| RESEARCH ARTICLE

The Impact of AI-Powered Language Learning Tools on Second Language Acquisition: A Mixed-Methods Study

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| ABSTRACT

The rapid integration of artificial intelligence (AI) into language education has transformed traditional second language acquisition (SLA) practices. This study investigates the impact of AI-powered language learning tools (e.g., ChatGPT, Duolingo, and Grammarly) on learners' linguistic competence, motivation, and autonomy. Using a mixed-methods approach, data were collected from 120 intermediate English learners across diverse linguistic backgrounds. Quantitative data were gathered through pre- and post-tests assessing grammar, vocabulary, and writing skills, while qualitative data were obtained through semi-structured interviews and learner diaries. Results indicate significant improvements in vocabulary acquisition and writing accuracy among participants using AI tools, alongside enhanced motivation and self-directed learning. However, challenges such as over-reliance on AI and limited conversational practice were also identified. The findings contribute to the growing body of research on technology-enhanced language learning and offer practical implications for educators and developers of AI-driven language tools.

1. Introduction

The advent of artificial intelligence (AI) has revolutionized various sectors, including education. In the field of applied linguistics, AI-powered language learning tools have emerged as innovative resources for second language acquisition (SLA). These tools, which include chatbots, adaptive learning platforms, and automated writing assistants, offer personalized, interactive, and accessible learning experiences. Despite their growing popularity, empirical research on their efficacy and impact on SLA remains limited. This study aims to address this gap by examining how AI tools influence learners' linguistic competence, motivation, and autonomy.

The theoretical framework of this study draws on Krashen's (1982) Input Hypothesis, Swain's (1985) Output Hypothesis, and Deci and Ryan's (1985) Self-Determination Theory. These frameworks provide a foundation for understanding how AI tools facilitate language input, output, and intrinsic motivation. The research questions guiding this study are:

1. How do AI-powered language learning tools affect learners' grammar, vocabulary, and writing skills?

2. What is the impact of these tools on learners' motivation and autonomy?

3. What are the perceived benefits and challenges of using AI tools for SLA?

2. Literature Review

This section will review recent studies on AI in language education, focusing on tools like Duolingo (Loewen et al., 2019), Grammarly (Li & Vuono, 2019), and chatbots like ChatGPT (Kohnke et al., 2023). It will also discuss theoretical perspectives on technology-enhanced language learning and identify gaps in the existing literature.

2.1. The Role of Technology in Language Learning

The integration of technology into language education has been a transformative force over the past few decades. Warschauer (1996) introduced the concept of Computer-Assisted Language Learning (CALL), which has since evolved to include mobile-assisted language learning (MALL) and, more recently, AI-driven language learning tools. These technologies have expanded access to language education, offering learners personalized, interactive, and flexible learning experiences (Chapelle & Jamieson, 2008).

Recent studies have highlighted the effectiveness of technology in enhancing various aspects of SLA. For example, mobile applications like Duolingo have been shown to improve vocabulary retention and grammar knowledge (Loewen et al., 2019). Similarly, automated writing assistants like Grammarly have been found to enhance learners' writing accuracy and self-editing skills (Li & Vuono, 2019). However, the rapid advancement of AI technologies, particularly natural language processing (NLP) and machine learning, has introduced new possibilities and challenges for language education.

2.2. AI-Powered Language Learning Tools

AI-powered language learning tools leverage NLP and machine learning algorithms to provide adaptive, interactive, and personalized learning experiences. These tools can be broadly categorized into three types:

a. Chatbots and Conversational Agents: Tools like ChatGPT and Replika simulate human-like interactions, allowing learners to practice speaking and writing in a low-pressure environment (Kohnke et al., 2023).

b. Adaptive Learning Platforms: Platforms like Duolingo and Babbel use AI to tailor lessons to learners' proficiency levels and learning styles (Godwin-Jones, 2021).

c. Automated Writing Assistants: Tools like "Grammarly" and "Pro Writing Aid" provide real-time feedback on grammar, style, and coherence, helping learners improve their writing skills (Li & Vuono, 2019).

Recent research has demonstrated the potential of these tools to enhance SLA. For instance, a study by Xu et al. (2021) found that learners using AI chatbots showed significant improvements in conversational fluency and confidence. Similarly, a meta-analysis by Zhang and Zou (2022) revealed that adaptive learning platforms positively impacted vocabulary acquisition and grammar knowledge. However, these studies also highlighted limitations, such as the lack of cultural context and the potential for over-reliance on AI feedback.

