Interdisciplinary Journal of Linguistics
Volume [18] 2025, 163-170

Efficacy of AI-Powered Adaptive Learning Systems in Enhancing Grammar Acquisition for Arab Learners of English: An Empirical Study

Javed Ahmad*
Mohsin Razza Khan**
Basim Hamdan Ibrahim ***
Kana'an****

Abstract

The challenge of mastering English grammar, particularly the verb tense system, is a well-documented hurdle for Arab learners. This study investigates the efficacy of an AI-powered adaptive learning platform in improving grammar accuracy compared to traditional teacher-led instruction. A quasi-experimental design was employed with 60 intermediate-level Arab ESL learners, divided into an experimental group (using an AI platform) and a control group (receiving standard instruction). Pre-tests and post-tests assessed proficiency in five key grammatical structures: simple present, present continuous, simple past, present perfect, and future tenses. Results, analyzed using a paired samples t-test, indicated a statistically significant improvement ($p < 0.01$) in the experimental group's post-test scores, with a mean increase of 22.5 points compared to 10.3 points in the control group. Furthermore, data from the AI platform's analytics revealed a correlation between the number of adaptive review cycles and final test performance. The study concludes that AI-driven, personalized learning pathways offer a potent method for addressing the persistent grammatical difficulties faced by Arab learners, recommending the integration of such tools as a supplement to traditional classroom teaching.

Keywords: AI in Education, ESL for Arab Learners, Adaptive Learning, Grammar Acquisition, Educational Technology, Empirical Study, Second Language Acquisition

1. Introduction

The global dominance of English has made its mastery a critical skill for academic and professional success in the Arab world. However,

* King Khalid University, KSA; jawed@kku.edu.sa
** King Khalid University, KSA; ncoka@kku.edu.sa
*** King Khalid University, KSA; mokhan@kku.edu.sa
**** King Khalid University, KSA; bkanan@kku.edu.sa

the process of teaching and learning English in Arab countries is fraught with challenges, many stemming from the profound linguistic differences between Arabic and English (Al-Jarf, 2021). These differences are particularly acute in the realm of grammar, where concepts such as verb conjugation, tense consistency, and the use of auxiliaries present significant hurdles. Arabic, a Semitic language, operates on a root-and-pattern system with a fundamentally different approach to expressing time and aspect, leading to frequent and systematic errors in English production (Kharma & Hajjaj, 1997; Scott & Tucker, 2019).

Traditional pedagogical methods, often reliant on rote memorization and teacher-centered instruction, have shown limited success in overcoming these deeply ingrained interferences. The one-size-fits-all approach fails to address the individual learning pace and specific error patterns of each student (Ellis, 2008). In recent years, Artificial Intelligence (AI) has emerged as a transformative force in education, promising personalized and adaptive learning experiences (Luckin et al., 2016). AI-powered platforms can diagnose a learner's weaknesses in real-time, provide immediate corrective feedback, and dynamically adjust the difficulty and focus of subsequent exercises.

This study posits that such AI-driven personalization is uniquely suited to tackle the grammatical challenges faced by Arab learners. While theoretical discussions on AI in education are abundant, there is a scarcity of empirical research measuring its direct impact on specific learner populations with distinct linguistic backgrounds (Zawacki-Richter et al., 2019). This paper aims to fill that gap by addressing the following research questions:

1. Is there a statistically significant difference in grammar acquisition between Arab learners using an AI-powered adaptive learning system and those receiving only traditional instruction?
2. What is the relationship between learner engagement with the AI system (measured by completed exercises and review cycles) and improvement in grammatical accuracy?

2. Literature Review

2.1. Grammatical Challenges for Arab Learners

The grammatical divergence between Arabic and English is a primary source of difficulty. Key areas of struggle identified in the literature include:

- **Verb Tenses:** The Arabic tense system is simpler, often distinguished primarily between past and non-past. This leads to confusion with English compound tenses like the present perfect (e.g., "I have eaten" vs. "I ate") and the misuse of continuous forms (e.g., "I am understanding the lesson") (Mourtaga, 2004; Alzu'bi, 2015).

- **Subject-Verb Agreement:** The concept is less rigid in Arabic, resulting in errors such as "He go to school" (Alsamadani, 2017).
- **Prepositions:** The mapping of prepositions between the two languages is rarely one-to-one, causing errors like "I am good in English" instead of "I am good at English" (Ghani, 2018).

2.2. AI and Adaptive Learning in Language Education

Adaptive learning systems use algorithms to tailor educational content to the needs of individual learners. In language learning, these systems can analyse a student's responses to identify patterns of error and then serve up customized practice exercises targeting those specific weaknesses (Zawacki-Richter et al., 2019). AI enhances this by incorporating Natural Language Processing (NLP) to provide nuanced feedback on writing and speaking, moving beyond simple multiple-choice corrections (Chassignol et al., 2018).

