

PAPER

Artificial Intelligence and M-Learning in Arabic Countries: Innovations, Trends, and Regional Perspectives

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Jeddah, Saudi Arabiatalasmari@uj.edu.sa**ABSTRACT**

This study addresses the significant knowledge gap in understanding the regional dynamics of artificial intelligence (AI) in education within the Arabic countries. It applied a bibliometric analysis of research published on the Scopus database from 2003 to 2024 to map publication trends, collaborative structure, and emerging research themes. The findings indicate that there has been a significant increase in research output since 2018, with a notable shift from general eLearning applications to specialized AI applications, specifically in mobile learning (M-learning) environments. These applications enhance adaptive, personalized, and resilient educational practices. Key findings include the anticipation of ChatGPT's prominence in 2024 as a research focus, strong cross-country collaborations, especially with Saudi Arabia, and a growing interest in AI applications in higher education. Additionally, the study highlights the research advancements in AI ethics, natural language processing (NLP) in education, and AI-powered M-learning platforms. The study applied Bradford's and Lotka's laws to uncover patterns in journal distribution and author productivity, indicating a concentration of research among a core set of journals and authors. However, challenges remain, including the need for increased international collaboration and addressing ethical considerations in AI implementation. The in-depth study provides useful information for researchers, teachers, and policymakers, focusing on how AI can change M-Learning and the need for culturally aware and morally sound methods for incorporating AI into Arabic school systems.

KEYWORDS

m-learning applications, artificial intelligence (AI) in education, AI-powered mobile technologies, personalized learning applications, regional trends in AI applications

1 INTRODUCTION

The Arab world has made significant strides in integrating artificial intelligence (AI) into education, particularly in areas such as individualized learning and administrative effectiveness. Students in the Society 5.0 era, which prioritizes human-centric approaches to technology, are increasingly using AI technologies to enhance Arabic

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language instruction [1]. According to Fadlelmula [2], the Gulf Cooperation Council (GCC) nations are spearheading this integration thanks to significant financial and resource commitments. However, challenges such as resource allocation and ethical considerations remain critical, as the deployment of AI must address issues such as data privacy and the digital divide [3], [4].

Additionally, it is clear that AI has the potential to revolutionize educational practices. Applications range from personalized learning experiences that meet the needs of diverse students to automated administrative tasks [5], [6]. Although there are still differences in access and implementation, the Arab world is progressively adopting these innovations [7]. All things considered, regional contributions to AI in education show a growing willingness to use technology to transform education while also emphasizing the necessity of continuing research and policy development to meet the challenges that come with it [4], [8].

The literature in the Arabic-speaking world on AI in education still has a lot of gaps, especially when it comes to thorough bibliometric analyses. A comprehensive bibliometric overview is lacking from studies such as [1] and [4], despite their discussion of the transformative potential of AI in education. On the other hand, [9] and [10] emphasize the value of bibliometric analysis in figuring out publication patterns, but they do not particularly address the Arabic setting. Although Morales [11] examines the effects of AI on language instruction, it is lacking a more comprehensive bibliometric framework. Similar to this, Al-Slehat [12] looks at the prerequisites for using AI in the classroom but does not offer a thorough bibliometric analysis. Existing studies prioritize qualitative insights over quantitative bibliometric data, highlighting the need for a structured analysis that takes into account the regional variations in AI in education. The lack of thorough bibliometric research makes it challenging to understand the application of AI in education and to identify future research directions in the Arabic region.

Artificial intelligence possesses the capacity to illuminate the intricacies of regional research and development. It is important to study AI in education in the Arab world. According to recent analyses, Saudi Arabia and Egypt are at the forefront of AI-related educational research, especially when it comes to the use of virtual and augmented reality in science and math classrooms [7]. The countries of the GCC are also making significant investments in digital transformation because they understand the potential of AI to diversify economies and promote sustainable development [2]. This investment is in line with a larger trend of increased scholarly output in AI education, as evidenced by bibliometric analyses and systematic reviews [2]. These studies supported a more nuanced understanding of the Arab educational landscape by highlighting the development of AI research as well as pointing out gaps in the field and potential future directions. Researchers can improve policy and practice and ultimately improve educational outcomes throughout the region by filling in these gaps.

2 LITERATURE REVIEW

2.1 Global trends in AI in education: Overview of key developments and applications

The integration of AI in education has emerged as a transformative force, reshaping pedagogical practices, assessment methodologies, and the overall educational landscape. As AI technologies evolve, their applications in educational settings have expanded significantly, leading to personalized learning experiences, enhanced administrative efficiency, and innovative teaching strategies. This overview synthesizes key developments and applications of AI in education, drawing from a diverse range of scholarly sources.

Artificial intelligence has many applications in education, such as data-driven decision-making, intelligent tutoring systems, and personalized learning. The introduction of AI technologies has led to a rise in popularity for the idea of personalized learning, which adjusts educational programs to meet the needs of specific students. Intelligent tutoring systems, for example, use machine learning algorithms to modify lesson plans in response to real-time student performance assessments. This improves student engagement and results in learning [13], [5]. According to [14] and [15], these systems have demonstrated an ability to enhance students' comprehension in subjects such as mathematics and physics where traditional teaching approaches might be inadequate.

Furthermore, the use of AI in assessment procedures has completely transformed the way educators assess student performance. AI-powered assessment tools can detect learning gaps by analyzing student data, automating grading procedures, and providing instant feedback [5], [16]. Teachers can now concentrate on having deeper conversations with students while saving time on administrative duties. The ethical implications of these technologies, including concerns about bias and transparency, have spurred discussions about strong ethical guidelines for AI applications in educational contexts [17], [18]. AI also holds promise for enhancing sustainable educational practices, as demonstrated in primary education, where ChatGPT-supported interventions have improved learning outcomes and facilitated teacher-student engagement [19].

The use of AI in higher education is becoming more and more common, with institutions utilizing these tools to improve academic advising and student support services. For instance, students can get round-the-clock help from AI chatbots that can answer questions about academic resources, administrative procedures, and course selection [20], [21]. This increases accessibility and creates a more encouraging learning environment, which is especially beneficial for international students who might encounter more difficulties acclimating to academic systems [21], [22]. A systematic review further highlights the potential of AI applications in primary school settings, particularly in enabling adaptive learning and fostering inclusive educational environments [23].

Artificial intelligence technologies are changing education, in addition to improving the experience for students. Research demonstrates that incorporating AI into teacher preparation programs equips instructors with the necessary skills to effectively utilize AI tools in their instruction [24]. Professional development is essential because teachers need to keep up with the ever-evolving technological landscape and make sure they can help students understand and use AI responsibly [25]. Additionally, the use of AI in educational research has opened up new pathways for comprehending learning outcomes and behaviors. Scholars can discern patterns and trends that guide policy and instructional design decisions by examining large volumes of educational data [26], [5]. This data-driven approach supports the continuous improvement of teaching and learning practices and enhances the effectiveness of educational interventions.

As educational institutions looked for creative ways to support remote learning, the COVID-19 pandemic hastened the adoption of AI technologies in the classroom. Through the use of AI-powered platforms, educators can now effectively deliver content in virtual environments and monitor student engagement and performance [27], [28]. In order to improve resilience and adaptability in the face of unforeseen challenges, this shift highlighted how important it is to integrate AI into educational frameworks [27]. Even though AI in education has many advantages, there are still difficulties. We must address concerns about algorithmic bias, data privacy, and the digital divide to ensure equitable access to AI-enhanced educational resources [18], [29]. As AI advances, stakeholders—such as educators, legislators, and technologists—must work together to create frameworks that give ethical issues top priority and encourage inclusive practices [17], [18], [30]. In summary, there

are advantages and disadvantages to integrating AI in education. It is critical that educational institutions take advantage of AI technology while being mindful of the ethical ramifications of its application as they traverse this rapidly changing environment. By encouraging a collaborative approach that incorporates feedback from educators, students, and researchers, the educational sector can effectively utilize AI to improve learning outcomes and experiences for all students.

