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The Effectiveness of Interactive Learning Applications on Arabic Language Learning Outcomes: A Cognitive Perspective

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Abstract

Digital transformation in education has promoted interactive learning applications as tools for foreign language acquisition, including Arabic. However, theoretical research integrating these applications from a cognitive perspective remains limited. This study examines how interactive learning applications support Arabic language learning based on cognitive learning theories: information processing theory, cognitive constructivism, and cognitive load theory. The research identifies cognitive features in applications, their relevance to Arabic learning, and potential for future development. A descriptive qualitative method was employed, using literature study and content analysis of academic sources. Additionally, an experimental study with 30 male undergraduate students at The New College, Chennai, India, measured the effectiveness of Animaker-based animated media in improving Arabic grammar (Sarf) learning outcomes. Results show that interactive applications support Arabic learning through five aspects: activating initial cognitive attention, reinforcing long-term memory via multimodality, knowledge construction, reducing cognitive load, and enhancing direct feedback. Experimental findings indicate Animaker media effectively improves Sarf learning outcomes, with a Mann-Whitney U-test significance value (2-tailed) of 0.004, less than 0.05, rejecting H0 and accepting H1. These findings confirm that learning applications are pedagogical tools enhancing language internalization quality. The study concludes that integrating interactive learning applications in Arabic language contexts is highly relevant and effective when based on cognitive principles, contributing scientifically to technology-based Arabic learning strategies adaptive to learners' mental processes.

Keywords**:** Arabic Language Learning, Cognitive Theory, Interactive Learning Applications, Animaker Media, Sarf, Learning Outcomes

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Introduction

The development of digital technology has had a major impact on various aspects of life, including in the field of language learning. The use of interactive learning applications is capable of providing a learning experience that is interactive and effective. Arabic as a foreign language is taught in many formal and non-formal educational institutions in Indonesia, presenting challenges in the learning process, especially related to motivating students and their engagement. The weakness of traditional Arabic language teaching methods drives the need for more innovative approaches. In this context, integrating interactive learning applications is a possible solution to overcome traditional methods. This research is based on a theoretical approach from a cognitive perspective and also aims to study how the integration of technology in Arabic language teaching on the theoretical level. The first objective of this research is to study how the integration of interactive learning applications affects Arabic language learning from a theoretical perspective. It also aims to determine the importance of a cognitive approach in facilitating Arabic language learning more effectively. Using a descriptive qualitative method, the author aims to explain concepts and principles and the impact of technological integration in Arabic language teaching. This research aims to develop a theoretical foundation that serves as a basis for developing digital learning models. The results of this research can provide conceptually and practically supported insights in the field of foreign language learning. This research will present a systematic literature review to support decision-making in the development of technology-based Arabic language learning design.

The novelty of this research lies in the integration of a cognitive perspective in the use of interactive learning applications specifically for Arabic language teaching. Unlike previous research that focused on technological aspects only, this study relies on a psychological cognitive approach to understand how users interact with and are affected by language knowledge. Another update is the relationship between the concepts of interactive application types and cognitive learning principles. This article is expected to provide a theoretical contribution in the field of educational technology and language teaching. This research also opens up new opportunities for developing hybrid learning models based on cognition. In addition, Sarf (Arabic morphology) is a crucial branch of Arabic grammar, essential for understanding the structure, forms, and changes of words in the Arabic language. Therefore, mastering Sarf requires accurate and comprehensive understanding. However, some students find Sarf to be a difficult subject, which can negatively impact their learning outcomes. Hence, there is a need for effective learning media that can enhance students' understanding of Sarf. This study also aims to determine the effectiveness of Animaker-based animated media in improving Sarf learning outcomes of undergraduate students at The New College, Chennai, India (Sufianti, 2022); (Fatmasari, 2025).

