Artificial Intelligence in Arabic Linguistic Landscape: Opportunities, Challenges, and Future Directions

Anas Hanandeh [1], Samer Ayasrah [2], Ibrahim Kofahi [3], Shorouq Qudah [4]

[1] *Faculty of Education and Arts, Sohar University , Sohar, Oman*
[2] *Special Education Department, Faculty of Educational and Psychological Sciences, Amman Arab University, Amman, Jordan*
[3] *School of Arts, Department of Arabic Language and Literature, The University of Jordan, Amman, Jordan*
[4] *Independent Researcher, Amman, Jordan*

Abstract **– The widespread use of artificial intelligence applications in current era has created unique opportunities and challenges for the broad linguistic field of Arabic language and the possibility of employing these applications in learning, generating, and proofreading Arabic language. The primary research question addresses the effectiveness and challenges of AI applications in Arabic language contexts. This study tests whether AI tools enhance Arabic language more than traditional methods, despite challenges. A comprehensive literature review of studies was conducted using a focused strategy on Google scholar, employing specific keywords such as "AI" and "Arabic language" and selecting studies related to AI's role in Arabic language education, translation and processing. This research sheds light on the relationship between AI applications and Arabic language, including a review of the research published in this field to identify the reality of using these applications and the extent of their effectiveness in serving Arabic language.**

A synthesis of the collected data identified the key themes, including current applications of AI in Arabic language learning, the development if natural language processing tools and the challenges of resource availability. The review highlights the considerable potential of AI in enhancing Arabic language and emphasizing their applications in understating and processing the language. Given the rapid and continuous development of these technologies, this study highlights emerging Arabic achievements in bridging the gap between Arabic language and modern technology and explores the future prospects of AI in Arabic language development. Moreover, this study contributes to the ongoing research on the intersection of Arabic language and AI addressing future research directions and promoting more effective AI-based education al tools for Arabic language.

Keywords **– Artificial intelligence (AI) applications, Arabic language, challenges and future prospects.**

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Corresponding author: Anas Hanandeh,
Faculty of Education and Arts, Sohar University, Sohar, Oman
Email: ahanandeh@su.edu.om

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1. Introduction

There are a number of applications of artificial intelligence that are widely used today and have proven to be unparalleled in the fields of education, economics, medicine, etc. As a result of the COVID-19 pandemic, advances in the fields of electronic learning and communication have significantly accelerated the learning and teaching process. As a result, modern applications such as virtual reality, augmented reality, and artificial intelligence were developed to assist students in learning, increasing their motivation, and developing their skills, thus accelerating the development of modern education. As Arabic is an important language, numerous studies have been conducted in artificial intelligence which have addressed the issue of learning and teaching different languages. The Holy Quran is written in Arabic, and is considered to symbolize the unity and identity of the country.

In addition to being among the four most widely used languages on the Internet, Arabic is spoken by approximately 500 million Arabs [1].

Thus, researchers are constantly utilizing modern technology in order to serve the Arabic language, such as using artificial intelligence to learn and teach Arabic.

The field of computer science defines artificial intelligence as automating intelligent behavior, including automated generation and correction of errors, in the field of language. Using these technologies, the language is processed, that is, its characteristics are converted from its original language to a digital language that can be understood by a computer [2] among the branches of artificial intelligence utilized in language learning is natural language processing (NLP), which enables computers to interpret, create, and process human language [3] this paper aims to explore how effective are current artificial intelligence applications in facilitating Arabic language learning and what unique challenges and solutions exist when developing artificial intelligence applications for the generation of Arabic content?