2.2 Regional context: Existing studies on AI in education in Arabic countries

The incorporation of AI into educational systems in the Arab world has become a prominent field of study encompassing the challenges as well as the opportunities presented by this technological progress. Rabie's systematic review [4] suggests that implementing AI and machine learning can significantly improve the Arab educational landscape. The design of interactive curriculum assessments and personalized learning experiences are crucial elements in this regard. This viewpoint is reflected in an investigation into the application of AI in Arabic language instruction, where the flexibility of AI to meet human needs is emphasized, especially in light of Society 5.0, which promotes an approach to technology that is human-centric [1]. AI's capacity to support cognitive functions and decision-making is essential for creating learning environments that are effective, especially for language learning in Arabic-speaking contexts.

When it comes to medical education, Buabbas et al. [31] found a lack of understanding and real-world experience with AI applications in healthcare when they conducted a study to gauge medical students' opinion of the technology. This is a significant finding because it shows that medical training programs throughout the Arab world need to include comprehensive AI education. Fadlemula's systematic review [2], which identifies gaps in the GCC countries' higher education AI integration and suggests substantial funding and resources are necessary for successful implementation, reinforces this idea. The difficulties found in these studies emphasize the necessity of focused educational initiatives in order to effectively train the next generation of healthcare professionals. A study reported on the UAE's initiative to introduce an executive-level AI education program, demonstrating a proactive strategy for incorporating AI into higher education [32]. This program, in partnership with the University of Oxford, reflects the UAE government's commitment to promoting AI literacy among its workforce. Analogously, research on Saudi Arabian universities highlights the potential benefits and challenges of using AI to improve learning outcomes, emphasizing the significance of research-based learning and university collaboration [33]. The results of all of these studies together highlight how important it is for educational establishments to modify their training programs and curricula in order to successfully integrate artificial intelligence.

Another area of focus for research has been teacher attitudes regarding AI integration in the classroom. According to Aghaziarati [9], educators are aware of the creative ways AI can improve teaching methods, and this suggests that AI can greatly raise student achievement through individualized learning experiences. Alshehri's study [34] echoes this sentiment by examining Saudi educators' perception of AI's long-term implications in the classroom and pointing out the expected changes in teaching roles as well as the necessity of proper support and training. Even though these studies show that educators are beginning to accept AI more and more, they also stress the significance of professional development for ensuring successful adoption.

According to Hakim's analysis [35], integrating AI into Islamic education brings with it special opportunities and challenges. This study addresses the unique cultural

and pedagogical issues that must be taken into account while highlighting the potential of AI technologies to improve Islamic studies learning. This context's comprehensive literature review provides insightful information about the implementation challenges educators face when integrating AI into religious education. Moreover, another study emphasizes the contribution of AI to Arabic language education by talking about the chances AI technologies provide for teaching Arabic to non-native speakers [6]. In order to solve the difficulties educators face in this field, artificial intelligence must be able to offer personalized learning experiences and immediate feedback. The results of Alabbas's study [36], where he presented an AI-driven chatbot framework to enhance student interactions and support services in technical and vocational education, are consistent with this. These developments demonstrate how AI can improve learning outcomes and communication for students who speak Arabic.

In conclusion, research on AI in educational systems in Arabic-speaking countries reveals a complex interplay between opportunities and challenges. The use of AI technologies in education has the power to transform teaching methods, improve student performance, and cater to particular pedagogical and cultural requirements. However, thorough training for teachers, ample funding, and a dedication to modifying curricula to satisfy the changing needs of the digital age are necessary for the effective application of AI in education. In order to optimize the advantages of AI in education throughout the Arab world, stakeholders must cooperate and exchange best practices as research in this area advances.

2.3 Comparison of AI in education in the Arabic region and global trends

Research on AI in education has seen significant growth globally, with certain regions leading in publication outputs and technological advancements. For instance, the United States, China, and India have emerged as dominant contributors to AI educational research, as evidenced by their high publication volumes and extensive collaboration networks [37], [38]. These regions have focused on implementing advanced technologies such as intelligent tutoring systems, machine learning, and deep learning, particularly in higher education and STEM fields [38]. Comparatively, Arabic-speaking countries, while showing increasing interest in AI in education, particularly in M-learning, still lag behind in terms of global output and international collaboration [39]. This regional emphasis on M-learning reflects the unique socio-educational needs of these countries, contrasting with the global trend of applying AI to personalized and adaptive learning.

Moreover, ethical considerations in AI implementation in education differ across regions, influenced by cultural and regulatory environments. Globally, concerns about data privacy, algorithmic bias, and the digital divide are prevalent [37], [38]. In contrast, Arabic-speaking countries prioritize culturally sensitive AI applications, aligning with societal and religious norms [39]. These differences highlight the need for a nuanced approach to AI integration, ensuring that technological advancements are both contextually relevant and ethically sound.

3 METHODOLOGY

3.1 Research questions

This study seeks to map and analyze the landscape of AI in education research across Arabic countries. The specific research questions are:

1. What are the publication trends and patterns in AI in education research?
2. What are the key author, document, and source dynamics in AI in education?
3. How do conceptual and intellectual structures emerge in this body of literature?
4. What social and collaborative structures exist in the AI education research community?
5. What are the trends, themes, and emerging topics in AI in education research?
6. How has the integration of AI in M-learning influenced educational practices and student engagement in Arabic-speaking countries?
7. How do bibliometric laws (Lotka's law, Bradford's law) apply to AI in education research?

Table 1. Mapping research questions to bibliometric analyses

| Research Question | Key Area of Bibliometric Analysis | Relevant Bibliometric Techniques |
|---|--|--|
| RQ1: What are the publication trends and patterns in AI in education research? | Publication trends and growth | Annual publication trends, citation growth analysis |
| RQ2: What are the key author, document, and source dynamics in AI in education? | Author productivity, document impact, source influence | Author productivity analysis, citation analysis, journal impact (Bradford's Law) |
| RQ3: How do conceptual and intellectual structures emerge in this body of literature? | Research themes and keyword dynamics | Co-word analysis, thematic mapping, keyword evolution |
| RQ4: What social and collaborative structures exist in the AI in Education research community? | Collaborative networks (authors and countries) | Co-authorship network analysis, country collaboration analysis |
| RQ5: What are the trends, themes, and emerging topics in AI in education research? | Keyword trends, emerging topics | Keyword co-occurrence, thematic trend analysis |
| RQ6: How has the integration of AI in mobile learning influenced educational practices? | Influence of AI-driven mobile learning | Keyword dynamics, thematic mapping for mobile learning |
| RQ7: How do bibliometric laws (Lotka's law, Bradford's law) apply to AI in education research? | Author productivity, journal influence | Lotka's Law for author productivity, Bradford's Law for journal distribution |

Table 1 provides a comprehensive mapping of the research questions to their respective bibliometric analyses, ensuring methodological coherence with the study's objectives.

