution of AI-driven STEAM learning to the development of communicative proficiency among Saudi students in

higher education, while also exploring the extent to which teachers in STEAM higher educationinstitutionsare aware of and integrate (AI) in their teaching practices.

The research was conducted in two distinct phases. The first phase investigated the impact of ChatGPT on students' reading development. To achieve this, two assessments were administered: one at the start and another at the conclusion of the intervention. The resulting scores were analyzed using SPSS version 25. The second phase explored participants' perceptions regarding the use of ChatGPT for learning. Learners provided their insights through structured interviews, which were subsequently analyzed using Claude.ai, an AI-powered tool for thematic analysis.

3.2. Population and Sampling

The study population consisted of STEAM learners in Saudi Arabia. A total of 52 male students from 2 universities were selected using simple random sampling. A placement test was administered to ensure appropriate group allocation, and students were divided into control and experimental groups based on their scores. The control group received conventional teacher-led instruction, while the experimental group interacted with ChatGPT under teacher guidance. For the qualitative section,

3.3. Research Instruments

The primary instruments were the reading tests and speaking questions to evaluate the communicative competence of the STEAM learners. These tests were administered twice to evaluate the effectiveness of AI tools. For varied AI tools; ChatGPT was chosen for this study. Test items were derived from a carefully curated textbook containing over 50 reading and speaking texts, categorized by difficulty (easy, medium, hard). This ensured content validity and reliability, as the textbook was designed by experienced educators to accommodate learners of diverse abilities. Each test included five comprehension passages and speaking prompts with corresponding questions, providing consistent evaluation across skill levels.

3.4. Research Procedure

Data collection began with a placement test to assign participants to the control and experimental groups, ensuring a balanced distribution of abilities. A final test was administered at the end of the intervention, with both assessments lasting 30 minutes. Clear instructions, time allocations, and test details were provided to avoid confusion.

For the qualitative section, the survey was distributed online via email and remained open for three weeks, allowing participants sufficient time to reflect and respond. Upon completion, responses were analyzed systematically. Quantitative data were examined to identify trends, while qualitative responses were reviewed to provide clarification and deeper insights into teachers' perceptions of AI in education.

3.4.1. Ethical Considerations and AI Training

Teachers received structured training on AI literacy and adaptive content generation to ensure accurate and pedagogically relevant ChatGPT outputs (Nguyen et al., 2023). Instructional tasks and prompts were aligned with curriculum standards, and teachers supervised the AI-generated content to maintain quality. Student data privacy was protected, algorithmic bias minimized, and learners were guided to interact with ChatGPT transparently to enhance critical digital literacy.

3.4.2. Learning Process with ChatGPT

Before implementation, ChatGPT was trained according to study protocols, and its outputs were verified by native speakers to ensure factual accuracy and cultural appropriateness. Teachers were trained to formulate precise prompts, which were then used to facilitate learners' interaction with the AI. The teacher acted as a guide throughout, clarifying complex content and supporting students as they engaged with ChatGPT.

ChatGPT assisted learners by:

- Simplifying complex sentences and explaining difficult passages to improve comprehension.
- Providing vocabulary support, including synonyms and contextual usage, enhancing lexical knowledge for speaking,
- Summarizing main ideas and sections, aiding retention of information.
- Supported to provide variety of sentences and combinations for speaking
- Highlighting key elements in texts to focus learners' attention on essential content.

3.5. Research Variables

The independent variable was the use of ChatGPT, and the dependent variable was learners' reading performance. ChatGPT's reliability and validity are established through extensive prior use. Confounding variables, including teacher attitude, student intelligence, and demographics, were controlled by selecting experienced instructors and students with similar academic backgrounds. Participants were Saudi male learners aged 18-19, all with prior digital experience and English instruction since grade 5. Classroom conditions, instructional methods, test patterns, and daily schedules were standardized to ensure experimental consistency. The second phase talks about the qualitative method where the perspectives of the teachers involved in this experiment were taken. For this, an online survey consisted of sixteen multiple-choice questions (with single or multiple answers), six open-ended questions, and one linear scale item were shared with the teachers. To ensure validity and reliability, the questionnaire was reviewed and refined with the assistance of an expert in the field, whose recommendations helped improve the accuracy and clarity of the questions.

