Exploring Bibliometric Trends in Augmented Reality Research for Vocabulary Enhancement

Asmah Mat Saud[1,2*], Mohd. Feham Md. Ghalib[2] and Radhwa Abu Bakar[2]

[1] Ministry of Education, Aras 1, Blok 2251, Jalan Usahawan 1, 63000 Cyberjaya, Selangor, Malaysia
[2] Department of Arabic Language and Literature, AbdulHamid AbuSulayman, Kulliyyah of Islamic Revealed Knowledge and Human Sciences, International Islamic University Malaysia
asmah9678@gmail.com

ABSTRACT

The integration of Augmented Reality (AR) in educational contexts has become an increasingly prominent area of research, particularly in the domain of vocabulary enhancement. As AR applications in education grow, a gap emerges, necessitating a thorough bibliometric examination of the scholarly landscape dedicated to vocabulary enhancement. This study aims to fill this void by systematically exploring existing literature, identifying publication trends, collaborative networks, and emerging themes. Employing Scopus, we will conduct a systematic bibliometric analysis. The search will concentrate on articles related to AR and vocabulary enhancement. Using bibliometric software, we will extract and analyse data from 2003 to 2023, encompassing publication trends, citation patterns, co-authorship networks, and keyword analyses to discern the intellectual structure of the field. Collaborative networks and interdisciplinary trends will be elucidated, providing a nuanced understanding of the global research landscape. Keyword analysis will shed light on emerging themes and technological nuances within AR applications for vocabulary learning. This bibliometric exploration aspires to contribute a comprehensive understanding of the state of AR research in vocabulary enhancement. By mapping bibliometric patterns, the study intends to guide future research, inform educators and researchers about key trends, and foster interdisciplinary collaboration. The anticipated findings promise valuable insights into the intellectual fabric of AR-enhanced vocabulary learning, ultimately contributing to the advancement of educational technology and pedagogical practices.

Keywords: augmented reality, education, learning, teaching, vocabulary

1. Introduction

The use of augmented reality (AR) in educational settings has been increasingly recognized for its potential to enhance learning experiences (Acevedo et al., 2022; Gargrish et al., 2020; Moorhouse & Jung, 2017) and improve student outcomes (Amalia et al., 2023; Galeh Nur Indriatno Putra Pratama et al., 2022; Hidayat et al., 2021; Marini et al., 2022). As a result, there has been a growing interest in the application of AR technology in various educational domains, including language learning and vocabulary enhancement. In this section, we will discuss the benefits of AR in educational contexts and its specific advantages in vocabulary learning.

Augmented reality (AR) brings numerous benefits to educational settings. Firstly, it offers immersive experiences by overlaying digital content onto the real world, creating engaging and interactive learning environments (AlGerafi et al., 2023). Another advantage is personalized learning, as AR technology enables the development of customized learning paths tailored to individual learners' needs and preferences, ultimately enhancing the effectiveness of the learning process (Nurkhamimi Zainuddin et al., 2016). Additionally, AR has demonstrated the

capability to enhance knowledge retention and skill acquisition, as evidenced by systematic reviews of existing literature (Nurkhamimi Zainuddin et al., 2016). Furthermore, the interactive and immersive nature of AR contributes to increased learner motivation and enthusiasm, fostering better engagement and overall learning outcomes (Arici et al., 2019).

Augmented reality (AR) emerges as a valuable tool for vocabulary enhancement, offering distinctive advantages in this educational domain. Contextual learning is facilitated as AR integrates vocabulary into real-world contexts, enabling learners to comprehend and remember words in their natural environment(Sungkur et al., 2016). Additionally, gamification elements, such as points, badges, and leaderboards, can be seamlessly incorporated into AR, enhancing the engagement and enjoyment of vocabulary learning (Ramadhan et al., 2022). Collaborative learning becomes achievable as AR enables learners to collaborate in virtual environments, promoting communication and teamwork(Cheng et al., 2019). Furthermore, the immersive nature of AR contributes to improved retention of new vocabulary, surpassing traditional methods like flashcards or memorization exercises (AlGerafi et al., 2023).

Bibliometric analysis offers a valuable lens through which to understand the evolving trends and patterns within AR research for vocabulary enhancement. By systematically examining publication data, citation patterns, and research collaborations, bibliometric analysis provides a comprehensive overview of the field's development, identifying key themes and emerging trends. This approach enables researchers and educators to gain insights into the most influential studies, leading researchers, and potential gaps in the literature, ultimately guiding future research directions and fostering innovation in educational technology.

In conclusion, the use of augmented reality in education, particularly for vocabulary enhancement, holds great promise for improving learning experiences and outcomes. By leveraging the benefits of AR, educators and researchers can develop innovative and effective strategies for vocabulary acquisition and learning. The proposed article, "Exploring Bibliometric Trends In Augmented Reality Research For Vocabulary Enhancement," aims to provide a comprehensive overview of the current state of AR research in the context of vocabulary learning, identify emerging trends, and offer valuable insights for researchers and practitioners in the field of educational technology and language learning.