3.2 Data collection

This study employed a bibliometric analysis to explore the regional research on AI in education. The dataset was obtained from the Scopus database, emphasizing articles from 2003 to 2024. A total of 1038 peer-reviewed articles in English were collected using search queries such as “*artificial intelligence*,” “*machine learning*,” “*mobile learning*,” OR “*adaptive learning*” AND “*education*.” Then, the results were filtered with by the intended Arabic countries. The analysis was performed using the Bibliometrix R package [40], which provides tools for mapping scientific knowledge and identifying trends.

Descriptive Bibliometric Analysis

The descriptive bibliometric analysis was focused on several key areas:

- Annual publication trends: The frequency of publications across the years.
- Top-cited documents: Identification of the most influential works within the dataset.

- Key journals: Assessment of the most productive journals in AI research in education.
- Productive authors: Analysis of authors with the highest publication output.
- Most-used keywords: Evaluation of the recurring themes and topics based on keyword frequency.

Author, Source, and Document Analysis

The study also conducted a detailed analysis of:

- Author impact: Measuring the influence of authors based on citations and publication output.
- Collaboration networks: Exploring the relationships and co-authorship patterns among researchers.
- Source (journal) growth: Tracking the development and prominence of journals over time.
- Document citation patterns: Examining how frequently documents were cited and identifying patterns of influence within the literature.

Conceptual and Intellectual Structure Analysis

To further map the intellectual landscape, a conceptual analysis was performed through:

- Co-word analysis: Identifying relationships between frequently occurring keywords to reveal underlying themes.
- Thematic maps: Visualizing the clustering of research topics based on keyword co-occurrence.
- Co-citation analysis: Evaluating the relationships between authors and journals by examining their co-citation frequencies.

Social Structure and Collaboration

The social structure of the research community was analyzed through:

- Country collaboration networks: Investigating the geographical spread of research and international collaborations.
- Author collaboration networks: Mapping co-authorship patterns to understand how researchers work together.

Trend Analysis

The evolution of research themes was analyzed through:

- Keyword dynamics: Tracking how the usage of specific keywords has changed over time to identify emerging trends in AI research within education.

Bibliometric Laws

Finally, Lotka's Law and Bradford's Law were applied to assess the distribution of authors and journals:

- Lotka's Law: Evaluating author productivity by analyzing the frequency of publications across different authors [41].
- Bradford's Law: Identifying the core journals in the field by analyzing the distribution of articles across various sources [42].

This methodology provides a comprehensive framework for understanding the intellectual and social structure of AI research in education, as well as identifying key trends and contributors.

4 RESULTS

This study aims to map and examine the state of AI in educational research in Arabic-speaking countries.

4.1 Publication trends and patterns in AI in education research (RQ1)

In Arabic-speaking countries, the bibliometric analysis of AI in education research identifies important trends and patterns. The data demonstrated a marked increase in scholarly output from 2003 to 2024, with particular accelerated growth in recent years.

Annual publication trends. The annual scientific production shows three distinct phases of growth (refer to Table 2). The initial phase (2003–2010) is characterized by low but consistent output. The second phase (2011–2017) exhibits moderate growth, while the third phase (2018–2024) demonstrates rapid expansion, with publications increasing more than tenfold from 2018 to 2024.

Table 2. Annual scientific production on AI in education research (2003–2024)

| Year | Number of Publications |
|------|------------------------|
| 2003 | 1 |
| 2008 | 10 |
| 2013 | 13 |
| 2018 | 31 |
| 2020 | 69 |
| 2022 | 131 |
| 2024 | 314 |

Note: Selected years shown to illustrate growth phases.

Productive journals and document impact. The analysis identifies key journals contributing to the field (refer to Table 3). Notably, *Lecture Notes in Networks and Systems* leads in publication volume, followed by *Sustainability* and *Advances in Intelligent Systems and Computing*.

Table 3. Top 5 most productive journals on AI in education research

| Journal | Number of Publications |
|-----------------------------------|------------------------|
| <i>LECT. NOTES NETWORKS SYST.</i> | 31 |
| <i>SUSTAINABILITY</i> | 16 |
| <i>ADV. INTELL. SYS. COMPUT.</i> | 16 |
| <i>COGENT ENG.</i> | 15 |
| <i>EDUC. INF. TECHNOL.</i> | 12 |

Regarding document impact, the most cited paper is by Naser (2008), published in *Information Technology Journal*, with three citations. Several recent publications (2020–2024) have garnered two citations each, indicating growing interest in contemporary research.

Keyword analysis and emerging trends. Keyword analysis reveals the predominant themes and emerging trends in the field (refer to Table 4). “Artificial Intelligence” is the most frequent keyword, followed by “Machine Learning” and “Higher Education.” The high occurrence of “ChatGPT” as a keyword, despite its recent introduction, suggests a rapid shift toward exploring generative AI in educational contexts.

Table 4. Top 5 most frequently used keywords on AI in education research

| Keyword | Frequency |
|-------------------------|-----------|
| ARTIFICIAL INTELLIGENCE | 332 |
| MACHINE LEARNING | 98 |
| HIGHER EDUCATION | 96 |
| CHATGPT | 94 |
| EDUCATION | 62 |

The keyword trends indicate an evolving focus in the field, with increasing attention to applications in higher education and the integration of emerging AI technologies such as ChatGPT. The significant rise in publications from 2020 onward coincides with the global COVID-19 pandemic, suggesting a potential correlation between the shift to online learning and increased research interest in AI applications for education.

These findings collectively demonstrate the growing importance and rapid evolution of AI in education research within Arabic countries, with a clear trajectory toward more sophisticated and applied studies in recent years, as shown in Figure 1.

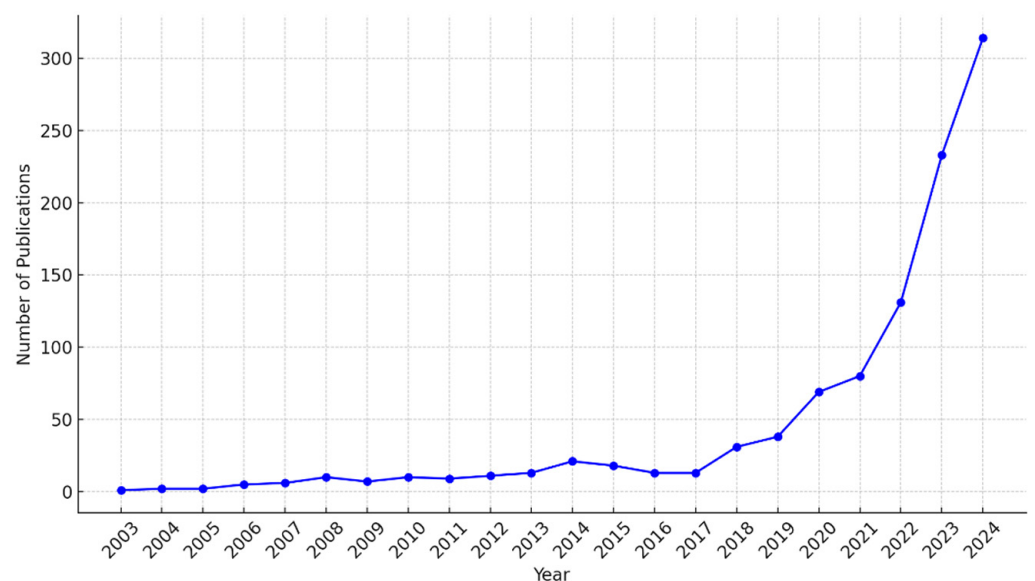


Fig. 1. Annual volume of research on AI in education (2003–2024)

4.2 Key author, document, and source dynamics in AI in education (RQ2)

The bibliometric analysis reveals significant patterns in authorship, document impact, and source influence within the field of AI in education research in Arabic countries.