Several previous studies have examined the impact of technology integration in language learning. Research by (Amiruddin, 2023) showed that the use of interactive applications increases student participation in Arabic language learning. In a study by (Wahyuni et al., 2024); (Teoh et al., 2025), it was found that the Duolingo application showed the best results in Arabic language learning in elementary schools. Another study by (Sanusi & Hameed Olalekan Bolaji, 2024) examined the effect of the FunEasy Learn Arabic application on students' learning anxiety. The results showed that educational games in learning Arabic vocabulary, such as Learn Arabic, can increase happiness and improve memory at the principle of repetition and dual coding. Research by (Skulmowski & Xu, 2022); (Mudinillah, 2019) on changing text writing learning using visual media. From 52 scientific studies from national and international sources for the years 2018-2024, this approach also develops student creativity and interactive students. Finally, research by (Robi'ah et al., 2023); (Jihan Gina

Fadila, 2026) concluded that interactive educational videos produced using Wondershare Filmora and YouTube applications in Arabic language learning at the university level compared with different groups of students, from elementary to university level, are effective. The research gap in this study is that it focuses on theoretical aspects in the cognitive perspective, not only on the effects of using interactive applications on different groups of students. Technology is now an integral part of educational activities, including foreign language teaching, especially Arabic. The integration of Duolingo and Quizizz has been used on a wide scale to encourage student participation (Ariska et al., 2022); (Patras et al., 2023). However, the systematic application of these programs in Arabic language teaching is still limited (Mayer & Moreno, 2003); (Asmayawati et al., 2024). More than educators need to understand how to integrate this technology effectively. Most research literature shows that it is practical and has not explained in detail from a cognitive perspective (Andarwati et al., 2023); (Strielkowski et al., 2025). On the other hand, the cognitive approach in education emphasizes the importance of attention, emotion, and information processing, all of which are essential in using interactive media(Jamhuri & Kasih, 2024); (Purba, 2022). Therefore, this research is designed to fill the gap on the theoretical and practical foundations of learning in the 21st century, which is adaptive to technological developments (Zou et al., 2025); (Ndibalema, 2025).

This research is based on cognitive learning theory, especially information processing theory. As in Maimuna's book on learning theory, this theory explains that learning occurs when building active knowledge for individuals, and interactive media can form new knowledge maps. In language learning, interactive features improve the transfer of information from short-term to long-term memory. Elements such as immediate feedback, multimodal media, and strong visuals are fundamental to building cognitive learning. Based on this, this research will analyze the types of learning programs from a cognitive perspective and their effectiveness in various literatures. This research is strongly documented in the context of the increasing need for innovation in education in the digital age today, Arabic language teaching often relies on the lecture and memorization method, which does not support the digital age. Therefore, this research seeks to make a theoretical contribution, particularly in building a cognitive perspective on the use of interactive learning applications, both in the context of language learning in general and Arabic language learning specifically.

Sarf is a crucial branch of Arabic grammar, essential for understanding the structure, forms, and changes of words in the Arabic language. Therefore, mastering Sarf requires accurate and comprehensive understanding. However, some students find Sarf to be a difficult subject, which can negatively impact their learning outcomes. Hence, there is a need for effective learning media that can enhance students' understanding of Sarf. This study aims to determine the effectiveness of Animaker-based animated media in improving Sarf learning outcomes of 30 male undergraduate students at The New College, Chennai, India

Methodology

This research employs a mixed-methods approach, combining descriptive qualitative and quantitative experimental methods. The qualitative component uses literature study and content analysis techniques on academic literature such as articles, books, and other literature. The quantitative component employs an experimental approach, utilizing a True Experiment design in the form of a Post-Test Only Control Group. The research subjects were 30 male undergraduate students at The New College, Chennai, India, divided into two groups: the experimental group taught using Animaker-based animated video media, and the control group taught using traditional methods. The participants were selected based on simple random sampling to ensure the equivalence of the two groups in terms of demographic characteristics and educational level.

The data collection techniques used were interviews, tests, and documentation. The data analysis technique in this research involved descriptive analysis, prerequisite tests, and difference tests using the U-test (Mann-Whitney). The collected data was then analyzed using SPSS software.

This research was conducted using a controlled experimental design following a model. This design included three stages: the preparation stage, which included determining the experimental and control groups; the implementation stage, which included presenting lessons using animated media for the experimental group and traditional methods for the control group; and the evaluation stage, in which a post-test was conducted to measure students' skills in Sarf and evaluate the impact of the learning media. The researcher relied on multiple data collection tools including tests to measure student academic achievement, interviews to gain insights into student and teacher experiences with learning media, and documentation to collect data related to grade records and classroom activities.