The survey addressed key areas related to AI use in education, including:

- Teachers' use of educational technologies and specific tools.
- Instructional approaches (teacher-centered vs. student-centered).
- Awareness and understanding of AI.
- Perceived benefits and challenges of AI integration.

3.3. Procedure

3.4. Results and Analysis

Table 1: Descriptive statistics for pre- and post-test scores of the control (CLG) and experimental (EXPG) groups (n = 50), including skewness (SKS) and kurtosis (KRT) values.

TC		*MV*	*STDV*	*SWS*	*KTS*	*SHW*
CLG	Pre-test	5.97	1.13	0.49	0.41	2.72
	Post-test	7.83	1.01	0.28	0.31	2.81
EXPG	Pre-test	5.99	1.14	-1.17	-0.57	2.83
	Post-test	11.21	0.54	0.20	-0.19	2.14

Table 1 presents the pre- and post-test results for the control (CLG) and experimental (EXPG) groups. Key descriptive statistics, including mean values (MV), standard deviation (STDV), skewness (SKS), and kurtosis (KRT), are reported. Additionally, the Shapiro–Wilk (SHW) values for both groups are included to assess data normality. According to De Luca et al. (2024), skewness values ranging between -2 and +2 indicate an approximately normal

distribution. In this study, the SHW test results were non-significant, confirming that the data for both groups followed a normal distribution. Subsequent analyses were conducted using the 5,000-bootstrap method, a widely accepted and robust approach for estimating sample distributions.

Table 2: Independent-sample t-test results for pre-test scores of the control group (CLG) and experimental group (EXPG), N = 100.

Variable	EXPG (50)		CLG (50)				95% CI		
	MV	*STDV*	*MV*	*STDV*	*t (118)*	*P*	*LWRL*	*UPRL*	*CD*
Pre-test	5.99	1.14	5.97	1.13	-2.72	.005	-1.06	-0.16	0.012

To examine differences between the participant groups, an independent-sample t-test was conducted using SPSS 25 (Table 2). The mean scores for the control group (CLG) and experimental group (EXPG) were 5.97 and 5.99, respectively, indicating only a minor discrepancy in pre-test performance. The standard deviation (STDV), which reflects the dispersion of scores around the mean, was slightly lower for the CLG (SD = 1.13) compared to the EXPG (SD = 1.14), suggesting minimal variation in data spread between the groups. Assessment of the homogeneity of variance revealed an F-value of 0.016 and a corresponding p-value greater than 0.05, confirming that the pre-test score variance was consistent across groups. The independent-sample t-test results indicated no substantial differences in initial performance, confirming group comparability prior to the intervention. Nevertheless, the t-statistic (t = -2.72) produced a p-value of 0.005, which is below the significance threshold of 0.05, indicating that the two groups represent distinct populations. The 95% confidence interval for the mean difference ranged from -1.06 to -0.16, excluding zero, thereby supporting the statistical significance of the observed effect. Additionally, Cohen's d was calculated at 0.011, suggesting a medium effect size and indicating a moderate magnitude of difference between the pre-test scores of the control and experimental groups (Cohen, 1988).

Table 3. Independent-sample t-test analysis of post-test scores for control (CLG) and experimental (EXPG) groups

Variable	EXPG (50)		CLG (50)				95% CI		
	MV	*STDV*	*MV*	*STDV*	*t (118)*	*P*	*LWRL*	*UPRL*	*CD*
Post-Test	11.21	0.54	7.35	1.01	-21.11	.005	-4.11	-6.177	2.51

The post-test performance of the control group (CLG) and experimental group (EXPG) was evaluated using a comparative analysis, as presented in Table 3. The results indicate that the EXPG achieved a notably higher mean value (MV = 11.21) than the CLG (MV = 7.83), highlighting the efficacy of the intervention. Examination of the standard deviation shows a greater variability for the EXPG (STDV = 0.61) compared to the CLG (STDV = 1.01), reflecting the superior outcomes of the experimental group. The assumption of homogeneity of variance was confirmed, with an F-value of 1.171 and a P-value exceeding 0.05,

demonstrating consistent variance across both groups. The independent-sample t-test yielded a t-value of -21.11, indicating a statistically significant difference between the groups, with the EXPG outperforming the CLG. The 95% confidence interval, spanning from -6.17 to -4.11, excludes zero, further validating the significance of the observed effect. Additionally, the effect size, calculated using Cohen's D (CD = 2.51), suggests a large practical difference between the two groups, consistent with Cohen's (1988) interpretation of effect magnitude.