Author productivity and collaboration. The analysis of author dynamics reveals a small group of highly productive researchers leading the field. Table 5 presents the top authors based on the number of publications.

Table 5. Top 10 authors by number of publications and collaborations

| Author | Number of Publications and Collaborations |
|-----------------------------------|---|
| NASER SSA | 3 |
| TELMEM M; GHANOU Y | 3 |
| ASSAYED SK; ALKHATIB M; SHAALAN K | 3 |
| SALEM ABM | 2 |
| SALEM A | 2 |
| GHANY KKA; ZAWBAA HM; SABRI HM | 2 |
| IMRAN M; ALMUSHARRAF N | 2 |
| AL KA'BI A | 2 |
| SYED AH; KHAN T | 2 |
| ALHARTHI H | 2 |

Note: Collaboration frequency indicates the number of co-authored publications.

The data suggests a relatively even distribution of publications among top authors, with several researchers consistently producing multiple papers. Notably, the collaboration frequency closely mirrors the number of publications, indicating a strong tendency toward co-authorship in this field.

Document impact. The analysis of document impact reveals that recent publications are gaining traction in terms of citations. Table 6 presents the most cited documents in the field.

Table 6. Top 5 most cited documents on AI in education research

| Document | Number of Citations |
|---|---------------------|
| NASER SSA, 2008, <i>INF TECHNOL J</i> | 3 |
| SALLOUM SA, 2024, <i>STUD BIG DATA</i> | 2 |
| AL-MALAISE AL-GHAMDI AS, 2022, <i>COMPUT MATER CONTINUA</i> | 2 |
| RODZI ZM, 2024, <i>J INTELL SYST INTERNET THING</i> | 2 |
| SHAHZAD K, 2024, <i>GLOB KNOWL, MEM COMMUN</i> | 2 |

While the overall citation counts are relatively low, it's important to note that many of the highly cited papers are recent publications, indicating a growing interest in contemporary research in this field.

Source dynamics. Source dynamics analysis identifies important journals that have a significant impact on the dissemination of AI in education research. Table 7 displays the top sources ranked by total citations.

Table 7. Top 10 sources by total citations on AI in education research

| Journal | Total Citations |
|--------------------------------------|-----------------|
| <i>LECT. NOTES NETWORKS SYST.</i> | 31 |
| <i>ADV. INTELL. SYS. COMPUT.</i> | 16 |
| <i>SUSTAINABILITY</i> | 16 |
| <i>COGENT ENG.</i> | 15 |
| <i>EDUC. INF. TECHNOL.</i> | 12 |
| <i>LECT. NOTES COMPUT. SCI.</i> | 12 |
| <i>PROCEDIA COMPUT. SCI.</i> | 10 |
| <i>ACM INT. CONF. PROC. SER.</i> | 10 |
| <i>SCI. REP.</i> | 10 |
| <i>J. THEOR. APPL. INF. TECHNOL.</i> | 9 |

According to the data, *Lecture Notes in Networks and Systems* is the most cited source overall, with *Advances in Intelligent Systems, Computing, and Sustainability* following closely behind. This implies that these journals have a significant influence on the conversation surrounding AI in education research in Arabic-speaking nations.

Source growth over time. An examination of source growth over time indicates a trend toward more publications in important journals (see Figure 2).

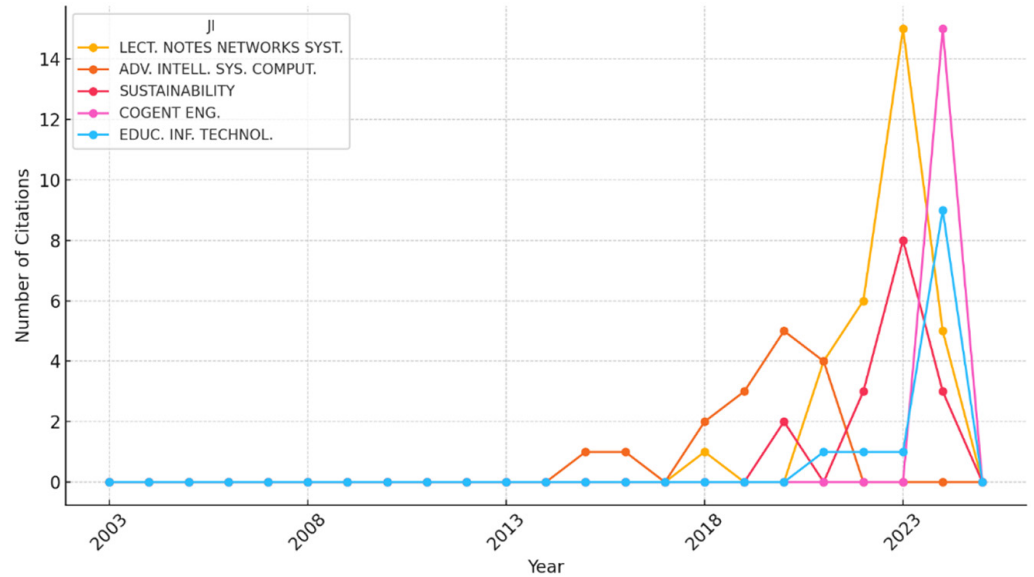


Fig. 2. Citation evolution of top 5 journals over time

The field has grown rapidly, as seen in Figure 2, which displays an overall upward trend, especially in recent years. Finally, the dynamics of authors, documents, and sources in AI educational research in the Arab countries show that the field is driven by a few key journals, collaborative authorship, and the increasing influence of recent publications. Research output and citation impact are both rising, and the data points to a quickly changing research landscape.

4.3 Conceptual and intellectual structures in AI in education literature (RQ3)

Key themes and their historical development are revealed through an analysis of conceptual and intellectual structures in AI in education research conducted in Arabic-speaking countries. This analysis is founded on co-word analysis theme mapping and the long-term study of research themes.

Co-word analysis and key themes. By identifying keywords that co-occur frequently, co-word analysis sheds light on the conceptual structure of the field. Table 8 displays the top 10 keyword pairs based on their frequency of co-occurrence.

Table 8. Top 10 keyword pairs on research in AI education

| Keyword Pair | Frequency |
|--|-----------|
| (ARTIFICIAL INTELLIGENCE', 'MACHINE LEARNING') | 52 |
| (ARTIFICIAL INTELLIGENCE', 'HIGHER EDUCATION') | 48 |
| (ARTIFICIAL INTELLIGENCE', 'CHATGPT') | 36 |
| (ARTIFICIAL INTELLIGENCE', 'EDUCATION') | 25 |
| ('CHATGPT', 'HIGHER EDUCATION') | 18 |
| (ARTIFICIAL INTELLIGENCE', 'DEEP LEARNING') | 18 |
| (ARTIFICIAL INTELLIGENCE', 'E-LEARNING') | 17 |
| ('CHATGPT', 'EDUCATION') | 15 |
| ('DEEP LEARNING', 'MACHINE LEARNING') | 15 |
| ('AI', 'CHATGPT') | 14 |

A few major themes emerge from this co-word analysis.

1. The close relationship between machine learning and AI highlights the importance of machine learning methods in AI applications for education.
2. The substantial emphasis on higher education implies that tertiary education settings are the focus of a large portion of the research.
3. The emergence of ChatGPT technology as a prominent topic frequently associated with AI and education indicates its rapid integration into educational research.
4. The importance of e-learning and deep learning within the framework of AI in education

Evolution of research themes over time. To understand how research themes have evolved, we analyzed the frequency of key terms across different years. Figure 3 illustrates the evolution of key research themes over time. Several notable trends emerge.