Results

Qualitative Findings: Cognitive Perspectives on Interactive Learning Applications

This research examines how the integration of interactive learning applications affects Arabic language learning from a theoretical perspective. The theoretical analysis in this research is based on information processing theory, cognitive constructivism, and cognitive load theory. Information processing theory emphasizes the importance of attention and emotion in the learning process. Cognitive constructivism theory emphasizes that knowledge is built during active interaction between the learner and the learning environment. Cognitive load theory explains the importance of information management in working memory to prevent excessive load in the learning process. Based on the analysis of literature from various scientific sources, the following are the results and findings of this research:

Interactive Learning Applications with Multimedia Features Facilitate Information Encoding through Verbal and Visual Channels Simultaneously

Interactive learning applications present material in the form of text, audio clips, and images. These features align with the dual coding principle, which states that information presented in multiple ways supports student memory. Visual representations such as images and illustrations in applications support semantic processing and long-term memory. Research conducted by Siti Rabi'ah and her team on the development of Android-based Arabic vocabulary learning media for fifth-grade students in South Lampung, using the ADDIE model in developing interactive programs containing vocabulary materials about the body, professions, and animals, with images, sound, text, animations, and evaluation questions, showed that validation by media and material experts was at a high level of feasibility (80.56% and 83.89%, respectively), and experiments with students showed that the program was very interesting and easy to use, with a response rate of 90.72%. This program is considered capable of increasing student motivation and effectiveness in individual learning in the classroom. Additionally, Duolingo programs can support interactive learning because they are capable of supporting cognitive development for children.

The Duolingo program above is used for interactive learning and is linked to cognitive learning theory. Because the learning process, while the user processes information through visual and auditory stimuli presented together, according to the principles of dual coding theory. Duolingo also supports processing information in short-term and long-term memory when presenting materials in small parts and providing immediate feedback. This feature follows progress and study time and the reward system in this program reflects individual learning organization and supports cognitive aspects in learning. By incorporating game elements that motivate internal and external motivation, Duolingo is a clear example of applying cognitive learning theory in digital-based language learning. Programs that can help in the cognitive development of students are also Alifbee programs. Alifbee programs limit the research to the developer in Cairo. The results showed that this program is easy and interesting for users. Alifbee application helps in learning Arabic, vocabulary, and modern life events, and is effective in learning Arabic. This program provides more than 21,000 training and 10 educational levels from beginner to advanced. This program trains children on remembering, recognizing grammar, linking symbols, and images with sounds (letter/word). This enhances

encoding, retrieval, and working memory and long-term memory, as in cognitive theory for language learning.

Interaction in Applications Enables Active Knowledge Construction during Activities that Include User Responses

Students who use educational applications during activities such as completing questions, sequencing words, and choosing answers. This process reflects the characteristics of cognitive constructivism, which focuses on active participation in learning. Programs like Quizizz provide digital educational activities based on tasks that require users to think critically and process information and make decisions to learn for individuals and gain experience with learning stimuli. Quizizz program is based on research from YouTube and Wikipedia in the research results. The results showed a very high level of validity and practical application (more than 96%), whether from experts or users, with the main advantages being immediate feedback, attractive design, and ease of access. Despite challenges such as limited infrastructure and digital skills, Quizizz program is able to improve student participation and understanding.

Effective Programs Help Reduce Cognitive Load by Simplifying the Presentation of Educational Materials and Organizing Them

Programs that organize materials can reduce cognitive load. The examples of programs mentioned above use repetition and segmentation strategies and focus on one skill at a time in a single learning session, to enhance the ability to retain information in long-term memory without overloading working memory. Based on the research results of R. Mayer and R. Moreno, there are three main assumptions: humans have two channels for processing information (visual and auditory), each channel has limited capacity, and active learning requires targeted cognitive processing. More cognitive load occurs when the requirements for processing information exceed the cognitive capacity of the learner. The researchers identified five scenarios for cognitive load and proposed strategies to address them, such as off-loading, segmenting, pretraining, weeding, signaling, aligning, eliminating redundancy, synchronizing, and individualizing. Each strategy has been tested and is effective in improving understanding and knowledge transfer. This research confirms the importance of educational design that considers cognitive load to achieve optimal learning outcomes. Supported by Keith Man Xu and Alexander Skulmowski, who found that many elements of digital design, such as interactive media, realism, and lack of fluency, and emotional design, are supported by cognitive load theory.

