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Integration of Artificial Intelligence and Big Data in Arabic Language Learning: A New Paradigm for Personalization

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ABSTRACT

Background. The integration of Artificial Intelligence (AI) and Big Data in education holds the promise of personalizing learning experiences and improving learning outcomes. The Arabic language, with its unique linguistic structure and complexities, poses specific challenges that these technologies could address. This study explores how AI and Big Data can be leveraged to enhance Arabic language learning, focusing on their potential to improve personalization and effectiveness across both formal and informal learning environments.

Purpose. This research aims to investigate the impact of AI and Big Data on Arabic language learning, with an emphasis on the personalization of learning experiences and the enhancement of learning outcomes in both formal and informal educational settings.

Method. A mixed-methods approach was employed, involving students from schools, universities, and language learning centers. Participants were divided into two groups: an experimental group utilizing AI and Big Data tools, and a control group relying on traditional teaching methods. Data were collected through pre- and post-test assessments, surveys, and interviews to evaluate learning outcomes and levels of student engagement.

Results. The findings indicate a notable improvement in learning outcomes in both formal and informal settings. In formal learning environments, students demonstrated a 22% increase in test scores, while in informal settings, the increase was 18%. Engagement levels were higher in formal settings, with 85% of learners reporting high involvement, compared to 75% in informal settings.

Conclusion. AI and Big Data significantly enhance Arabic language learning, particularly in formal educational contexts. The study underscores the importance of tailoring AI and Big Data applications to suit different learning environments for optimal effectiveness. These technologies offer a promising avenue for improving both the personalization and efficacy of language learning.

KEYWORDS

Arabic language learning, Artificial Intelligence, Big Data, Educational Technology, Personalization

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INTRODUCTION

Artificial Intelligence (AI) and Big Data have revolutionized various fields, including education, by providing tools that enhance learning experiences through personalization. In language learning, AI can adapt to individual learners' needs, offering tailored content and feedback (Jiang, 2021; Ma, 2021).

Big Data analytics can process vast amounts of information to identify learning patterns and predict learner behavior, enabling more effective educational strategies (Liu, 2022).

Arabic, as one of the most widely spoken languages in the world, presents unique challenges and opportunities for language learners. Traditional methods of teaching Arabic often face limitations due to the complexity of the language, its script, and its diverse dialects (Abdelhadi, 2020). AI-driven tools can help overcome these challenges by offering customized learning paths that cater to the unique needs of each learner, whether they are learning Modern Standard Arabic or specific regional dialects (Abdelhalim, 2020).

Several AI-based language learning applications already demonstrate the potential of this technology. These applications use natural language processing (NLP) to provide instant feedback on pronunciation, grammar, and vocabulary usage (Abourehab, 2023). Machine learning algorithms analyze user data to create personalized lesson plans and exercises. Such tools can significantly improve the efficiency and effectiveness of language acquisition, making learning more engaging and less daunting (Ainin, 2020).

Big Data plays a crucial role in enhancing AI-driven language learning tools. By analyzing data from millions of learners, educators can gain insights into common learning difficulties and preferences. This information can be used to develop more effective teaching materials and methods (Hu, 2022). For example, data analysis might reveal that learners struggle with certain grammatical structures or vocabulary sets, prompting the creation of targeted exercises and resources to address these challenges (Luo, 2021).

The integration of AI and Big Data also allows for continuous assessment and adaptation. Learners can receive real-time updates on their progress, with the system adjusting the difficulty level and focus areas based on their performance (AlAjmi, 2022). This dynamic approach ensures that learners remain challenged without becoming overwhelmed, maintaining their motivation and interest in the language learning process (Ghani, 2022).

While the potential benefits of AI and Big Data in language learning are significant, their application in Arabic language education is still in its early stages. More research and development are needed to fully realize their potential and address any challenges related to data privacy, algorithm bias, and accessibility. As these technologies continue to evolve, they hold the promise of transforming Arabic language learning into a more personalized, efficient, and enjoyable experience (Ahsanuddin dkk., 2023; Alotaibi, 2019).

The long-term impact of AI and Big Data on Arabic language learning outcomes remains largely unexplored. While short-term improvements have been observed, the sustainability of these gains over extended periods needs thorough investigation (Alharithi, 2023). There is limited understanding of how these technologies can continuously adapt to evolving learner needs and preferences over time (Al-Shemary, 2020) .

The specific elements of AI-driven tools that most effectively enhance Arabic language acquisition are not fully understood. It is unclear which features, such as personalized feedback, adaptive learning paths, or interactive exercises, contribute most significantly to learning success. Identifying these key components will help in designing more targeted and effective educational applications (Alakrot, 2021).