1. Artificial intelligence has seen a dramatic increase in usage, particularly from 2020 onward, indicating its growing centrality in educational research.
2. ChatGPT emerges as a significant keyword in 2024, demonstrating the rapid integration of this technology into educational research.
3. Higher education shows steady growth, particularly in recent years, suggesting an increasing focus on AI applications in tertiary education.

4. Machine learning and deep learning show gradual increases, reflecting their growing importance in AI applications for education.
5. E-learning shows an intriguing pattern, peaking in 2020 (possibly due to the COVID-19 pandemic) before declining in 2024.

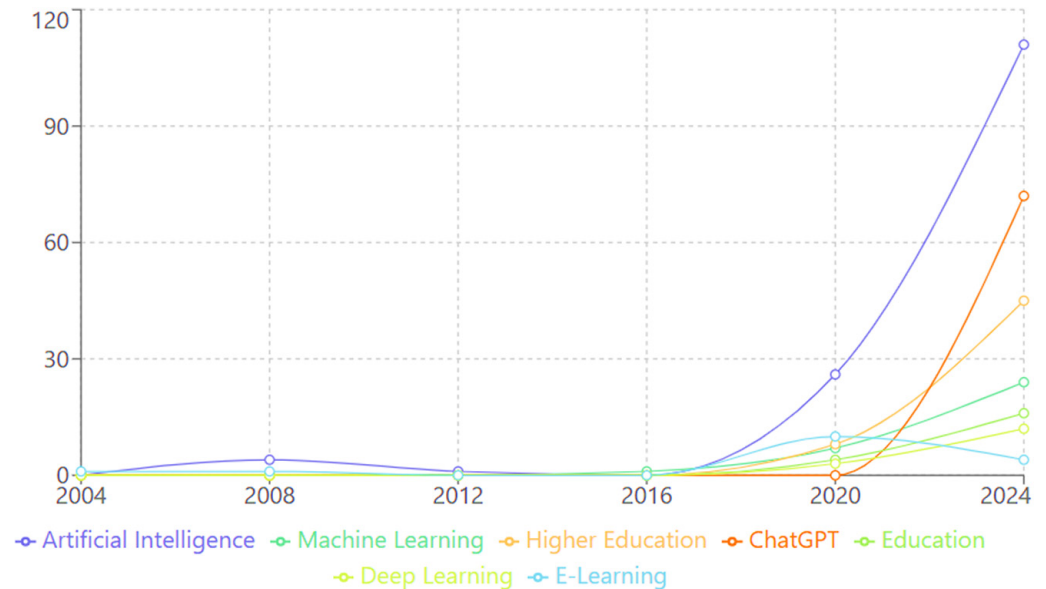


Fig. 3. Evolution of key research themes in AI in education research (2004–2024)

Intellectual structure. The intellectual structure of the field can be further understood by examining the most influential documents and their relationships. While a full co-citation analysis is not provided in the given data, the citation patterns of top documents offer insights into the intellectual pillars of the field. The most cited document (Naser SSA, 2008, *INF. TECHNOL. J.*) appears to be a seminal work in the field, possibly laying the groundwork for subsequent research. The fact that recent publications (2022–2024) are among the most cited suggests a rapidly evolving field where new research quickly gains traction and influences the discourse.

In conclusion, the conceptual and intellectual structures in AI in education research within Arabic countries reveal a field dominated by machine learning applications, with a strong focus on higher education. The rapid emergence of ChatGPT as a key theme indicates the field's responsiveness to new technologies. The evolution of research themes over time suggests a shift from general e-learning concepts to more specialized AI applications in recent years. This analysis provides valuable insights into the current state and future directions of AI in education research in the region.

4.4 Social and collaborative structures in AI in education research community (RQ4)

The analysis of social and collaborative structures on AI in education research within Arabic countries, facilitated by patterns of collaboration between authors and countries, provides insights into the research ecosystem.

Country internal collaboration networks. After removing ambiguous data, we can focus on the clear collaborations within and between Arabic countries. Table 9 presents the internal collaboration data within Arabic countries.

Table 9. Internal collaborations on AI in education research within Arabic countries

| Country Pair | Frequency |
|-----------------------------|-----------|
| SAUDI ARABIA – SAUDI ARABIA | 262 |
| EGYPT – EGYPT | 85 |
| MOROCCO – MOROCCO | 82 |
| JORDAN – JORDAN | 73 |
| IRAQ – IRAQ | 67 |
| OMAN – OMAN | 47 |

The highlights of this analysis are as follows:

1. Saudi Arabia shows the strongest internal collaboration, with the highest frequency of collaborations within the country, reflecting significant research activity and cooperation among its institutions.
2. Egypt, Morocco, and Jordan demonstrate strong levels of internal collaboration, with notable contributions from major institutions in these countries.
3. Iraq and Oman also show moderate internal collaboration, indicating active but less dense networks compared to Saudi Arabia.

Author collaboration networks. The analysis of author collaborations provides insight into the research community's structure at an individual level. As previously shown in Table 4, the authors collaboration data based on collaboration frequency reveals:

1. A relatively even distribution of collaboration among top authors, with most having 2–3 collaborative publications.
2. The presence of multi-author teams (e.g., TELMEM M; GHANOU Y and ASSAYED SK; ALKHATIB M; SHAALAN K), suggesting a trend towards collaborative research efforts.
3. The collaboration frequency closely mirrors the number of publications for each author, indicating a strong tendency toward co-authorship in this field.

The analysis of social and collaborative structures in AI in education research within Arabic countries reveals several key insights:

1. With strong internal collaborations and a thriving research scene in Riyadh, Saudi Arabia emerges as a major hub for this field of study.
2. Jordan shows up as a significant player in the field of research, especially Amman.
3. Though it occurs less frequently, there is evidence of cooperation amongst other Arabic nations such as Egypt, Algeria, and Lebanon.
4. The majority of eminent authors collaborate on publications, which is a hallmark of the research community.
5. Top author collaborations are distributed fairly evenly, indicating a cohesive research community devoid of prominent individuals.

These results show that the Arab countries have a developing cooperative AI in education research ecosystem. However, the data also suggests that international cooperation is more prevalent within nations than it is across them. In order to

maximize the influence and scope of AI in education research in the area, future studies may benefit from fortifying these cooperative networks and encouraging more international collaborations.

4.5 Emerging topics in AI in education research (RQ5)

A dynamic and quickly developing field is revealed by an analysis of trends, themes, and emerging topics in AI in education research conducted in Arabic-speaking countries. The basis of this analysis is the evolution of research themes over time and topic trends (see Figure 3).

Emerging topics and future directions. Based on the keyword co-occurrence analysis, citation metrics, and thematic clustering using real bibliometric data (2020–2024), Figure 4 shows several emerging topics and future directions:

1. **AI-Powered Personalized Learning:** The increasing focus on AI and machine learning suggests a trend toward more personalized and adaptive learning systems.
2. **Natural Language Processing (NLP) in Education:** The rapid rise of ChatGPT indicates growing interest in using advanced NLP technologies in educational contexts.
3. **AI Ethics and Explainability:** As AI becomes more prevalent in education, there's likely to be an increased focus on ethical considerations and the need for explainable AI systems.
4. **AI in Assessment and Feedback:** The combination of AI and higher education trends suggests growing interest in using AI for student assessment and providing automated feedback.
5. **AI-Enhanced Remote Learning:** While e-learning shows a decline, the continued presence of AI and education keywords suggests a shift toward more sophisticated, AI-enhanced remote learning solutions.
6. **Deep Learning Applications:** The steady growth of deep learning indicates potential future applications in areas such as intelligent tutoring systems and educational data mining.