2. Literature Review

According to Al-Gharaibeh [4], machine translation can facilitate communication among speakers of diverse languages and contribute to the future of the Arabic language as artificial intelligence advances. It has been emphasized that the use of machine translation applications facilitates the exchange of Arabic texts into other languages, such as English, thus facilitating communication. As well, using machine learning applications to assist learning, teaching, and translation of the Arabic language has numerous advantages, including the enhancement of the learning process and motivation among learners, which motivates them to comprehend and understand the language. Al-Gharaibeh [4] suggests that artificial intelligence has the potential to pose a number of challenges to the Arabic language, such as preserving Arabic linguistic and cultural identity and fearing that western culture will infiltrate Arabic as a result of these applications and programs. Consequently, linguistic security, machine translation accuracy, and preventing tampering with this information must be considered. In order to improve understanding and development of the Arabic language, as well as to promote innovation, one of the proposed solutions to this challenge is to improve user interfaces in Arabic. Compared to other languages, there are few applications that help developers and researchers learn and disseminate Arabic language.

Therefore, researchers and developers should focus on research for the purpose of increasing Arabic language learning and dissemination.

In Sheikh Ali [5]'s study of the future of the Arabic language in the era of artificial intelligence, several topics were discussed, including artificial intelligence and its role in serving Arabic literature. With its linguistic richness, the Arabic language offers children access to the heritage of previous eras that is unmatched by any other language. This study utilized an analytical descriptive method, and the researcher discussed the role of artificial intelligence in developing various skills and technologies related to self-learning, exploration-driven learning, and reducing the amount of time and effort required to learn and teach languages in general. Through the use of the Word processing application, technology can be used to linguistically proofread Arabic sentences and show any errors that may occur and correct them using the word processing program. These applications provide native and non-native speakers of Arabic with an opportunity to learn, teach, and translate Arabic without the assistance of a human translator. Nevertheless, these applications do have a number of limitations that make it difficult to achieve their objectives with complete accuracy when it comes to creating sentences, forming sentences, or correcting errors that may arise as a result. In spite of the fact that this development indicates significant future surprises in the field, it may also indicate that the results of the research will be highly accurate in the future. With the development of these modern technologies, natural language processing (NLP) applications have become known for their excellent features and results in the processing of a wide variety of languages.

In [6] it was noted that chatbots, or automated chat programs, which are computer programs that simulate conversations and dialogues between human users, were discussed, especially those conducted through the Internet and designed to mimic human behaviour through the comprehension of written or read material. The use of artificial intelligence techniques in chatbots distinguishes chatbots from other types of robots. By examining the most important of these robots, this review demonstrates the extent to which these robots are capable of understanding dialogue in various contexts. During this study, the following Arabic language conversion models will be examined: AraBERT, CAMeLBERT, AraElectra, and AraElectra-SQuAD [6], [7], [8], [9]. To evaluate its performance, extensive experiments were conducted. Despite the low number of chatbots available for the Arabic language compared to those available for the English language, AraElectra-SQuAD performed more accurately than the other models.

The use of Arabic, which is a complex and rich language, presents a number of difficulties and challenges. Thus, the study recommends that these models be developed and updated, as they are capable of understanding dialogue contexts and providing answers to users' questions and can also serve as virtual personal assistants.

In order to gain the greatest benefit from artificial intelligence in the learning of Arabic, Abou Adel [10] examined two of the most successful experiments that have been conducted in the field of artificial intelligence in Arabic language learning. Busuu and Arabits are different since they utilize an interactive approach of teaching Arabic language which is based on scientific methodological standards. As an example, Busuu users are able to communicate with fluent Arabic speakers to correct their language errors, while Arabits [11] use images and sounds to teach the letters in a unique manner. In this study, 265 female students from the Kingdom of Saudi Arabia attended Al-Yamamah University during the first and second semesters of 2021/2022. Due to the many advantages associated with these two previous applications, researchers were motivated to examine the impact of these two applications on Arabic language learning among students. As they emphasize the four skills of Arabic language: listening, writing, reading, and speaking, they emphasize the principle of integration in teaching the Arabic language.