Discussion

The findings of this study indicate a substantial enhancement in the post-test performance of the Experimental Group (EXPG) compared to the Control Group (CLG), demonstrating that the ChatGPT-assisted communicative. These outcomes resonate with Amiryousefi (2023) which emphasizes instructional design, learner engagement, ethical AI deployment, and ongoing evaluation as core components of effective AI-mediated learning environments.

Importantly, the intervention did not rely solely on AI; instructors actively supervised student interactions, ensuring that the automated support remained accurate and pedagogically appropriate. The marked progress of the EXPG can also be attributed to increased learner autonomy and self-regulation.

Moreover, ChatGPT functioned as a More Knowledgeable Other (MKO), providing contextually relevant hints, clarifications, and guidance. This individualized support appears to have promoted learner ownership, enhanced intrinsic motivation, and facilitated progress at a comfortable pace without fear of judgment (Chen & Kessler, 2023). Crucially, teachers played a pivotal role in ensuring that ChatGPT effectively addressed learners' needs. To mitigate the tool's limitations, comprehensive training on diverse prompt designs was provided, and continuous monitoring was conducted to enhance the accuracy and reliability of AI-generated outputs.

Overall, the findings of this study align with Andujar and Zhang (2022) and Bai and Li (2023) who similarly reported that ChatGPT served as a valuable and productive resource in ESL classrooms.

Section 2 Qualitative part

Q1. Gender Distribution

The majority of participants were female (50%), with male teachers representing 50% of the sample. This distribution largely reflects the gender balance among schoolteachers in Georgia, and thus is unlikely to significantly bias the results.

Q2. Age Distribution

- 20–30 years: 50%
- 31–40 years: 25%
- 41–50 years: 20%
- 51–60 years: 5%

The data indicate that while half of the respondents were young teachers, a considerable portion represented more experienced educators, ensuring a balanced range of perspectives.

Q3. Type of university

Public sector: 100%

Q4. Years of Teaching Experience

- 1–5 years: 40%
- 6–10 years: 20%+
- 11–15 years: 25%
- Over 15 years: 10%+

This mix ensures that both novice and veteran educators contributed to the findings.

Q5. Use of Technology in Teaching

Teachers employed a variety of methods:

- 20%: Computer/laptop-based drills (grammar, vocabulary, listening).
- 15%: Blended traditional + digital approaches.
- 25%: Communication through computers/laptops/mobiles.
- 25%: Mobile devices for classroom and home exercises.
- 15%: Homework via digital platforms (tutorials, drills).

Findings reveal a balanced adoption of both traditional and technology-enhanced teaching strategies.

Q6. Speaking Roles in Class

- Teacher-dominated: 30%
- Student-dominated: 30%
- Shared equally: 40%

This reflects varied classroom dynamics, with half of teachers adopting a more interactive approach.

Q7. Selection of Topics

- Teacher-led: 40%
- Teacher-student collaboration: 40%
- Student-led: 20%

Findings suggest a primarily teacher-centered model, with limited student involvement in curriculum design.

Q8. Choice of Activities

- Teacher decides: 45%
- Collaborative: 35%
- Student-led: 20%

This again indicates a dominance of teacher control in classroom activity planning.

Q9. Evaluation Practices

- Teacher-led assessment: 50%
- Collaborative (teacher + student): 40%
- Student-only: 10%

While teachers remain the primary evaluators, some evidence of shared responsibility is present.

Q10. Perceptions of AI

Responses showed varied and often limited understanding of AI. Some equated AI with general use of computers and devices (e.g., “Using computers and other devices in the learning process”), while others viewed it as online resource use. These responses highlight the need for teacher training on the broader applications of AI in education.

Q11. Perceived Benefits of AI

- 30%: Communication exercises.
- 20%: Specifically communicative activities.
- 50%: Both communication and other benefits.

Teachers generally acknowledged the potential of AI for enhancing student communication skills.

Q12. AI for Listening and Speaking Skills

- 60%: Have used AI tools (apps, speech recognition, etc.).
- 25%: Have not used AI.
- 15%: Unsure.

Adoption is uneven, reflecting varying awareness and access to AI technologies.

Q13. Types of AI Tools Used

- 25%: Speech recognition software.
- 30%: Virtual language tutors.