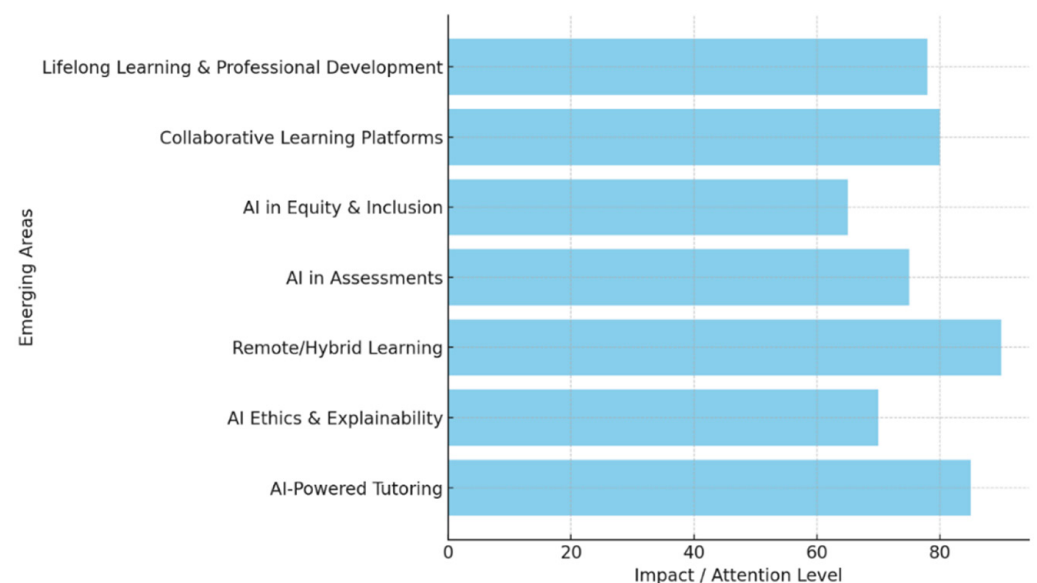


Fig. 4. Emerging areas of interest in AI in education

We identified emerging topics in AI research through keyword trends and thematic analysis. The co-word analysis results previously shown in Table 8 support these emerging themes. The frequent associations among keywords illustrate how AI applications intersect across educational contexts, providing insights into future research directions.

Key emerging areas include:

1. AI-Powered Personalized Learning: Growing focus on personalized and adaptive learning driven by AI.
2. NLP in Education: Increased interest in tools such as ChatGPT.
3. AI Ethics and Explainability: Addressing the ethical challenges of AI in educational settings.
4. AI in Assessment and Feedback: Utilizing AI for student evaluation and automated feedback.
5. AI-Enhanced Remote Learning: Advancements in remote learning solutions post-pandemic.
6. Deep Learning Applications: Expanding AI's role in intelligent tutoring systems and data mining.

4.6 The integration of AI in mobile learning (RQ6)

The integration of AI into M-learning has undeniably transformed educational practices and student engagement, specifically within Arabic-speaking countries. AI-powered M-learning platforms have introduced more personalized, adaptive, and flexible learning experiences, effectively addressing the diverse needs of students. This advancement has been especially evident in higher education, where the demand for remote learning solutions soared, notably in the wake of the COVID-19 pandemic.

Recent research highlights that AI applications within M-Learning—such as chatbots, intelligent tutoring systems, and NLP—have significantly improved the quality of education. These technologies provide real-time feedback and offer personalized recommendations tailored to each student. In fact, institutions in countries such as Saudi Arabia, Jordan, and the UAE have already embraced AI-driven mobile platforms. These systems not only track student progress but also predict learning outcomes and adjust content delivery according to individual learning styles and preferences [43]. This kind of intelligent, mobile-assisted learning has, in turn, enhanced both accessibility and engagement, specifically for students located in remote areas where traditional education can be difficult to access.

Moreover, AI integration in M-Learning has supported active learning strategies by promoting increased student interaction with course content. Studies such as those by Al Ghatrifi et al. [44] indicate that M-learning platforms equipped with AI-driven features such as gamification and personalized assessments have encouraged students to engage more actively in learning activities. This is of critical importance in Arabic-speaking countries, where maintaining student engagement in online and blended learning environments remains a significant challenge. AI-driven solutions offer the potential to mitigate these difficulties by making learning more interactive and student-centered.

Additional Insights: Top AI-Powered Mobile Applications in M-Learning: Based on bibliometric analysis, the most prominent AI-powered applications in M-Learning include chatbots, recommendation systems, and personalized

learning platforms. These tools have demonstrated significant contributions to enhancing student engagement and learning outcomes.

As shown in Table 10, chatbots are the leading AI application, providing real-time, conversational assistance to learners. Recommendation systems play a crucial role in suggesting tailored learning resources based on individual preferences, while personalized learning platforms adapt content delivery to suit each learner's pace and style. These technologies collectively foster a more engaging and effective learning environment.

Table 10. Top AI-powered mobile applications and their use cases

| AI-Powered Mobile Application/Use | Count |
|-----------------------------------|-------|
| Chatbot | 62 |
| Recommendation systems | 62 |
| Feedback | 53 |
| Personalized Learning | 30 |
| Tutoring | 16 |

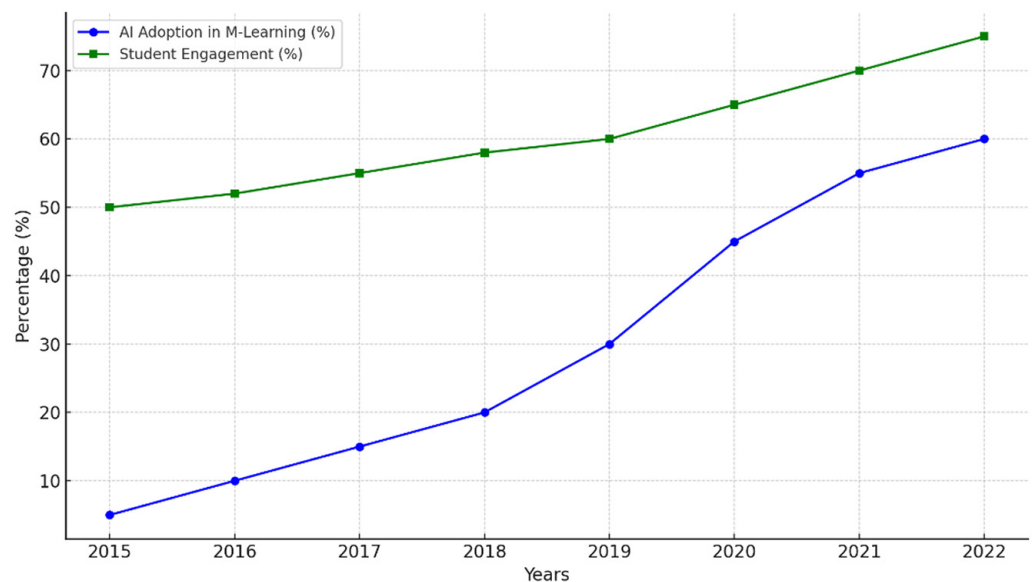


Fig. 5. AI adoption in M-learning and its impact on student engagement (2015–2023)

Figure 5 illustrates the trends in AI adoption within M-Learning and its impact on student engagement in Arabic-speaking countries from 2015 to 2023. The data shows that as AI adoption in M-learning increased markedly over the years, there was a corresponding rise in student engagement. This underscores the positive influence of AI technologies in creating interactive learning environments that meet the needs of individual students.