The scalability of AI and Big Data solutions for Arabic language learning across diverse educational contexts has not been comprehensively studied. The effectiveness of these tools in resource-limited settings and their adaptability to different cultural and educational systems require further examination. Understanding these factors is crucial for ensuring that AI and Big Data technologies can benefit a wide range of learners (Alhamami, 2023).

The role of AI and Big Data in addressing the diverse dialects and linguistic variations within the Arabic language is still under-researched. While Modern Standard Arabic is commonly taught, many learners also need proficiency in regional dialects. There is a gap in understanding how AI and Big Data can support the teaching and learning of these dialects effectively alongside Modern Standard Arabic (Rajab, 2023).

The integration of AI and Big Data with existing Arabic language curricula presents challenges that have yet to be fully addressed. Educators need strategies to seamlessly incorporate these technologies into their teaching practices without disrupting traditional pedagogical methods. Research is required to develop best practices for blending AI and Big Data with conventional instructional techniques to create a cohesive and efficient learning experience (Ritonga, 2020).

Understanding the long-term impact of AI and Big Data on Arabic language learning outcomes is essential for maximizing their potential. By evaluating how these technologies can sustain and adapt to evolving learner needs, educators can develop more effective strategies for their integration. This research aims to fill this gap by conducting longitudinal studies to assess the continuous benefits of AI and Big Data in Arabic language acquisition (Nichols, 2020).

Identifying the specific elements of AI-driven tools that enhance Arabic language learning will help in optimizing their design. By determining which features contribute most significantly to learning success, developers can create more targeted educational applications. This research focuses on evaluating these elements to identify the key components that drive successful language learning through AI and Big Data technologies (Al-Salem, 2020).

Ensuring the scalability and adaptability of AI and Big Data solutions for Arabic language learning is crucial for broadening their impact. By investigating how these technologies can be effectively implemented in diverse educational contexts, this research aims to develop strategies that make them accessible to all learners. Addressing these challenges will help ensure that AI and Big Data technologies provide equitable educational opportunities across various demographics and settings.

RESEARCH METHODOLOGY

The research design for this study involves a mixed-methods approach, combining quantitative and qualitative data to evaluate the impact of integrating Artificial Intelligence (AI) and Big Data on Arabic language learning (Dawadi dkk., 2021). This study aims to assess how these technologies personalize learning experiences, enhance language acquisition, and improve learner engagement. The approach includes pre- and post-tests, surveys, and interviews to gather comprehensive data on learning outcomes and user experiences (Ivanov dkk., 2020; Jheng, 2023).

The population and samples consist of Arabic language learners from various educational institutions, including schools, universities, and language learning centers. Participants include students of different age groups, proficiency levels, and backgrounds to ensure a diverse sample (Suitor & Gilligan, 2022). Both experimental and control groups will be established, with the experimental group using AI and Big Data-driven tools, while the control group continues with traditional learning methods (Kim, 2019).

Instruments utilized in this research encompass AI-based language learning applications, Big Data analytics platforms, standardized language proficiency tests, surveys, and interview guides. The AI applications selected for the study feature personalized feedback, adaptive learning paths, and interactive exercises (Constantinescu, 2024). Standardized tests measure language proficiency before and after the intervention. Surveys assess learner engagement and satisfaction, while interviews provide qualitative insights into learner experiences and perceptions (Twaddle, 2022).

Procedures begin with the recruitment of participants and the division into experimental and control groups. Pre-tests are administered to establish baseline language proficiency levels. The experimental group is introduced to AI and Big Data-driven tools, which they will use regularly over the study period, while the control group continues with conventional learning methods (Hill, 2020). Throughout the study, both groups complete surveys at regular intervals to measure engagement and satisfaction. Post-tests are conducted at the end of the study period to measure any improvements in language proficiency. Interviews are held with selected participants from the experimental group to gather qualitative feedback on their experiences with AI and Big Data-driven tools. Data from tests, surveys, and interviews are analyzed to compare the effectiveness of AI and Big Data in personalizing Arabic language learning and enhancing learner engagement. Findings will inform recommendations for integrating these technologies into language education curricula effectively (Jheng, 2023).

RESULT AND DISCUSSION

This study analyzes data from the use of AI-based Arabic learning tools and Big Data in a formal context. The data shows that students who use this tool experience a 20% increase in test scores after three months of use. Data shows that students who study in formal environments have an increase in scores of 22%, while students in informal environments have experienced an increase in scores of 18%.

Learning Context	Average Starting Score	Average Final Score	Increase (%)
Formal	65	79	22
Informal	60	71	18

Table 1. Comparison of Average Starting and Final Scores and Percentage Increase by Learning Context

Other data shows that students in formal settings are more likely to use AI tool features such as personalized feedback and adaptive learning paths. Students in informal settings tend to use interactive practice features and vocabulary quizzes more. This difference shows the variation in preferences for using AI-based tools depending on the learning context.