Previous studies have shown the general effectiveness of Computer-Assisted Language Learning (CALL). However, the current generation of AI-driven platforms represents a qualitative leap from earlier, static CALL software (Bax, 2003). They offer a dynamic, responsive learning environment that can, in theory, provide the intensive, personalized practice needed to restructure a learner's interlanguage grammar, a concept central to second language acquisition theory (Ellis, 2008). The principles of spaced repetition and retrieval practice, which are strongly supported by cognitive science (Kang, 2016), can be seamlessly embedded and automated within these AI systems, making them ideal for mastering difficult grammatical structures.

3. Methodology

3.1. Research Design

A quasi-experimental pre-test/post-test control group design was employed. This design was chosen to compare the outcomes of two different instructional interventions under controlled conditions, a standard approach in educational technology research (Creswell & Creswell, 2018).

3.2. Participants

A sample of 60 intermediate-level Arab learners of English (aged 18-25) was recruited from a university foundation program. Participants were randomly assigned to one of two groups:

- **Experimental Group (n=30):** Received instruction supplemented with use of the "LinguaBot AI" adaptive learning platform for 30 minutes daily, three times a week.
- **Control Group (n=30):** Received only the standard, teacher-led grammar instruction for the same duration and frequency.

All participants had a comparable initial proficiency level, as confirmed by a placement test and the pre-study grammar test.

3.3. Instrument and Procedure

The study was conducted over an 8-week period.

- **Pre-test:** All participants completed a 50-item grammar test focusing on the five target structures: simple present, present continuous, simple past, present perfect, and future tenses. The test included multiple-choice, error identification, and sentence completion items, designed based on common error patterns outlined by Al-Jarf (2021) and Mourtaga (2004).
- **Intervention:** The control group attended traditional classes involving explicit rule explanation, group work, and textbook exercises, a methodology still prevalent in many Arab EFL contexts (Al-Mekhlafi, 2011). The experimental group attended the same classes but also used the "LinguaBot AI" platform. This platform provided initial diagnostic tests, generated personalized exercise sets, offered instant feedback with explanations, and forced review of previously missed concepts, embodying the adaptive learning principles described by Chassignol et al. (2018).
- **Post-test:** At the end of the 8 weeks, all participants took a parallel-form post-test identical in structure and difficulty to the pre-test.
- **Data Collection:** The AI platform logged user data, including the number of exercises completed and the number of "adaptive review cycles" triggered for each learner.

3.4. Data Analysis

Pre-test and post-test scores were analysed using a paired samples t-test to determine the statistical significance of the improvement within each group. An independent samples t-test was used to compare the post-test scores between the two groups. Data from the AI platform was analysed using Pearson's correlation to examine the relationship between engagement metrics and learning gains. The alpha level for statistical significance was set at $p < 0.05$.

4. Results and Discussion

4.1. Quantitative Results

The pre-test and post-test scores for both groups are summarized in Table 1.

Group	Pre-test Mean (SD)	Post-test Mean (SD)	Mean Gain
Experimental (AI)	58.4 (5.2)	80.9 (4.8)	**+22.5**
Control (Traditional)	57.9 (5.5)	68.2 (5.1)	**+10.3**

Table 1. Pre-test and Post-test Score Comparison (out of 100)

A paired-samples t-test revealed that the improvement within the experimental group was statistically significant, $t(29) = 15.32$, $p < .001$. The improvement in the control group was also significant, $t(29) = 8.45$, $p < .001$, but the magnitude of gain was substantially smaller. An independent samples t-test confirmed that the post-test scores of the experimental group were significantly higher than those of the control group, $t(58) = 10.11$, $p < .001$.

Participant ID	Exercises Completed	Adaptive Review Cycles	Post-test Score
EXP-01	245	18	85
EXP-02	198	12	78
EXP-03	310	25	92
...	...	...	...
EXP-30	225	15	81
Correlation (r)	**0.75**	**0.82**	-

Table 2. AI Platform Engagement vs. Post-test Score (Experimental Group Only)

Analysis of the AI platform data (Table 2) showed a strong positive correlation between the number of adaptive review cycles a learner completed and their final post-test score ($r = 0.82$, $p < .001$). The correlation between the total number of exercises and the post-test score was also positive and strong ($r = 0.75$, $p < .001$).

4.2. Discussion

The results provide a clear affirmative answer to the first research question. The significantly greater improvement of the experimental group demonstrates that supplementing traditional instruction with an AI-powered adaptive learning system is more effective for grammar acquisition than traditional instruction alone. The AI system's ability to provide unlimited, personalized practice and immediate feedback appears to have accelerated the learning process and led to greater internalization of the target grammatical rules, supporting the theories of personalized learning espoused by Luckin et al. (2016).

The findings related to the second research question are equally compelling. The strong correlation between adaptive review cycles and post-test performance suggests that the system's core adaptive mechanic—revisiting and retesting problematic concepts—is a key driver of its efficacy. This aligns with the pedagogical principles of deliberate practice (Ericsson et al., 1993) and the spacing effect (Kang, 2016), which are difficult to implement consistently in a heterogeneous classroom setting. The AI system automates and personalizes this process, ensuring that learners repeatedly practice their specific weaknesses until mastery is achieved, directly addressing the fossilization of common errors noted by Al-Mekhlafi (2011).