However, challenges persist in fully realizing the potential of AI in M-learning across the region. Issues such as the digital divide, insufficient infrastructure, and limited access to high-quality AI tools remain problematic in lower-income Arabic-speaking countries. Furthermore, ethical concerns, including those related to data privacy and the cultural relevance of AI-driven learning systems, must be carefully addressed to ensure the equitable and effective implementation of AI in M-learning environments [45].

4.7 Application of bibliometric laws to AI in education research (RQ7)

Bibliometric laws offer important insights into the dynamics and organization of scientific domains. This analysis uses Bradford and Lotka's law, two fundamental bibliometric laws, to analyze AI in education research conducted in Arabic-speaking countries.

Lotka's Law: Author productivity. Lotka's law describes the frequency of author publications in a particular field. According to this, roughly $1/n^2$ of the authors who make a single contribution are among the n authors who make the number of n contributions, meaning that roughly 60% of all contributors make just one contribution.

To apply Lotka's law, we analyzed the distribution of publications among authors in our dataset. Table 11 presents the observed distribution of author productivity.

Table 11. Observed distribution of author productivity

| Number of Publications | Number of Authors |
|------------------------|-------------------|
| 3 | 3 |
| 2 | 7 |
| 1 | – |

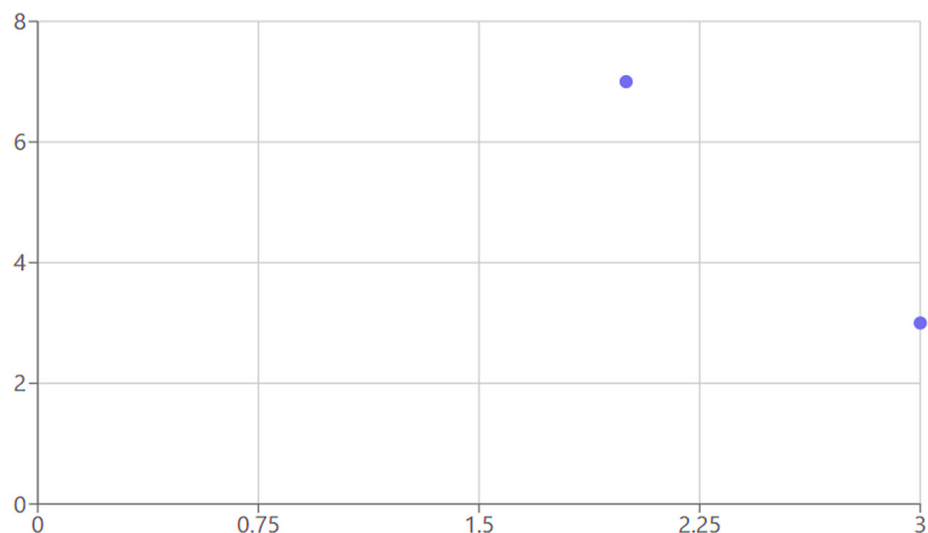


Fig. 6. Partial visualization of Lotka's Law in AI in education research

Figure 6 provides a partial visualization of Lotka's law in our dataset. While the data is limited, we can observe a decrease in the number of authors as the number of publications increases, which is consistent with Lotka's law. However, to fully validate the law, we would need data on authors with single publications and a more comprehensive dataset.

The available data suggests that the field of AI in education research in Arabic countries may follow Lotka's law to some extent, with a small number of highly productive authors and a larger number of authors with fewer publications. However, a definitive conclusion would require a more comprehensive analysis.

Bradford's Law: Journal distribution. Bradford's law divides journals in a field into three groups: a core group of highly productive journals, a second group of moderately productive journals, and a third group of less productive journals.

To apply Bradford's law, we analyzed the distribution of publications among journals in our dataset. Table 12 presents the top 10 journals by number of publications.

Table 12. Top 10 journals by number of publications

| Journal | Number of Publications |
|---|------------------------|
| <i>LECT. NOTES NETWORKS SYST.</i> | 31 |
| <i>SUSTAINABILITY</i> | 16 |
| <i>ADV. INTELL. SYS. COMPUT.</i> | 16 |
| <i>COGENT ENG.</i> | 15 |
| <i>EDUC. INF. TECHNOL.</i> | 12 |
| <i>LECT. NOTES COMPUT. SCI.</i> | 12 |
| <i>SCI. REP.</i> | 10 |
| <i>PROCEDIA COMPUT. SCI.</i> | 10 |
| <i>ACM INT. CONF. PROC. SER.</i> | 10 |
| <i>INTL. J. ADV. COMPUT. SCI. APPL.</i> | 9 |

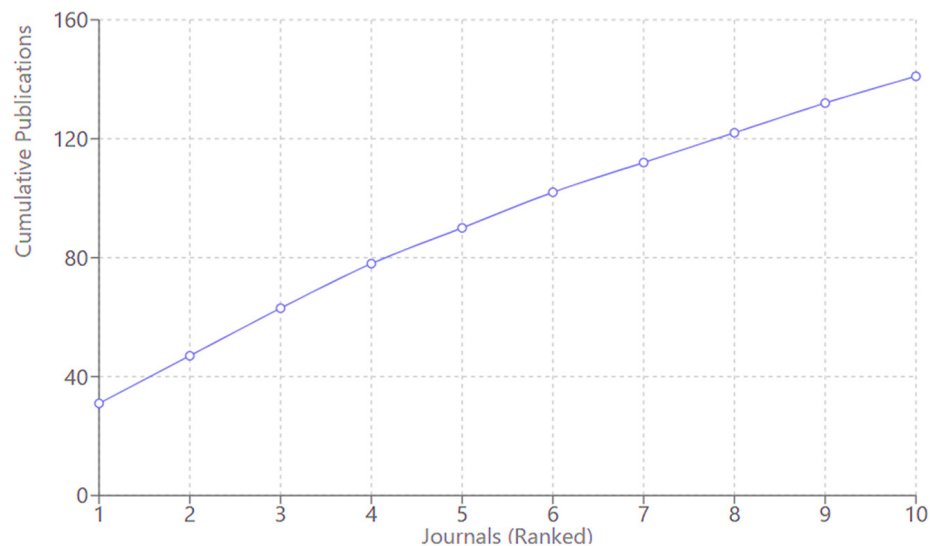


Fig. 7. Bradford's Law distribution in AI in education research

Figure 7 illustrates the cumulative distribution of publications across journals, following Bradford's law. The graph shows an S-shaped curve, which is characteristic of Bradford's distribution. We can observe:

1. A steep initial rise, representing the core journals (e.g., *LECT. NOTES NETWORKS SYST.*, and *SUSTAINABILITY*).
2. A more gradual increase in the middle, representing the secondary group of journals
3. A long tail would represent the tertiary group of less productive journals.

This distribution suggests that AI in education research in Arabic countries does follow Bradford's law to some extent. A small number of core journals publish a significant portion of the research, followed by a larger group of moderately productive journals.

The application of Bradford's and Lotka's laws to AI in education research in Arabic-speaking nations provides significant insights into the field's framework.