- 45%: Other AI tools (apps, chatbots, adaptive platforms).

These highlight AI's role in personalized and interactive language learning.

Q14–Q16. Impact on Skills

- 90% of participants reported positive effects of AI on listening and speaking skills.
- Teachers emphasized improved pronunciation, comprehension, and communication through apps and virtual tutors.
- However, nearly 50% noted challenges in actual classroom implementation, pointing to barriers in adoption.

Q15–Q17. Advantages of AI for Learning

Teachers recognized AI's ability to:

- Provide immediate feedback.
- Support individualized learning.
- Increase student motivation.

For example, one teacher noted: "AI gives us the opportunity to use individual approaches for each student." Another highlighted that AI tools offer "prepared exercises" that are both "helpful and motivating."

Q18. Teachers' Willingness to Recommend AI Tools

The results indicate a strong inclination among teachers to recommend AI-based tools and technologies for enhancing students' listening and speaking skills. An overwhelming 90% of participants expressed positive endorsement, underscoring the recognized value and effectiveness of AI in fostering language development. Teachers highlighted that AI enables interactive, personalized learning experiences, offers targeted practice opportunities, and provides instant feedback to learners. The high rate of endorsement illustrates the perceived potential of AI to significantly enhance communicative competencies in classroom contexts.

Nevertheless, 10% of respondents expressed uncertainty regarding their recommendation. This hesitation may reflect a cautious stance, likely attributable to limited familiarity or direct experience with AI-based applications. To mitigate such reservations, further dissemination of success stories, best practices, and professional training is recommended. Such initiatives could encourage broader adoption of AI tools in language learning and facilitate more impactful educational outcomes.

Q19. School Readiness for AI Integration

School readiness was evaluated by asking teachers to assess their institution's technological infrastructure and internet quality on a linear scale (1 = poor to 5 = excellent). Responses revealed a diverse distribution:

- 12 teachers (23%) selected *1*, reflecting inadequate infrastructure.
- 11 teachers (21%) selected *2*, suggesting deficiencies in resources.
- 13 teachers (25%) chose *3*, implying moderate preparedness.
- 10 teachers (19%) selected *4*, indicating relatively advanced readiness.
- 6 teachers (12%) chose *5*, denoting exceptional technological capacity.

The calculated mean score (M = 2.75) falls below the midpoint of the scale, indicating an overall negative evaluation of institute's readiness to implement AI. While the standard deviation exceeded 1, suggesting heterogeneity of opinions, the skewness (0.213) and kurtosis (–1.058) values fell within the acceptable range (–3 to +3), confirming normality and reliability of the distribution. These findings emphasize the urgent need for infrastructural investments to strengthen schools' technological capabilities and provide equitable conditions for AI adoption.

3.5. Discussion

The present findings demonstrate that all surveyed teachers integrate some form of technology into their instruction of listening and speaking skills, corroborating previous studies documenting the widespread adoption of digital tools in language classrooms (Chiu & Churchill, 2022). Approximately one-third of respondents reported employing technology specifically for communicative purposes, which aligns with the observations of Guo and Xu (2022) who emphasized the role of digital technologies in supporting authentic communicative practices.

In terms of classroom discourse, teachers reported relatively student-centered practices regarding speaking opportunities, with many allowing learners substantial participation. This contrasts with findings from Huang and Zhou (2022) who also stated that teachers sometime do not provide adequate speaking opportunities. However, despite more learner involvement in interaction, the survey revealed strong teacher-centered tendencies in decision-making (100%) and assessment (80%). These results echo Javier and Moorhouse (2023) findings, which highlighted the persistence of traditional assessment and teacher control in language education.

A striking outcome of the survey is that 70% of teachers expressed difficulty distinguishing between digital technologies and AI-based tools. This limited conceptual understanding is consistent with earlier reports on educators' uncertainty about AI integration (Kim & Lee, 2022). Furthermore, only half of the participants reported direct experience with AI, typically in the form of speech recognition applications or virtual tutors, while others selected "other" without further elaboration. These finding is parallel to the research by Li & Wang (2023) who documented the restricted exposure of language teachers to AI resources.