In addition, these two applications are distinguished by the fact that they facilitate active learning among students by providing content in an engaging, interactive and fun manner, as well as evaluative questions that provide appropriate feedback to help students identify their strengths and weaknesses by providing appropriate feedback. One of the most popular language learning applications [12] is Busuu, which is used by millions of users. Further, one of its benefits is that it enables self-learning without the help of a teacher due to its sequential presentation of information that is easy to comprehend and apply. One of the most important advantages of this application is the ability to communicate with Arabic speakers so that they can assist users in correcting and rectifying their mistakes. However, Arabits was distinguished for its ability to teach only one language, which was Arabic. As part of this application, users were able to learn about their strengths and weaknesses during their learning process by learning about the exits of letters as well as their correct pronunciation, while receiving various questions regarding their strengths and weaknesses. A number of technical challenges are associated with the use of these two applications, including the ability to distinguish voices automatically.

Researchers concluded that artificial intelligence techniques should be utilized in conjunction with scientific methodologies in order to present scientific content in applications that are effective.

From the perspective of teachers, [13] examined the use of artificial intelligence to serve the Arabic language in an effort to gain a better understanding of the viewpoints of Arabic language teachers regarding artificial intelligence in teaching Arabic language and to identify the extent to which artificial intelligence contributes to the development of students' Arabic language proficiency. The study followed a descriptive survey approach to obtain information from individuals directly through questionnaires, and the study population was composed of 2013 male and female teachers who taught Arabic language through the 2nd semester of the academic year 2022/2023 in the Directorate of Education in Minya, Egypt. Following the study, some recommendations were made regarding the provision of an appropriate infrastructure to enable the use of artificial intelligence techniques and applications for the teaching of Arabic, along with training and preparing Arabic language teachers for the use of artificial intelligence applications, in addition to spreading the culture of artificial intelligence and its application in education. Conferences and electronic seminars in this area are effective methods of learning in this field. Moreover, the study recommended that educational institutions, such as the Ministry of Education, work together with the private sector to provide modern software and applications to enhance the learning of the Arabic language.

By utilizing a quasi-experimental approach and relying upon descriptive and analytical methods, Al-Tlouhi [14] sought to determine the impact of AI platforms on e-learning in Arabic language topics at the primary stage. A total of thirty students attended the Arab Academy of Qatar during the semester of 2023 as part of the study sample. It was found that there was a statistically significant difference in the effectiveness of artificial intelligence platforms in aiding students in learning Arabic between the experimental group and the control group. Also, it is indicated that there is an urgent need to develop and create applications for artificial intelligence to be used for learning different languages, since these applications provide features that enhance students' learning and motivational abilities. As one of the most important recommendations concluded, scientific conferences are required to discuss the use of artificial intelligence applications to advance education and learning processes, as well as encourage teachers to utilize these applications as widely as possible due to their effectiveness and many advantages.

Using qualitative research methodology, [15] examined the extent to which artificial intelligence is used to teach Arabic at Aladdin State University of Islam in Makassar, which conducted interviews with students and faculty. As a result of the study, most students used chat applications to correct their writing grammatically, understand grammar, and comprehend morphology. Artificial intelligence applications that support learning the Arabic language have been discussed, such as the smart teaching system, which provides customized support to the student based on his learning speed and requirements. Voice or personal assistants were also discussed for interacting in the Arabic language, such as Google Assistant, for example, which identifies symbols and letters and pronounces or translates them across different languages. The results also indicate that most female and male students are using chatbots to improve their Arabic language skills, indicating that the use of artificial intelligence applications is on the rise. In light of the limited use of these applications at Al-Islam State University for improving pronunciation of the Arabic language, a number of challenges have emerged as a result of the limited use of these applications. It is difficult for students to self-learn without a teacher, and it is difficult to provide students with appropriate instructions and commands to assist them with these applications because training and qualifications are required.

A study by Binhaidara and Morsy [16] provides insight into the advantages of investing in artificial intelligence and using it to learn Arabic, as well as the use of Duolingo as a model for a platform that utilizes artificial intelligence to teach languages [17], [18]. In order to answer the study's questions, descriptive analytical methods were used. Non-arabic native speakers face a number of difficulties when learning the language. As a result, apps such as Duolingo are being developed to address this issue by providing a variety of features that enhance learners' learning experiences by offering continuous support and feedback, and making them aware of their strengths and weaknesses. It is also important to provide them with individualized learning opportunities.