5. Conclusion and Implications

This empirical study provides robust evidence that AI-powered adaptive learning systems are a highly effective tool for teaching English grammar to Arab learners. By offering personalized pathways, instant feedback, and forced review of challenging concepts, these systems directly address the limitations of traditional, one-size-fits-all pedagogy.

The implications for ESL instructors and curriculum designers in the Arab world are significant. AI should not be viewed as a replacement for teachers but as a powerful supplement that can free up classroom time for more communicative, interactive activities. Teachers can leverage these tools to identify common class-wide issues from the aggregated data while the system handles individualized skill-and-drill practice.

5.1. Limitations and Future Research

This study was limited to grammar acquisition and a specific intermediate-level learner profile. Future research should investigate the impact of AI on other skills like writing and speaking, explore its effectiveness with beginner and advanced learners, and conduct longitudinal studies to assess long-term retention. Furthermore, studying the integration models of AI tools within a blended learning framework would be highly valuable for practical applications.

References

Al-Jarf, Reima. "Learning English Grammar Online by Arab ESL Freshmen: Difficulties and Solutions." *Journal of English Language Teaching and Applied Linguistics*, vol. 3, no. 4, 2021, pp. 1-11.

Al-Mekhlafi, A. M. "The Difficulties of Learning English Grammar in the Arab EFL Context: A Case Study of UAE High School Students." *Journal of Education and Practice*, vol. 2, no. 4, 2011, pp. 34-52.

Alsamadani, H. A. "The Effect of Explicit Instruction of English Tenses on Arab ESL Students' Writing Accuracy." *International Journal of Education and Literacy Studies*, vol. 5, no. 3, 2017, pp. 1-7.

Alzu'bi, Mohammad Akram. "The Most Common Grammatical Errors Made by Undergraduate EFL Learners at Al-Balqa Applied University." *International Journal of English Language and Linguistics Research*, vol. 3, no. 6, 2015, pp. 12-33.

Bax, Stephen. "CALL—Past, Present, and Future." *System*, vol. 31, no. 1, 2003, pp. 13-28.

Chassignol, Maëlis, et al. "Artificial Intelligence Trends in Education: A Narrative Overview." *Procedia Computer Science*, vol. 136, 2018, pp. 16-24.

Creswell, John W., and J. David Creswell. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 5th ed., SAGE Publications, 2018.

Ellis, Rod. *The Study of Second Language Acquisition*. 2nd ed., Oxford UP, 2008.

Ericsson, K. Anders, et al. "The Role of Deliberate Practice in the Acquisition of Expert Performance." *Psychological Review*, vol. 100, no. 3, 1993, pp. 363-406.

Ghani, Miloud A. "A Study of the Errors Made by Arab EFL Learners in the Use of Prepositions." *International Journal of Applied Linguistics and English Literature*, vol. 7, no. 6, 2018, pp. 188-194.

Kang, Sean H. K. "Spaced Repetition Promotes Efficient and Effective Learning: Policy Implications for Instruction." *Policy Insights from the Behavioral and Brain Sciences*, vol. 3, no. 1, 2016, pp. 12-19.

Kharma, Nayef, and Ali Hajjaj. *Errors in English among Arabic Speakers: Analysis and Remedy*. Longman, 1997.

Luckin, Rose, et al. *Intelligence Unleashed: An Argument for AI in Education*. Pearson Education, 2016.

Mourtaga, Kamal R. "Some Problems Facing Arab Learners of English." *Journal of Al-Aqsa University*, vol. 8, 2004, pp. 75-87.

Scott, Mike, and G. Richard Tucker. *Error Analysis and English-Language Strategies of Arab Students*. ERIC, 2019.

Zawacki-Richter, Olaf, et al. "Systematic Review of Research on Artificial Intelligence Applications in Higher Education – Where are the Educators?" *International Journal of Educational Technology in Higher Education*, vol. 16, no. 39, 2019, pp. 1-27.

Appendix A: Sample Grammar Test Items (Pre-test/Post-test)

Section 1: Multiple Choice

Choose the correct verb form to complete the sentence.

1. She _____ to the market every day.

   (a) Go
   (b) Goes
   (c) (c) is going
   (d) (d) went

2. I _____ my homework yet.

   (a) didn't finish

   (b) haven't finished

(c) don't finish

(d) am not finishing

Section 2: Error Identification

Identify the error in the following sentence.

3. He is play football right now.

   A | B | C | D

4. They have lived in Dubai since five years.

   A | B | C | D

Section 3: Sentence Completion

Complete the sentence with the correct form of the verb in parentheses.

5. Last year, we _____ (travel) to Egypt.
6. Look! It _____ (rain) outside.

Appendix B: Sample Data Log from "LinguaBot AI" Platform

Timestamp	User ID	Exercise Type	Target Grammar	User Answer	Correct Answer	Adaptive Review Triggered?
2023-10-26 14:05:12	EXP-15	Fill-in-the-blank	Present Perfect	I have saw	I have seen	Yes
2023-10-26 14:07:30	EXP-15	Multiple Choice	Present Perfect	...	...	No
2023-10-27 09:15:01	EXP-15	Review Exercise	Present Perfect	I have seen	I have seen	No (Concept Mastered)