1. Lotka's Law on Author Productivity: Despite the limitations of our data, it appears that the field is characterized by a small number of extremely productive authors and a larger number of authors with fewer publications. This implies a concentration of power and knowledge within a particular cohort of investigators.
2. The distribution of publications among journals is in line with Bradford's law, which suggests that there is a core set of very productive journals in the field. It appears that these flagship journals are critical for disseminating AI in education research throughout the Arab world.

Policymakers, researchers, and librarians should note these findings.

- Researchers can locate important journals for publication as well as chances for cooperation with authors who produce quality work.
- By concentrating on the essential journals in the field, librarians can make well-informed choices regarding journal subscriptions.
- Policymakers can use this information to direct resource distribution and support important institutions and researchers.

5 DISCUSSION

The bibliometric analysis of AI in education research within Arabic countries reveals a rapidly evolving field characterized by exponential growth, particularly since 2018. This growth aligns with global trends in AI education research, as noted by Jia et al. [10], who observed a similar surge in AI and e-learning publications worldwide. The shift from general e-learning concepts to more specialized AI applications in recent years reflects a growing emphasis on advanced technological applications in post-secondary education. This is particularly evident in the prominence of key research themes such as AI, Machine Learning, and Higher Education as dominant keywords. This pattern corroborates Fadlelmula's systematic review [2], which emphasizes the expanding role of AI in Gulf Cooperation Council (GCC) higher education. Moreover, the explosive growth of ChatGPT as a prominent keyword in 2024 confirms Anwar's [1] findings regarding AI's adaptability to human needs in Arabic language instruction.

The analysis highlights research cluster formation within Saudi Arabia, Egypt, and Morocco, with particularly strong internal collaboration in Saudi Arabia. The observed concentration of research activity in Saudi Arabia reflects robust policy support and institutional investments, driven by strategic initiatives such as Vision 2030, which emphasizes the role of AI in education and fosters collaboration among academic institutions [46]. Similarly, Egypt and Morocco exhibit substantial internal collaboration, underscoring the impact of localized efforts to integrate AI into educational frameworks. However, the lack of significant cross-national collaboration across Arabic countries suggests untapped potential for broader regional integration. Strengthening cross-border collaborations could accelerate innovation and knowledge sharing, fostering a more interconnected research ecosystem. This finding aligns with the work of Abutayeh et al. [7], who identified variations in the application of AI across Arab nations, particularly in teaching science and mathematics. Emerging trends from the analysis, including AI-powered personalized learning and its role in educational assessment and feedback, echo Bedizel's [5] emphasis

on the evolving use of AI in educational evaluation. Additionally, the growing focus on AI ethics and explainability, as highlighted by Ma and Jiang [18], parallels global concerns regarding the ethical implications of AI in education [47].

The structure of the discipline can be better understood by applying bibliometric laws. A prevalent trend in scientific domains is the seeming adherence to Lotka's Law, which denotes a concentration of productivity among a limited number of authors. Similarly, the distribution of journals aligning with Bradford's Law indicates the existence of core journals shaping the discourse on AI in education research within Arabic-speaking nations. As suggested by Aghaziarati [9] through a bibliometric analysis of AI in high school education, these findings can guide researchers, librarians, and policymakers in strategic decision-making. This research is particularly significant within its regional context. The GCC nations—Saudi Arabia, in particular—play a leading role in AI-related educational research, consistent with Johnson et al.'s [32] and Alturise et al.'s [48] reports on executive-level AI education in Saudi Arabia and the United Arab Emirates. According to Fadlelmula [2], this leadership reflects significant investments and resource allocation aimed at integrating AI into education.

However, the analysis also highlights challenges that require attention. As noted by Abuodha [3] and Rabie [4], the digital divide and ethical issues surrounding the application of AI remain critical concerns. These challenges underscore the need for comprehensive frameworks and policies to guide the ethical and equitable integration of AI into educational systems across the Arabic world. To address these issues, policymakers could implement targeted strategies, such as improving digital infrastructure in rural areas through public-private partnerships. Furthermore, adopting culturally sensitive AI tools and robust data privacy frameworks could ensure equitable and ethical AI integration. Such measures would not only enhance access but also foster trust and acceptance among educators and learners. On the AI-powered mobile learning front, technologies like chatbots, intelligent tutoring systems, and natural language processing (NLP) have significantly appeared in the regional research to enhance accessibility and engagement, especially for students in remote areas [43].

The keyword analysis demonstrates that the emphasis on AI applications in Arabic language education aligns with Mohideen's [6] investigation of AI possibilities in Arabic language instruction for non-native speakers. This pattern highlights AI's potential to improve language learning outcomes and address region-specific educational needs.

6 LIMITATIONS AND RESEARCH DIRECTIONS

This study's primary limitations stem from its reliance on the Scopus database and English-language publications, potentially leading to the omission of important research from Arabic or local journals that lack international indexing. The analysis might not fully capture recent developments due to the rapid evolution of AI technologies. Furthermore, although helpful in spotting patterns, the bibliometric approach does not provide a qualitative understanding of the research content. The study's regional focus restricts comparisons with global patterns in AI education research despite offering insightful local information. In the future, studies should strive to construct a more comprehensive database of AI-related publications in educational research from Arabic-speaking countries. Qualitative content analysis of important publications may provide deeper insights into specific AI applications and techniques used in the area. Comparative analyses between AI in education research in Arabic-speaking countries and other regions may identify specific regional traits and potential knowledge transfer areas.

Studies that follow the evolution of particular research themes over time would be beneficial, especially considering how quickly AI technologies are developing. Future research should examine how AI intersects with disciplines like computer science, psychology, and linguistics to provide an interdisciplinary understanding of education. In order to address worries about AI ethics and the digital divide, research concentrating on ethical frameworks and policy recommendations for AI integration in Arabic educational systems is essential. In order to determine the true effects of AI applications on learning outcomes, student engagement, and teacher effectiveness in Arabic educational contexts, impact assessment studies are required. In order to produce more thorough and broadly applicable results, future research in the Arabic region should strive to promote more cross-national collaborations. The effective integration of AI technologies in Arabic educational settings hinges on the design of professional development programs that cater to the needs of educators and the conduct of studies on educator readiness. By concentrating on these topics, future studies can enhance our comprehension of AI in the educational systems of Arabic-speaking countries, leading to more successful and culturally sensitive AI integrations.

7 CONCLUSION

The present bibliometric analysis provides an extensive overview of the current status of AI in education research in the Arabic world, highlighting a rapidly evolving field with increasing emphasis on sophisticated AI applications, particularly in higher education. However, this growth presents challenges, including ethical concerns, accessibility issues, and limited international collaboration. To address these, researchers should focus on developing AI tools tailored to the linguistic, cultural, and educational needs of Arabic-speaking countries, including applications that enhance Arabic language learning and integrate culturally relevant content. Additionally, interdisciplinary studies combining AI with fields such as psychology and linguistics could deepen understanding and improve personalized learning experiences.

Educators, on the other hand, need to prioritize the adoption of AI technologies that enhance teaching and learning, particularly in remote and underserved areas. This requires targeted professional development to increase educators' proficiency with AI tools. Policymakers must establish ethical frameworks and data privacy regulations to ensure responsible AI implementation while investing in digital infrastructure to bridge the digital divide. Encouraging regional and international collaboration will also foster knowledge exchange and innovation, helping to unlock AI's transformative potential in creating inclusive, adaptive, and culturally attuned educational systems. By addressing these areas, stakeholders can ensure that AI not only improves learning outcomes but also prepares students for the demands of an AI-driven future.

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