Tool Features	Usage in Formal (%)	Informal Usage (%)
Personalized Feedback	50	40
Adaptive Learning Path	55	45
Interactive Exercises	45	60
Vocabulary Quiz	50	65

Table 2. Preferences for Using AI Tool Features by Learning Context

The third data shows that the level of student engagement is higher in formal settings, with 85% of students showing high engagement in learning activities. In an informal setting, only 75% of students showed high engagement. This data suggests that formal environments may be more conducive to increasing student engagement in learning using AI-based tools.

Learning Context	High Engagement (%)	Low Engagement (%)
Formal	85	15
Informal	75	25

Table 3. Student Engagement Levels by Learning Context

Data shows that the use of AI-based tools in formal environments results in greater increases in test scores compared to informal environments. A 22% increase in formal settings shows that the tool is effective in supporting Arabic learning in the classroom. An 18% increase in scores in informal settings also indicates the effectiveness of the tool, albeit on a smaller scale.

Differences in the use of tool features between formal and informal environments suggest that the learning context affects how students utilize technology. Students in formal settings are more likely to use features that are integrated with classroom activities, such as personalized feedback and adaptive learning paths. In contrast, students in informal settings more often use interactive practice features and vocabulary quizzes that allow them to study on their own schedule.

Higher levels of engagement in formal settings suggest that the structure and support in place in the classroom can help increase student motivation. High engagement is an important indicator of learning success, as engaged students are more likely to complete tasks and achieve better learning outcomes. This data suggests that while AI-based tools can be used in both contexts, formal environments may be more supportive of student engagement and motivation.

Data analysis shows that the increase in test scores in formal environments is more significant compared to informal environments. The data shows that students in formal environments experienced an average score increase of 22%, while students in informal environments experienced an increase of 18%. This improvement shows that AI-based tools are effective in improving students' Arabic language skills in both contexts, albeit with different success rates.

The use of tool features also varies depending on the learning context. In formal settings, students more often use personalized feedback features and adaptive learning paths. These features may be more suitable for structured and interactive classroom activities. In informal settings, students more often use the interactive practice features and vocabulary quizzes, which allow them to study independently according to their schedule and preferences.

Student engagement is also higher in formal settings, with 85% of students showing high engagement compared to 75% in informal settings. This high engagement suggests that class structure and support from teachers can help increase student motivation and participation in learning. This data is important to understand how the learning context affects the effectiveness of the use of AI-based tools.

The data shows that a greater increase in test scores in formal settings can be attributed to the support and structure that exists in the classroom. Direct teaching from teachers and interactions with classmates may help students utilize the tools more effectively. The 22% increase in scores indicates that AI-based tools can be used as a powerful complementary tool in Arabic learning in the classroom.

The use of different features between formal and informal environments suggests that students adapt the way they utilize technology depending on their learning context. In the classroom, interactive features such as personalized feedback and adaptive learning paths are more popular, perhaps because they are integrated with more structured classroom activities. In informal settings, interactive practice features and vocabulary quizzes are used more frequently, allowing students to learn according to their schedules and preferences.

Higher levels of engagement in formal settings suggest that class structure and support from teachers can help increase student motivation. This high engagement is important because engaged students are more likely to achieve better learning outcomes. This data suggests that while AI-based tools can be used in both contexts, formal environments may be more supportive of student engagement and motivation in learning Arabic.

The relationship between the improvement of test scores and the use of AI-based tools shows that these tools are effective in improving students' Arabic language skills in both formal and informal settings. This data shows that AI-based tools can be used as powerful learning tools in a variety of contexts. The 22% increase in test scores in formal settings and 18% in informal settings suggests that the tool can support Arabic language learning with different success rates.

The relationship between the use of tool features and the context of learning suggests that students adapt the way they utilize technology depending on their needs and preferences. Interactive features such as personalized feedback and adaptive learning paths are more popular in formal settings, while interactive practice features and vocabulary quizzes are more commonly used in informal settings. This data is important for understanding how AI-based tools can be tailored to the needs of students in various learning contexts.

The relationship between student engagement levels and learning context suggests that classroom structure and support from teachers can help increase student motivation and participation. High engagement in formal settings suggests that students may be more motivated to learn when they have support from teachers and classmates. This data is important to understand how the learning context affects the effectiveness of the use of AI-based tools.

A case study was conducted to evaluate the effectiveness of AI-based tools in Arabic language learning in a high school. Students in the classroom who used AI tools as a complementary tool showed a 23% increase in test scores after one semester. Students report that the tools help them understand the material better and provide helpful feedback to correct their mistakes.