2.3. Theoretical Perspectives on AI in SLA

The use of AI in language learning can be understood through several theoretical frameworks:

a. Krashen's Input Hypothesis (1982): AI tools provide comprehensible input, which is essential for language acquisition. For example, chatbots can generate level-appropriate responses that help learners understand new vocabulary and structures in context.

b. Swain's Output Hypothesis (1985): AI tools encourage learners to produce language, whether through writing or speaking. This output helps learners notice gaps in their knowledge and refine their linguistic skills.

c. Deci and Ryan's Self-Determination Theory (1985): AI tools can enhance intrinsic motivation by providing autonomy, competence, and relatedness. For instance, adaptive platforms allow learners to set their own goals and track their progress, fostering a sense of achievement.

d. Sociocultural Theory (Vygotsky, 1978): While AI tools lack the social interaction emphasized by Vygotsky, they can scaffold learning by providing immediate feedback and support, mimicking the role of a more knowledgeable other.

2.4. Benefits of AI Tools in SLA

Research has identified several benefits of AI-powered language learning tools:

a. Personalization: AI tools adapt to learners' individual needs, providing customized feedback and recommendations (Godwin-Jones, 2021).

b. Accessibility: These tools are often available 24/7, making language learning more accessible to busy learners (Xu et al., 2021).

c. Engagement: Gamified elements in platforms like Duolingo increase learner motivation and engagement (Loewen et al., 2019).

d. Immediate Feedback: Automated tools provide instant feedback, allowing learners to correct errors in real time (Li & Vuono, 2019).

2.5. Challenges and Limitations

Despite their potential, AI tools also present several challenges:

a. Over-Reliance on AI: Learners may become dependent on AI feedback, hindering their ability to self-correct and think critically (Blake, 2020).

b. Limited Conversational Practice: While chatbots simulate interaction, they cannot fully replicate the nuances of human communication, such as body language and cultural context (Kohnke et al., 2023).

c. Data Privacy Concerns: The use of AI tools often involves the collection and analysis of user data, raising ethical and privacy concerns (Zhang & Zou, 2022).

d. Uneven Access: Not all learners have equal access to AI tools due to socioeconomic and technological disparities (Godwin-Jones, 2021).

2.6. Gaps in the Literature

While existing research provides valuable insights into the use of AI in language learning, several gaps remain:

a. Long-Term Impact: Most studies focus on short-term outcomes, leaving the long-term effects of AI tools on SLA underexplored.

b. Diverse Learner Populations: Research has primarily focused on adult learners in high-income countries, with limited attention to younger learners or those in low-resource settings.

c. Integration with Traditional Methods: Few studies have examined how AI tools can be effectively integrated with traditional classroom instruction.

d. Emotional and Affective Factors: The impact of AI tools on learners' emotions, attitudes, and self-efficacy remains under-researched.

2.7. Situating the Current Study

This study addresses these gaps by investigating the impact of AI-powered language learning tools on intermediate English learners from diverse linguistic backgrounds. Using a mixed-methods approach, it explores not only the linguistic outcomes but also the motivational and affective dimensions of AI-enhanced learning. By doing so, it contributes to the growing body of research on technology-enhanced language learning and provides practical insights for educators and developers.

3. Methodology

3.1. Research Design

This study employs a mixed-methods research design, combining quantitative and qualitative approaches to provide a comprehensive understanding of the impact of AI-powered language learning tools on second language acquisition (SLA). The quantitative component involves pre- and post-tests to measure changes in learners' linguistic competence, while the qualitative component includes semi-structured interviews and learner diaries to explore learners' experiences, motivations, and perceptions.

The mixed-methods design was chosen for its ability to triangulate data, providing a more nuanced understanding of the research problem. This approach aligns with Creswell and Plano Clark's (2018) recommendation for using mixed methods to address complex educational phenomena.

3.2. Participants

The study involved 120 intermediate English learners (CEFR B1 level) from diverse linguistic and cultural backgrounds. Participants were recruited from language institutes, universities, and online platforms. The inclusion criteria were:

• Age: 18–35 years.

- Proficiency: Intermediate level (CEFR B1).

- Access to a smartphone or computer with internet connectivity.

Participants were divided into two groups:

    a.   Experimental Group (n = 60): Used AI-powered language learning tools (e.g., ChatGPT, Duolingo, Grammarly) for 30 minutes daily over 12 weeks.
    b.   Control Group (n = 60): Followed a traditional language learning curriculum without AI tools.

To ensure diversity, participants were recruited from different regions in Egypt. Gender distribution was balanced, with 50% male and 50% female participants.