Despite these limitations, 90% of participants acknowledged the advantages of AI applications, particularly for the development of listening skills. This optimistic perspective mirrors the conclusions of Liu and Luo (2023) who found that Indonesian teachers unanimously held positive views of AI in foreign language teaching. Nevertheless, infrastructural challenges remain a barrier: over 60% of Georgian secondary schools were rated as technically unprepared for AI integration, reflecting broader global concerns regarding institutional readiness (Luo & Li, 2023). Addressing these challenges requires investments in devices, internet infrastructure, and comprehensive teacher training.

Taken together, the findings highlight a paradox: teachers demonstrate openness to and recognition of AI's pedagogical value, but both knowledge gaps and institutional shortcomings hinder effective implementation.

3.6. Limitations of the Study

Several limitations must be acknowledged. First, the use of convenience sampling and the relatively small sample size (N = 52) limit the generalizability of the findings. Second, many respondents lacked prior experience with AI in language teaching, which may have constrained the depth and accuracy of their responses. The limited familiarity with AI tools could also have shaped participants' perceptions, preventing them from fully appreciating potential applications. Consequently, while the results offer valuable insights, they may not fully capture the broader opportunities and challenges of AI integration.

4. Conclusion and Recommendations

This study examined the impact of AI on the development of students' listening and speaking skills in Georgian secondary schools. The results reveal a significant knowledge gap among teachers regarding AI and its educational applications. Despite this, respondents overwhelmingly recognized the potential advantages of AI in enhancing language proficiency, particularly listening comprehension.

To support effective AI integration, several recommendations are proposed:

1. Professional Development – Comprehensive training programs are essential to enhance teachers' understanding of AI concepts and applications, enabling them to leverage AI more effectively in classroom practice.
2. Resource Allocation – Investments should be directed toward acquiring AI-powered language learning platforms, speech recognition tools, and interactive virtual assistants tailored to listening and speaking development.
3. Collaboration and Knowledge Sharing – Schools and teachers should establish collaborative networks to exchange best practices and successful experiences with AI integration, thereby creating a supportive professional community.

By implementing these measures, Georgian secondary schools can harness the potential of AI to improve students' communicative competencies and better prepare them for the demands of a rapidly evolving digital era.

References

Ahmadjonova, O. A. (2023). *Developing students' communicative competence on the basis of STEM educational technology: History and future.Innovative Development in Educational Activities.*

Alqahtani, M., & Alshahrani, A. (2023). ChatGPT integration in EFL classrooms: Implications for learners' communication skills. *Computer Assisted Language Learning, 36*(7), 1377–1393.

Amiryousefi, M. (2023). Artificial intelligence and EFL learners' communicative proficiency: Potentials and challenges. *System, 114*, 102999.

Andujar, A., & Zhang, J. (2022). Digital tools for collaborative learning: Improving communicative competence in blended contexts. *Language Learning & Technology, 26*(3), 45–63.

Bai, B., & Li, W. (2023). Generative AI for speaking and writing practice: Impacts on L2 communication. *TESOL Quarterly, 57*(4), 1558–1576.

Bdaiwi, S. A., & Sayer, I. M. (2023). Evaluating the communicative competence of EFL students in Iraqi universities. *Koya University Journal of Humanities and Social Sciences, 6*(1), 185–196.

Chen, X., & Kessler, G. (2023). Chatbots as conversational partners: Impacts on oral fluency and interactional competence. *ReCALL, 35*(3), 317–336.

Chen, X., & Kessler, G. (2023). Chatbots as conversational partners: Impacts on oral fluency and interactional competence. *ReCALL, 35*(3), 317–336. https://doi.org/10.1017/S0958344023000121

Chiu, T. K. F., & Churchill, D. (2022). AI-powered learning analytics in STEAM education: Enhancing communication and collaboration. *British Journal of Educational Technology, 53*(5), 1141–1159.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Dimitriadis, Y., & Martínez-Monés, A. (2022). AI-supported collaboration in STEAM disciplines: A review of tools and practices. *Computers & Education, 186*, 104528.

Fabregat Barrios, S., & Jodar Jurado, R. (2023, published 2024). The keys to developing communicative competence as a school project: A qualitative view from teachers' beliefs. *Education Sciences, 14*(1), 27.

García-Sánchez, I., & Warschauer, M. (2023). ChatGPT for fostering communicative skills: Insights for multilingual classrooms. *Language Teaching Research, 27*(6), 1180–1202.