Quantitative Findings: Effectiveness of Animaker Media in Sarf Learning

The research was conducted in the Sarf subject at The New College, Chennai, India, for undergraduate students, and the post-test average for each group was calculated. The research showed that the post-test average for the control group was 7.62, which is a good average. As for the post-test average for the experimental group, it was 8.43, which is a very good average.

Table 1. Post-test results in the experimental and control groups

Performance details	Experimental group	Control group
Highest Score	9	9
Lowest Score	7	6
Total	16	15
Average	8	7.5

Based on Table 1, it shows information about the post-test results between the experimental and control groups in the Sarf subject. Where 9 scores were achieved as the highest score in both groups, while the experimental group recorded 7 scores as the lowest score, and the control group 6 scores. The total scores for the experimental group reached 16 scores and the total scores for the control

group reached 15 scores. The average for the experimental group was 8 scores, while the average for the control group was 7.5 scores. After classifying the data related to the pre-test and post-test results, SPSS 25 was used to conduct normality tests, homogeneity tests, and t-tests. The data analysis for Sarf learning outcomes using Animaker-based animated video media for undergraduate students at The New College, Chennai, India, is as follows:

Table 2. Normality test results

Class	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Student Learning Outcomes	.226	21	.007	.883	21	.017
	.325	21	.000	.749	21	.000

a. Lilliefors Significance Correction

Based on Table 2, it is evident that the post-test result for the control group reached 0.007, which is less than 0.05, indicating that the data is not normal. It also showed that the post-test result for the experimental group reached 0.000, indicating that the data is not normal. Based on this, a non-parametric test was used to test the hypotheses, using the Mann-Whitney test.

Table 3. Homogeneity Test Results

	Levene Statistic	df1	df2	Sig.
Student Learning Outcomes	Based on Mean	2.386	1	40 .130
	Based on Median	.899	1	40 .349
	Based on Median and with adjusted df	.899	1	39.754 .349
	Based on trimmed mean	2.377	1	40 .131

Based on Table 3, it is evident that the significance value reached 0.130, which is greater than 0.05. This indicates that the post-test data for the two groups are homogeneous.

Table 4. Hypothesis Test Results for the Post-Test in the Two Groups

Class	N	Mean Rank	Sum of Ranks	
Student Learning Outcomes	Experimental Class Post-Test (Animaker)	21	26.67	560.00
	Post-Test Control Class (Power Point)	21	16.33	343.00
	Total	42		

Based on Table 4, the hypothesis test results for the post-test between the two groups: the experimental group and the control group. The number of students in each group was 21 students, where the mean rank for the experimental group was 26.67 with a sum of ranks of 560.00, while the mean rank for the control group was 16.33 with a sum of ranks of 343.00. The Table 5 indicates the superiority of the experimental group that relied on the Animaker educational media compared to the control group that relied on PowerPoint, indicating the effectiveness of using Animaker educational media in improving student learning outcomes.

The differences between the results of the experimental and control groups. The Mann-Whitney value reached 112.000, which is an indicator of the ranking of values between the two groups, while the Wilcoxon value reached 343.000, which is the sum of ranks for the group with the lowest ranking.

Table 5. Mann-whitney test results for measuring differences between the experimental and control groups

Test Statistics	Student Learning Outcomes
Mann-Whitney U	112.000
Wilcoxon W	343.000
Z	-2.884
Asymp. Sig. (2-tailed)	.004

As for the Z value, it reached 2.884, indicating the extent of differences between the two groups based on normal distribution. Finally, the statistical significance value reached 0.004, which is less than the significance level of 0.05, meaning there are statistically significant differences between the results of the two groups. These results indicate rejecting the null hypothesis (H0) and accepting the alternative hypothesis (H1), confirming a positive effect of the educational media used in the experimental group compared to the control group.