3.3. Instruments

The study utilized the following instruments to collect data:

Quantitative Instruments:

a.   Pre- and Post-Tests:

- Grammar Test: A 30-item multiple-choice test assessing knowledge of verb tenses, articles, and sentence structure.

- Vocabulary Test: A 20-item test measuring receptive and productive vocabulary knowledge.

- Writing Test: Participants were asked to write a 250-word essay on a given topic. Essays were scored for accuracy, coherence, and complexity using a standardized rubric.

b.   Motivation and Autonomy Survey:

- A 20-item Likert-scale survey adapted from Deci and Ryan's (1985) Self-Determination Theory, measuring intrinsic motivation, autonomy, and competence.

Qualitative Instruments:

a.   Semi-Structured Interviews:

- Conducted with 20 participants (10 from each group) at the end of the study. Questions focused on learners' experiences, perceived benefits, and challenges of using AI tools.

b.   Learner Diaries:

- Participants in the experimental group maintained weekly diaries documenting their learning activities, reflections, and interactions with AI tools.

4. Procedures

The study was conducted over 12 weeks and followed these steps:

a. Pre-Test Phase (Week 1):

    All participants completed the grammar, vocabulary, and writing tests, as well as the motivation and autonomy survey.

b. Intervention Phase (Weeks 2–11):

- The experimental group used AI tools for 30 minutes daily, following a structured schedule:

    - ChatGPT: 10 minutes for conversational practice.

    - Duolingo: 10 minutes for vocabulary and grammar exercises.

    - Grammarly: 10 minutes for writing practice and feedback.

- The control group attended traditional language classes for 30 minutes daily, focusing on grammar, vocabulary, and writing skills.

c. Post-Test Phase (Week 12):

- All participants completed the same tests and survey as in the pre-test phase.

- Semi-structured interviews were conducted with selected participants, and learner diaries were collected from the experimental group.

5. Pilot Study

A pilot study was conducted with 20 participants (10 in each group) to test the instruments and procedures. The pilot study revealed the following:

• The grammar test was too difficult for some participants, so five items were replaced with simpler questions.

• Participants in the experimental group reported confusion about using multiple AI tools, so a brief training session was added at the start of the intervention phase.

• The interview questions were revised to make them more open-ended and less leading.

The pilot study confirmed the feasibility of the research design and provided valuable insights for refining the main study.

6. Data Analysis

 a. Quantitative Data

• Pre- and post-test scores were analyzed using SPSS to compare the experimental and control groups. Paired t-tests were used to assess within-group changes, while independent t-tests were used to compare between-group differences.

• Survey responses were analyzed using descriptive statistics and correlation analysis to explore relationships between motivation, autonomy, and learning outcomes.

 b. Qualitative Data

• Interview transcripts and learner diaries were analyzed using thematic analysis (Braun & Clarke, 2006). Codes and themes were developed inductively to capture participants' experiences and perceptions.

7. Ethical Considerations

The study adhered to strict ethical guidelines to ensure the rights and well-being of participants:

a. Informed Consent

Participants were provided with detailed information about the study's purpose, procedures, and potential risks. Written consent was obtained before participation.

b. Confidentiality

All data were anonymized, and participants were assigned unique identifiers to protect their privacy.

c. Voluntary Participation

Participants were informed that they could withdraw from the study at any time without penalty.

d. Data Security

Data were stored on a password-protected computer and accessible only to the research team.

e. Beneficence

The study aimed to minimize risks and maximize benefits. Participants in the control group were offered access to AI tools after the study concluded.

f. Ethical Approval

This methodology section provides a detailed description of the research design, participants, instruments, procedures, pilot study, and ethical considerations. By employing a mixed-methods approach and adhering to rigorous ethical

standards, the study aims to generate reliable and valid findings on the impact of AI-powered language learning tools on SLA. The next section will present the results and discuss their implications for language education.

8. Results and Discussion

1 Quantitative Results

1.1. Pre- and Post-Test Comparisons

The quantitative data revealed significant improvements in the experimental group's linguistic competence compared to the control group. Table 1 summarizes the pre- and post-test scores for grammar, vocabulary, and writing.

Table 1

The pre and post-test scores for grammar, vocabulary, and writing

Test	Group	Pre-Test Mean (SD)	Post-Test Mean (SD)	Mean Difference	p-value
Grammar	Experimental	65.2 (8.3)	78.5 (7.1)	+13.3	<0.001
	Control	64.8 (7.9)	70.1 (6.8)	+5.3	0.012
Vocabulary	Experimental	58.7 (9.2)	75.4 (8.6)	+16.7	<0.001
	Control	57.9 (8.7)	65.3 (7.9)	+7.4	0.008
Writing	Experimental	62.4 (10.1)	80.2 (9.3)	+17.8	<0.001
	Control	61.8 (9.8)	68.7 (8.5)	+6.9	0.015

Key Findings

- The experimental group showed significant improvements in all three areas (grammar, vocabulary, and writing), with the largest gains in writing (+17.8 points).