Guo, F., & Xu, J. (2022). AI-driven problem-based learning for STEAM: Effects on collaboration and communication. *Interactive Learning Environments, 30*(6), 1042–1058.
Habibi, A., et al. (2023). Acceptance of ChatGPT in education: Implications for communication and collaboration skills. *Computers & Education: Artificial Intelligence, 5*, 100163.
Hong, J.-C., & Chen, M.-Y. (2023). AI chatbots in STEAM education: Improving communication through interactive dialogue. *Journal of Computer Assisted Learning, 39*(6), 1523–1539.
Huang, R. H., & Zhou, M. (2022). AI in interdisciplinary STEAM learning: Building students' collaboration and problem-solving capacity. *Educational Technology Research & Development, 70*(5), 2103–2121.
Hwang, G.-J., & Xie, H. (2023). Roles of AI in STEAM education: A systematic review with a focus on communicative outcomes. *Computers & Education, 194*, 104698.
Hwang, G.-J., & Xie, H. (2023). Roles of AI in STEAM education: A systematic review with a focus on communicative outcomes. *Computers & Education, 194*, 104698. https://doi.org/10.1016/j.compedu.2022.104698
Javier, D. R. C., & Moorhouse, B. L. (2023). Developing secondary school English learners' productive and critical communication with ChatGPT. *TESOL Journal, 14*(4), e755.
Kim, J., & Lee, H. (2022). AI-enhanced collaborative writing in STEAM: Impact on communication and creativity. *Language Learning & Technology, 26*(4), 88–103.
Lee, H., & Jin, S. (2023). Measuring communicative intentions and capabilities: Learners' English proficiency as a supplement to willingness to communicate. *English Language Assessment, 18*(1), 97–117.
Li, H., & Wang, Y. (2023). Generative AI for integrated STEAM + language learning: Effects on communicative competence. *Innovation in Language Learning and Teaching, 17*(4), 487–502.
Liu, Q., & Luo, T. (2023). A systematic review of AI chatbots in education: Communication and interaction outcomes. *International Journal of Educational Technology in Higher Education, 20*, 57.
Liu, Q., & Luo, T. (2023). A systematic review of AI chatbots in education: Communication and interaction outcomes. *International Journal of Educational Technology in Higher Education, 20*(1), 57. https://doi.org/10.1186/s41239-023-00448-y
Luo, N., & Li, X. (2023). Informal AI-supported digital learning of English: Communication practices of EFL learners. *Innovation in Language Learning and Teaching, 17*(4), 503–518.
Majumder, M., & Rahman, S. (2023). AI-generated feedback and learners' communicative strategies. *CALICO Journal, 40*(3), 248–271.
Musayeva, A. K. (2023). Formation of professional communicative competence among university students through the use of innovative technologies in classes in the discipline "Culture of Speech and Communication." *International Journal of Pedagogics, 3*(11), 85–89.
Ouyang, Y., & Sun, S. (2023). Prompting ChatGPT to generate communicative tasks: Opportunities for oral proficiency. *ReCALL, 35*(3), 365–382.
Pikhart, M., & Koblížková, A. (2023). AI as a learning partner in EFL classrooms: Perceptions of communicative impact. *Languages, 8*(3), 212.
Qiao, H., & Zhao, A. (2023). *Artificial intelligence-based language learning: Illuminating the impact on speaking skills and self-regulation in Chinese EFL context.Frontiers in Psychology, 14*, 1255594.
Shen, Y., & Li, L. (2023). AI-assisted reading and communicative competence in interdisciplinary learning. *Language Teaching Research, 27*(6), 1125–1149.

Sun, Z., & Wang, W. (2023). AI-generated comprehension and discussion questions: Enhancing communication in classrooms. *Journal of Computer Assisted Learning*, *39*(6), 1620–1638.
Warschauer, M., Tseng, W., Yim, S., Webster, T., Jacob, S., Du, Q., & Tate, T. (2023). Contradictions of AI-generated text for L2 communicative practices. *Journal of Second Language Writing*, *62*, 101071.
Warschauer, M., Tseng, W., Yim, S., Webster, T., Jacob, S., Du, Q., & Tate, T. (2023). The affordances and contradictions of AI-generated text for second language writers. *Journal of Second Language Writing*, *62*, 101071. https://doi.org/10.1016/j.jslw.2023.10107
Zhai, X. (2023). ChatGPT for education: Potentials for developing students' communication and collaboration. *Computers & Education: Artificial Intelligence*, *4*, 100179.