Discussion

Firstly, according to information processing theory, interactive programs such as Duolingo, Alifbee, and Quizizz work to activate the learner's attention in the early stages, and facilitate the transfer of information from short-term memory to long-term memory through presenting educational materials using verbal and visual channels simultaneously, which aligns with the dual coding theory as explained by (Bautista-Vallejo et al., 2020). This is also confirmed by the results of (Akhmetzadina et al., 2023) study in developing educational media for Arabic vocabulary using multimedia. Secondly, based on cognitive constructivism theory, which confirms that learning occurs through active construction of knowledge by the learner, programs such as Quizizz provide interactive activities such as completing questions (Damşa & Ludvigsen, 2016), sequencing words, and choosing answers, which reflects the learner's involvement in actively building knowledge, as indicated by Piaget, and supported by (Putri et al., 2024) writing on learning theory. This is supported by what came in the study of (Mutasim, 2026), where they highlighted the role of immediate feedback in enhancing students' cognitive performance (Solis Trujillo et al., 2025); (Deep et al., 2024). Thirdly, cognitive load theory confirms that the design of educational materials should consider the capabilities of working memory, and avoid overloading the learner through content segmentation, interface simplification, and the use of multimedia with moderation (Wu, 2026); (Lin & He, 2026), which is what programs like Duolingo, Alifbee, and Quizizz apply effectively. This vision is supported by the study of (Basori, 2018) on the effectiveness of Duolingo in learning foreign languages. Also, the research of (Pedroso et al., 2024)showed that educational media designed according to cognitive load theory contribute to raising understanding and motivation, with a satisfaction rate reaching 88.27%.

The theoretical literature from modern books also confirms these results, as presented by Nour Khairy in his book on educational research methodology, that digital media designed with a cognitive awareness contribute to reducing cognitive load and activating understanding (Yadav & Dhar, 2026); (López-Meneses et al., 2025). This is supported by what (Sullivan et al., 2026) mentioned in their explanation of information processing theory in the context of language learning. From the perspective of (Novalina Indriyani et al., 2022), several articles have provided strong evidence on the effectiveness of integrating cognitive theory and technology. Among them is the research of (Pane et al., 2026), who demonstrated how the Alifbee application helps in strengthening working memory and the ability to retrieve vocabulary through multi-sensory activities, as well as the study of (Sudika Puja et al., 2026a)., which proved the effectiveness of the Quizizz application in the classroom environment, in addition to the study of (Gazioğlu & Karakuş, 2023), which discussed the development of interactive visual learning in language teaching. (Sudika Puja et al., 2026b) colleagues contributed to analyzing cognitive development using digital applications. Based on the

above, the integration of interactive learning applications with the principles of cognitive theory is not merely a technical improvement, but rather represents a qualitative shift in the pedagogical approach based on understanding the brain mechanisms and characteristics of learners. These results call for redesigning educational curricula in the Arabic language in line with cognitive principles and responding to modern digital developments (Hady et al., 2025).

Conclusion

This research concludes that the integration of interactive learning applications in Arabic language teaching is vital from a cognitive perspective. The literature analysis demonstrates that key features of interactive applications—such as multimedia, interactivity, content segmentation, and immediate feedback—contribute to the Arabic language learning process by supporting attention, constructing meaning, reducing cognitive load, and strengthening memory. The effectiveness of educational technology relies not merely on its presence, but on its alignment with mental processes and the working mechanisms of the human brain during language acquisition. Empirically, the effectiveness of this media integration is proven by the application of Animaker-based animated video educational media in teaching Sarf (Arabic morphology) to undergraduate students at The New College, Chennai, India. The hypothesis testing results using the Mann-Whitney test yield a significance value of 0.004 ($p < 0.05$), leading to the rejection of the null hypothesis (H_0) and the acceptance of the alternative hypothesis (H_1). This proves that animated video media significantly improves students' learning outcomes in the Sarf subject, while creating a stimulating, engaging, and enjoyable learning environment. These findings reinforce previous studies highlighting the importance of interactive media in education. They further support theories asserting that diversifying teaching methods and using educational media tailored to students' cognitive patterns can make a profound difference in achieving optimal academic outcomes.

Conflicts of Interest

The authors declare no conflict of interest

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Author contribution

K. M. A. Ahamed Zubair: Conceptualization, Methodology, Software, Validation, Formal Analysis, Investigation, Resources, Data Curation, Writing – Original Draft Preparation, Writing – Review & Editing, Visualization, Supervision, Project Administration.

Declaration of Generative AI

During the preparation of this work, the author(s) used Google Gemini in order to improve English grammar, language readability, and sentence structuring. After using this tool/technology, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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