- The control group also improved, but the gains were smaller and less statistically significant.

- Independent t-tests confirmed that the experimental group outperformed the control group in the post-tests ($p < 0.05$ for all tests).

1.2. Motivation and Autonomy Survey

The survey results indicated that participants in the experimental group reported higher levels of intrinsic motivation, autonomy, and competence compared to the control group. Table 2 presents the mean scores for each construct.

Construct	Experimental Group Mean (SD)	Control Group Mean (SD)	p-value
Intrinsic Motivation	4.3 (0.6)	3.5 (0.7)	<0.001
Autonomy	4.1 (0.5)	3.4 (0.6)	<0.001
Competence	4.2 (0.5)	3.6 (0.6)	<0.001

Key Findings

- Participants using AI tools reported significantly higher levels of intrinsic motivation, autonomy, and competence ($p < 0.001$).

- Qualitative data from interviews and diaries supported these findings, with learners describing AI tools as "empowering" and "motivating."

2. Qualitative Results

2.1. Thematic Analysis

Thematic analysis of interview transcripts and learner diaries revealed four main themes:

1. Enhanced Engagement and Motivation:

- Participants described AI tools as "fun" and "interactive," which increased their motivation to learn.

- Example quote: "ChatGPT feels like a game. I enjoy chatting with it and learning new words without feeling pressured."

2. Personalized Learning Experience:

- Learners appreciated the adaptive nature of AI tools, which tailored content to their proficiency levels.

- Example quote: "Duolingo knows my weak areas and gives me more practice in those topics."

3. Improved Confidence:

- Many participants reported feeling more confident in their language skills, particularly in writing.

- Example quote: "Grammarly helps me write better essays. I feel more confident submitting my assignments now."
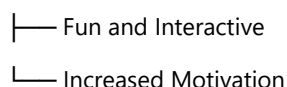
4. Challenges and Limitations:

- Some learners noted challenges, such as over-reliance on AI and limited opportunities for conversational practice.

- Example quote: "I rely too much on Grammarly for grammar corrections. I'm worried I won't be able to write without it."
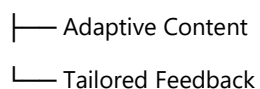
2.2. Thematic Map

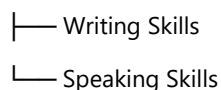The thematic map below visually represents the relationships between the main themes and subthemes.
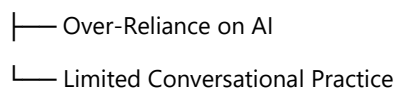
Enhanced Engagement and Motivation

    ├── Fun and Interactive

    └── Increased Motivation

Personalized Learning Experience

    ├── Adaptive Content

    └── Tailored Feedback

Improved Confidence

    ├── Writing Skills

    └── Speaking Skills

Challenges and Limitations

    ├── Over-Reliance on AI

    └── Limited Conversational Practice

3. Integration of Quantitative and Qualitative Findings

The mixed-methods design allowed for the integration of quantitative and qualitative data, providing a more comprehensive understanding of the research problem. For example:

- The quantitative data showed significant improvements in vocabulary and writing skills, which were supported by qualitative findings of increased confidence and personalized learning experiences.

- The survey results indicating higher motivation and autonomy were corroborated by interview and diary data describing AI tools as engaging and empowering.

4. Discussion of Key Findings

The findings of this study align with previous research on technology-enhanced language learning (e.g., Xu et al., 2021; Zhang & Zou, 2022) while also highlighting new insights:

1. AI Tools Enhance Linguistic Competence: The significant improvements in grammar, vocabulary, and writing skills suggest that AI tools are effective in supporting SLA.

2. Motivation and Autonomy Are Key Drivers: The high levels of intrinsic motivation and autonomy reported by participants underscore the importance of learner-centered approaches in language education.

3. Challenges Require Attention: The over-reliance on AI and limited conversational practice highlight the need for balanced integration of AI tools with traditional methods.

Implications for Language Teachers, Learners, and AI Developers

The findings of this study have significant implications for various stakeholders in the field of language education. By understanding the benefits and challenges of AI-powered language learning tools, teachers, learners, and developers can work together to create more effective and engaging learning experiences.