As emphasized by [19], Arabic language must be preserved from diacritical changes that may alter sentence meaning or result in incorrect interpretations. A comparison of different letter formation methods was conducted in order to determine the accuracy of letter formation. Upon including the models, the accuracy of the results was assessed by comparing them with previously obtained data. This study indicates that tools based on artificial intelligence models exhibit a lower error rate than those based on language grammar models.

In fact, artificial intelligence models can be able to form the last letters in a manner appropriate for their capability to comprehend complete sentences and to understand the context in which the words appear in a complete sentence. The accuracy of these tools is higher than that of a human, but it remains lower than that of a regular human. They possess numerous advantages, and their potential is quite promising. As mentioned in this study, there is a risk of slowing down the processing and digitization of the Arabic language, primarily because of the negatives associated with the lack of interaction between the various search engines and Arabic texts, as well as the difficulty or lack of interaction between translation software and Arabic language, and the absence of scientific products as a result of the lack of research tools available. According to statistics published by the Linguistics Data Consortium, only 8% of the research published in 2020 is related to Arabic.

There are several artificial intelligence applications that have been developed, including the CAMeL Tools [20[, [21], which are considered open source tools that can be used by anyone. By utilizing artificial intelligence techniques, this application provides a wide range of options which assist with the formation and parsing of Arabic language with a high rate and accuracy. In addition to the Egyptian dialect, the system is also capable of working in two other colloquial dialects: the Levantine dialect and the Gulf dialect. The project involved collecting over 100 million words for inclusion. A new tool has been developed that clarifies difficult vocabulary and simplifies it for readers, making these masterpieces of Arabic literature easier for them to comprehend. It is referred to as “SAMER”. Additionally, another tool was developed within the "Maknouna Dictionary" project, which aims to list 37 thousand words, phrases, and dialects from Palestinian dialects, including those that have been eradicated. To preserve these words and to benefit from them, a dictionary was developed to contain them. Moreover, one of the intriguing aspects of the project is that most of the words were collected from living individuals, some of whom had already passed away at the time of the project's launch [22].

The emerging field of artificial intelligence (AI) presents a variety of opportunities and challenges for Arabic linguists. Additionally, [4] and [5] have emphasized the importance of machine learning translation and natural language processing to bridge communication gaps and enhance Arab language learning. Nevertheless, there are several concerns that arise, such as the cultural and linguistic interrelationship [4] emphasizing the necessity of culturally sensitive AI applications.

Alruqi and Alzahrani [6] stated the potential of artificial intelligence employed in chatbots to provide an interactive learning experience despite the absence of Arabic-specific models. In addition, applications such as Busuu and Arabits demonstrate how artificial intelligence can be used to improve Arabic language learning through interactive and engaging approaches [10]. It should be noted, however, that the effectiveness of such technologies is contingent upon overcoming a number of technical and accessibility obstacles. These studies suggest that artificial intelligence may have a significant impact on Arabic language learning, provided that researchers and experts continue to address these challenges in an intelligent manner. To explore these possibilities further, this study employs a comprehensive methodology to assess the effectiveness of AI applications in Arabic language learning and address the identified challenges.

3. Methodology

The purpose of this study was to evaluate how artificial intelligence can be integrated into Arabic language learning, teaching, and linguistic processing. As a result of a thorough examination of existing studies, this study was able to identify the main themes, challenges, and future directions associated with the intersection of artificial intelligence and the Arabic language. The methodology includes a detailed research approach, an effective searching strategy, clearly defined selection criteria, and a robust process of synthesis and analysis to comprehensively assess the current literature.

3.1. Research Approach

Study methodology incorporated a literature review approach to examine the integration of artificial intelligence into Arabic language teaching, learning, and linguistic processing. Furthermore, the adopted approach provided a deeper understanding of artificial intelligence and Arabic rather than strictly adhering to a predetermined protocol.