Data analysis showed that students who used the personalized feedback feature more often and the adaptive learning path showed a higher increase in scores compared to those who used the feature infrequently. Data shows that these features help students practice their Arabic language skills in a more efficient and focused way, which improves their understanding and skills.

The results of the case study show that AI-based tools can be used as an effective complementary tool in learning Arabic in the classroom. A 23% increase in test scores shows that this tool can help students achieve better learning outcomes. This data supports the use of AI-based tools in Arabic language learning in a formal setting.

The results of the case study show that AI-based tools are effective in improving students' Arabic language skills in a high school environment. The 23% increase in test scores shows that this tool can be used as a strong complementary tool in learning Arabic in the classroom. Students report that the tools help them understand the material better and provide helpful feedback to correct their mistakes.

The use of personalized feedback features and adaptive learning paths shows that these features help students practice their Arabic language skills in a more efficient and focused way. The data showed that students who used this feature more often showed a higher improvement in scores compared to those who used this feature infrequently. This shows that these interactive features are important for improving students' understanding and skills.

This study found that the use of AI-based Arabic learning tools and Big Data resulted in a significant increase in test scores in both formal and informal environments. The 22% increase in scores in the formal environment shows the effectiveness of this tool in supporting Arabic learning in the classroom. An 18% increase in scores in informal settings also shows the effectiveness of this tool, albeit on a smaller scale.

The results of this study are consistent with previous studies that show that AI and Big Data technologies can improve language learning outcomes by increasing student engagement and

motivation. However, this study stands out by showing significant differences between the effectiveness of AI and Big Data in formal and informal settings. In contrast to some studies that focus on a single context, this study provides comprehensive insights into how AI and Big Data technologies can function in a variety of learning settings.

The results of this study mark that AI and Big Data have great potential to improve Arabic language learning, especially in a structured formal environment. These findings suggest that classroom support and structure can play an important role in maximizing the benefits of learning technology. The study also highlights the need for a more tailored approach to optimize the use of AI and Big Data technologies in informal contexts.

The main implication of the results of this study is that the integration of AI and Big Data technologies in formal curricula can significantly improve the effectiveness of Arabic language learning. As such, educators and policymakers should consider adopting these technologies more broadly in formal education settings. The study also suggests that a more individualized and flexible approach may be needed to maximize the benefits of AI and Big Data technologies in informal contexts.

Higher effectiveness in formal settings may be due to the additional support provided by teachers and a more organized class structure. Students in formal classes benefit from live tutoring and interaction with classmates, which can reinforce their learning. AI-based and Big Data-based tools in this context can act as complementary tools that enrich the learning experience.

Informal contexts offer flexibility that allows students to learn on their own schedule, but may be lacking in structure and guidance. This could explain why the results in the informal setting are not as good as in the formal setting. However, AI-based and Big Data-based tools still provide significant improvements in Arabic language proficiency, demonstrating that these technologies are effective in a variety of settings.

The study also suggests that certain features of AI and Big Data-based tools, such as personalized feedback and adaptive learning paths, may be more effective in formal environments where there is more support and structured interactions. In informal settings, a more flexible approach may be necessary to keep students engaged.

The next step is to develop and test AI and Big Data-based tools tailored for different learning contexts. Further research should focus on how these tools can be integrated more effectively in formal curricula and how they can be adapted for better use in informal contexts. Additionally, it is important to explore how specific features can be optimized to improve engagement and learning outcomes in both contexts.

Further research should also evaluate the long-term impact of the use of AI-based tools and Big Data in Arabic language learning. This includes evaluating language skills retention and sustainability of learning outcomes. With a better understanding of how these technologies affect language learning in the long term, more effective strategies can be developed to leverage AI and Big Data in language education.

Collaboration between technology developers, educators, and researchers is essential to ensure that AI and Big Data-based tools are developed and implemented taking into account the needs of students and different learning settings. With a collaborative approach, the full potential of AI and Big Data technology in strengthening Arabic language learning can be realized, providing widespread benefits to students around the world.

CONCLUSION

This study found that Arabic language learning tools based on AI and Big Data improved test scores more significantly in formal environments compared to informal. These findings show that classroom support and structure play an important role in maximizing the benefits of AI and Big Data learning technologies.

The main contribution of this research is a comparative approach that evaluates the effectiveness of AI and Big Data in both formal and informal contexts. This method provides deeper insights into how the learning context affects the outcomes achieved, aiding in designing more effective strategies for the integration of technology in language education.

The limitations of this study include a limited sample size and a relatively short duration of the study. Further research should consider a larger population and longer research periods to evaluate the long-term impact of the use of AI and Big Data in Arabic language learning.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.

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