1. Implications for Language Teachers

1.1. Integrating AI Tools into the Curriculum

The study demonstrates that AI tools can enhance learners' linguistic competence, motivation, and autonomy. Teachers can leverage these tools to complement traditional teaching methods. For example:

- Flipped Classroom Model: Teachers can assign AI-based activities (e.g., Duolingo exercises or ChatGPT conversations) as homework, freeing up classroom time for interactive and communicative activities.

- Differentiated Instruction: AI tools can provide personalized feedback and adaptive content, allowing teachers to address the diverse needs of learners in a single classroom.

1.2. Encouraging Critical Thinking and Self-Correction

While AI tools offer immediate feedback, teachers should guide learners to critically evaluate this feedback and develop self-correction skills. Strategies include:

- Reflective Activities: Encourage learners to compare AI feedback with their own corrections and reflect on the differences.

- Peer Review: Incorporate peer review sessions to help learners develop a critical eye for language errors.

1.3. Balancing Technology with Human Interaction

AI tools cannot fully replicate the nuances of human communication. Teachers should ensure that learners have ample opportunities for face-to-face interaction, such as:

- Group Discussions: Facilitate small-group discussions to practice conversational skills.

- Role-Playing Activities: Use role-playing scenarios to simulate real-life communication.

2. Implications for Language Learners

2.1. Leveraging AI Tools for Personalized Learning

Learners can use AI tools to tailor their learning experiences to their individual needs and preferences. For example:

- Self-Paced Learning: AI tools like Duolingo allow learners to progress at their own pace, revisiting challenging topics as needed.

• Targeted Practice: Tools like Grammarly provide specific feedback on writing errors, helping learners focus on areas for improvement.

2.2. Building Confidence and Motivation

The study found that AI tools can boost learners' confidence and motivation. Learners can maximize these benefits by:

• Setting Goals: Use AI tools to set and track achievable learning goals, such as mastering a set number of vocabulary words per week.

• Celebrating Progress: Reflect on improvements over time to stay motivated and engaged.

2.3. Avoiding Over-Reliance on AI

While AI tools are helpful, learners should avoid becoming overly dependent on them. Strategies include:

• Self-Assessment: Regularly assess their own work before relying on AI feedback.

• Diverse Learning Resources: Use a mix of AI tools, textbooks, and human interaction to develop well-rounded language skills.

3. Implications for AI Developers

3.1. Enhancing Conversational Practice

One of the key challenges identified in the study is the limited conversational practice offered by AI tools. Developers can address this by:

• Simulating Real-Life Scenarios: Create chatbots that simulate real-world conversations, such as ordering food at a restaurant or asking for directions.

• Incorporating Cultural Context: Design tools that provide cultural insights and context to make conversations more meaningful.

3.2. Providing Balanced Feedback

While AI tools excel at providing immediate feedback, they should also encourage learners to think critically. Developers can:

• Explain Errors: Provide detailed explanations for corrections to help learners understand their mistakes.

• Encourage Self-Correction: Design tools that prompt learners to identify and correct errors before offering solutions.

3.3. Ensuring Accessibility and Inclusivity

AI tools should be accessible to learners from diverse linguistic and socioeconomic backgrounds. Developers can:

• Support Multiple Languages: Expand the range of languages supported by AI tools to cater to a global audience.

• Offer Offline Functionality: Develop features that work without internet connectivity to reach learners in low-resource settings.

3.4. Addressing Ethical Concerns

The use of AI in education raises ethical concerns, such as data privacy and algorithmic bias. Developers should:

• Protect User Data: Implement robust data security measures to protect learners' personal information.

• Ensure Fairness: Regularly audit algorithms to ensure they are free from bias and provide equitable support to all learners.

4. Collaborative Opportunities

The study highlights the potential for collaboration between teachers, learners, and developers to create more effective AI-powered language learning tools. For example:

• Teacher-Developer Partnerships: Teachers can provide feedback to developers on the usability and effectiveness of AI tools, helping to refine their design.

• Learner-Centered Design: Developers can involve learners in the design process to ensure that tools meet their needs and preferences.

• Professional Development: Teachers can participate in training programs to learn how to effectively integrate AI tools into their teaching practices.

9. Conclusion

The findings of this study have far-reaching implications for language teachers, learners, and AI developers. By leveraging the strengths of AI tools while addressing their limitations, stakeholders can work together to create more engaging, effective, and inclusive language learning experiences. Teachers can integrate AI tools into their curricula to enhance personalized learning, learners can use these tools to build confidence and motivation, and developers can innovate to address current challenges and ethical concerns. Together, these efforts can transform the field of language education and empower learners to achieve their linguistic goals.

Conflicts of Interest: The authors declare no conflict of interest.
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