3.2. Searching Strategy

The primary source for literature was Google scholar, which was utilized due to its extensive repository of scholarly articles across disciplines. To ensure that the most relevant studies were identified, a focused search strategy was employed, using specific keywords. Furthermore, the ‘allintitle:’ operate was used to restrict search results to documents whose title explicitly monitors 'Artificial intelligence' and 'Arabic language'.

Consequently, studies directly addressing the review's main focus were targeted. In order to ensure a comprehensive coverage of the topic, the following search queries were used: "Arabic language" "Artificial intelligence", "Arabic language" "AI" and "Arabic " "AI"

3.3. Selection Criteria.

There were a number of articles included in the review that address the application of artificial intelligence in the context of the Arabic language in terms of teaching, learning, translation, and processing. Both Arabic and English language publications were considered in order to ensure a comprehensive understanding of the field. What is more, the relevant information related to AI technologies were discussed and special attention was given to the students that highlighted the challenges, opportunities and future directions of the intersection of AI and Arabic language.

3.4. Synthesis and Analysis

A synthesis of the collected data was conducted in order to identify emerging themes and trends in the literature. In addition, the analysis focused on constructing a unified narrative which defines the current AI applications that are confined to the Arabic language domain, highlighting major advances, challenges, and future research directions.

4. Results and Discussion

To explore the current trends and focal areas in AI and Arabic language, NVIVO 12 was utilized to generate graphics to summarize the predominant world views regarding AI and Arabic language. In addition, the generated word cloud provides an overview of the most frequently used terms in the revised literature about AI applications in Arabic. A number of terms and concepts have been studied in recent years, including: "learning," "Arabic language," "artificial intelligence," "machine," and "applications".

Figure 1. Word cloud analysis of AI applications in Arabic language research

Figure 1 illustrates the thematic landscape addressed by the literature review presented in this study. This narrative emphasizes the strong use of artificial intelligence technologies in learning environments, particularly language learning environments. The results of this study align with those observed by [10] and [14] that utilized artificial intelligence to learn Arabic. A major feature of the "Arabic language" theme is its emphasis on language acquisition, learning, and translation in Arabic. This aligns with [16]'s study which highlighted the use of platforms such as Duolingo in mastering the Arabic language. A key component of the literature review was also the term "artificial intelligence". Further, it appears from the graph that it is juxtaposed with two other themes, which are "machine" and "applications" suggesting a broader examination of AI's potential in terms of machine learning and natural language. According to [5], artificial intelligence has a significant role to play in Arabic literature.

It is also in line with the study conducted by [6] regarding the use of chatbots for learning Arabic. It is interesting to note that the convergence of themes "research," "study," "educational," and "university" suggest a concerted effort is being made to deepen the use of artificial intelligence in Arabic language pedagogy. Al-Gharaibeh [4] notes that such efforts will assist in addressing cultural challenges. Furthermore, it appears from the visual data that there is a significant focus on utilizing AI's applications in educational contexts. In addition, the dominant themes that appeared in the word cloud indicate that these themes have received the most attention, indicating the priorities guiding the current literature review. Aside from illustrating the current trends in AI applications for Arabic language, Figure 1 also provides guidance for future research directions. Furthermore, Figure 2 below demonstrates the results of the text search query from NVivo showing the most prevalent topics discussed in the context of AI and the Arabic language.

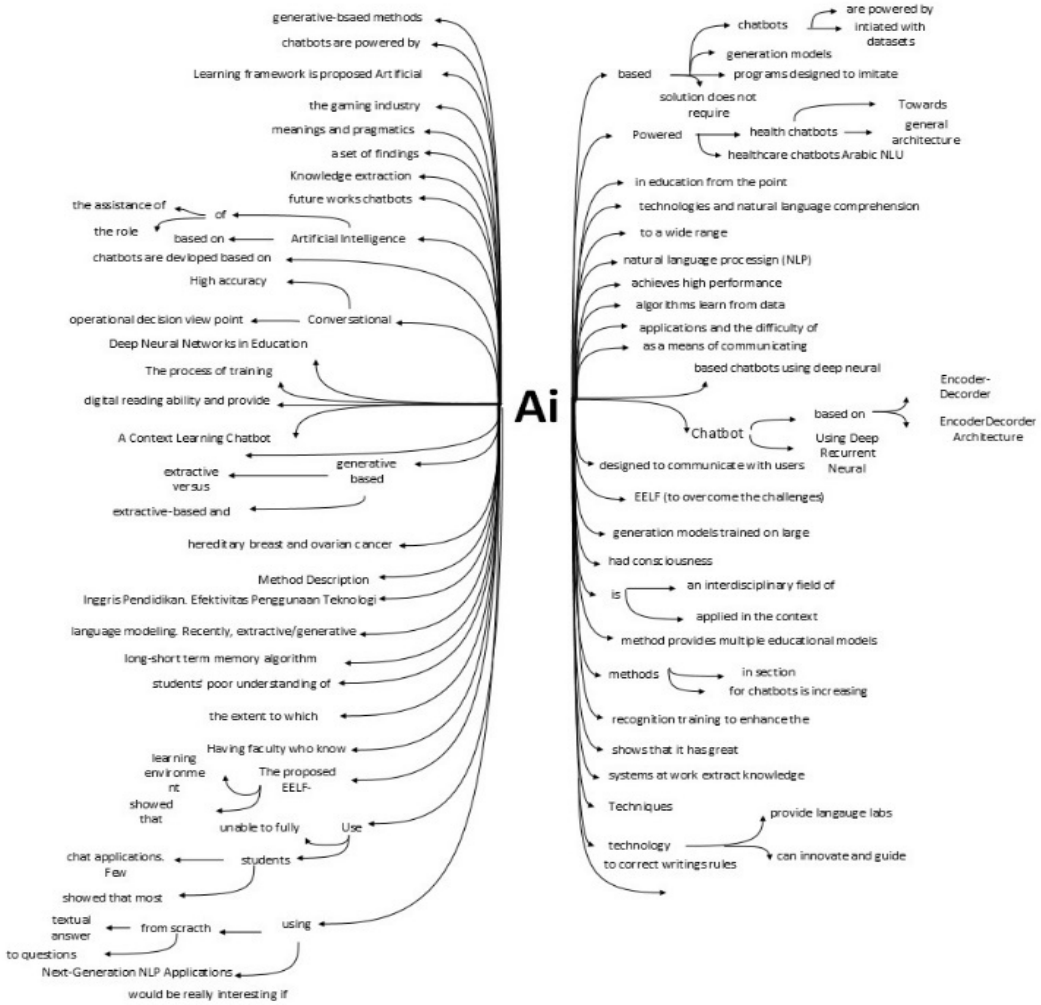

Figure 2. Text search query results, initially generated by NVivo and redrawn in Visio, showing the most prevalent topics discussed in the context of AI and the Arabic language.

The results of NVivo's text search query are shown in Figure 2, which illustrate the thematic focus found in the literature examined, as well as the intersection between the Arabic language and artificial intelligence. Several key areas of scholarly research are represented in the figures, including “chatbots” “NLP applications” and “deep neural networks” According to Figure 2 above, the results of the NVivo search query reveal a rich tapestry of concepts commonly used in this field. It is also evident that "Artificial Intelligence" has a central place amongst other domains. Nearby is "chatbots", which is commonly observed. This illustrates the significance of artificial intelligence for language learning and practice. In line with [6] results on utilizing artificial intelligence-driven chatbots for language interaction facilitation, and this is also associated with the use of "deep neural networks" and "encoder-decoder architectures" It is evident that such technologies are being made to enhance learning processes, as well as demonstrating the capability of artificial intelligence to navigate human language complexity.

The significance of natural language processing in education can be highlighted through the connection between "NLP applications" and "education", particularly with language learning environments. It has been demonstrated by [5] and others that NLP serves as a cornerstone for developing AI tools to enhance Arabic linguistic comprehension. In addition, the terms "knowledge extraction," "interactive," and "healthcare chatbots" indicate that artificial intelligence is expanding beyond general language learning into more specific fields in which nuanced communication is essential. A visual representation of the key points discussed throughout the study is also provided in Figure 2. According to the article, AI applications in Arabic linguistic landscapes are a rapidly developing field that is characterized by both challenges and opportunities. As a result, continuous research and development in artificial intelligence is necessary to address the complexity of Arabic language. Furthermore, the paper discussion will be synthesized with the results of this study.

In previous studies, it has been shown that artificial intelligence can be used to enhance learning and teaching of the Arabic language, as well as facilitating communication between speakers of other languages and those who learn it, as well as providing learners with personalized and interactive learning. Several techniques and models are used to accomplish this, including machine translation.

Using computer algorithms, machine translation automatically translates texts and conversations from one language to another. The complex grammatical structure of the Arabic language, which differentiates it from other languages, presents some challenges in machine translation of Arabic because it affects the accuracy of translation from and into Arabic. Furthermore, the Arabic language has many dialects, which presents another challenge. In most cases, machine translation applications translate texts and conversations in Standard Arabic as the primary language. There are some differences when using different dialects of the Arabic language, since this involves the use of new terms and words with different pronunciations, which is challenging when translating these texts accurately.

It is important to note that Arabic language words can have different meanings depending on the context in which they are used, and therefore, machine translation software and applications may not be able to translate these words accurately. The applications of machine learning were also discussed above, which is the process of teaching computers to learn and make decisions. For analysis and correlation of words and their translations in the Arabic language, a computer is provided with a large number of words and their translations. For example, when using machine learning to translate a three-word phrase, the words are analyzed and then the context in which they appear is recognized so that a correct translation can be provided to the user. There has been some concern regarding the application of artificial intelligence that is linked to the Western cultural hierarchy of the Arabic language, especially since many of the artificial intelligence applications used in this field were developed by Western societies, thus aiding in the transmission of different cultures and traditions, as well as the use of some English words as alternatives to Arabic ones.

The role of artificial intelligence appears when using various chatbots to generate and correct phrases written in Arabic, and in light of the tremendous role that these robots play in providing dedicated support to language learners, there is a shortage of these applications that address the Arabic language accurately due to some challenges associated with the richness of the language. Due to Arabic's multiple contexts in which words are used, which can change their meaning, it is imperative to develop artificial intelligence models to theorize the skills of its speakers. In order to increase awareness of the importance of using modern technologies, such as artificial intelligence, in learning, teaching, and correcting Arabic, conferences, seminars, and lectures are also necessary, according to studies.

What is more, due to the danger of being behind in the field of learning, disseminating and processing Arabic language in comparison to other languages, it is possible to be delayed in keeping up with modern technologies. There is a lack of Arabic content on the Internet when compared to other languages available, and some search engines may refuse to index Arabic in the future if there is no content available.

5. Conclusion

By offering a wide range of opportunities and challenges associated with generating, learning, and proofreading Arabic content, AI applications have significantly transformed the landscape of the Arabic language in our era. A review of previous literature was conducted in order to assess the current effectiveness of AI tools in improving Arabic language settings. This study examines the interaction between AI and Arabic language. According to the study, artificial intelligence has the potential to revolutionize Arabic language learning by developing advanced models capable of comprehending Arabic content. Despite this, there are a number of challenges and obstacles that limit its optimal application in Arabic language contexts. Furthermore, the study demonstrates the Arabs' efforts to align AI with the Arabic linguistic needs that also aim to enhance their language proficiency.

Further, it discussed possible innovations in the fields that could bridge the gap between artificial intelligence applications and Arabic languages. An excellent opportunity exists in deploying artificial intelligence in education, particularly in Arabic teaching and learning. For AI to be beneficial, teachers and students need to be trained in how to use AI tools and to be offered lessons on ethical use of AI apps to enhance the Arabic teaching and learning process without compromising ethical standards. Furthermore, more artificial intelligence applications that can assist and improve learning are required by developers. As a result, educational institutions should provide a good infrastructure in order to facilitate research and publication to find the best ways to enhance and improve the Arabic language learning process, such as the use of up-to-date technologies, technical support, as well as a strong internet connection.

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