2. Literature Review

2.1. Augmented Reality in Specialized Education

Three studies showcase its potential benefits for children with specific learning needs. (Aborokbah, 2021) employs AR to aid dyslexic children in Arabic language learning, enhancing academic performance, concentration, and short-term memory. The process involves identifying dyslexia-related challenges, collecting data, and constructing a target product. (Alkadhi et al., 2020) present Yohka, an AR storybook for children with Autism Spectrum Disorder (ASD), offering an interactive reading experience. The co-design process involves stakeholders, emphasizing user-centered design for effective educational and therapeutic technologies. The third study centres on the development of mixed reality platforms for children with autism spectrum disorder (ASD). The collaborative initiative in Qatar resulted in an AR application for English and Arabic vocabulary acquisition. This study explores the integration of AR technology to facilitate real-time instruction, virtual assistance, and communication among teachers, students, and parents, emphasizing its potential impact on specialized education (Khowaja et al., 2021). These three studies illustrate how AR applications can positively impact diverse learning scenarios for children with specific needs.

2.2. Diverse Educational Applications of Augmented Reality

The second theme encompasses various educational applications of AR technology. (Ouertani & Tatwany, 2019) explore the widespread use of Augmented Reality (AR) technologies, particularly focusing on real-time Arabic text translation via a mobile application. Overcoming language limitations, the application employs text detection, extraction, and translation components. Tested under various conditions, the translation process proves efficient, albeit with recognition relying on cloud processing. A user study assesses usability and satisfaction, highlighting the potential of AR in language translation applications. (Hashim et al., 2017) present the ARabic Mobile Augmented Reality (MAR) application, focusing on early Arabic language learning through animation, 3D objects, and multimedia elements. (Almutairi & Al-Megren, 2017) delve into literacy development for deaf children using Arabic Sign Language (ArSL), emphasizing the importance of diverse perspectives. (Asif et al., 2020) address challenges faced by autistic children through an Intelligent Education System, showcasing AR and machine learning applications in both English and Arabic. This theme underscores the versatility of AR in catering to diverse educational needs.

2.3. Integration of Augmented Reality in Language Education

In the realm of language education, the utilization of augmented reality (AR) applications holds the promise of bridging the gap between theoretical language instruction and practical language application (Huertas-Abril et al., 2021; Majid et al., 2015; Taskiran, 2019). AR, known for its distinctive characteristic of blending the virtual and the physical, is particularly well-suited for language instruction by enabling learners to perceive, hear, and interact with language elements in their authentic context (Akcayir & Akcayir, 2016). For example, learners can use their mobile devices to point at objects or scenes and instantly receive translations or pronunciations (Wan Daud et al., 2021). This technology allows them to engage in dialogues with virtual characters, practice language in real-life scenarios, and explore cultural aspects within the language environment (Liao et al., 2023).

2.4. Integration of Augmented Reality in Vocabulary Learning

The fourth theme revolves around the integration of augmented reality into vocabulary learning, specifically Arabic. (Hamada, 2018) provides an overview of AR's potential in transforming user-computer interfaces into entertainment systems, with a sample AR system designed for teaching Arabic vocabulary to kindergarten children. (Asbulah et al., 2022) contribute insights into the readiness of Arabic language teachers in Malaysia to incorporate augmented reality into instruction, examining their expertise and attitudes. In addition, the study by (Nurkhamimi Zainuddin et al., 2016) identified the potential of multimedia in the Arabic vocabulary domain. Initially positioned as a tool in the realm of e-learning, multimedia is seamlessly integrated into the learning process, aiming to enhance the educational experience by providing relevance and entertainment for students. The effective utilization of this educational tool is contingent upon the involvement of educators and seasoned trainers who possess a thorough understanding of both intrinsic and extrinsic motivation factors influencing learners.

3. Problem Statement

This article, "Mapping The Frontier: Bibliometric Patterns In Augmented Reality Research For Vocabulary Enhancement," aims to illuminate a critical gap in the current landscape of augmented reality (AR) research, specifically within the context of vocabulary learning.

Despite the burgeoning interest and advancements in AR applications for education, a comprehensive bibliometric analysis is lacking, leaving unexplored nuances and patterns in the evolving field of vocabulary enhancement. Previous studies have laid a foundation, but limitations exist in terms of the scope, methodologies employed, and specific aspects of vocabulary learning addressed. By conducting a meticulous bibliometric examination, this research seeks to fill this void, providing a panoramic view of the existing literature. The study is poised to uncover patterns, trends, and collaborative networks, offering valuable insights that can inform educators, researchers, and developers alike. The implications of this research extend beyond academic curiosity, contributing to the refinement of AR applications, enriching pedagogical strategies, and ultimately optimizing the vocabulary learning experience.

4. Research Question

The review of existing literature reveals a growing body of systematic evaluations and meta-analyses on methodologies utilized in augmented reality-based vocabulary learning. Notably, there has been a recent surge in research dedicated to exploring diverse methodologies for augmented reality research in vocabulary enhancement. This trend highlights the increasing significance and focus on augmented reality technology in enhancing educational outcomes. While the current research on augmented reality in vocabulary enhancement is limited, a few studies have utilized bibliometric mapping methods to examine the broader educational landscape related to vocabulary teaching and learning with augmented reality technology. This study adopts a meta-analysis approach to investigate the teaching of Arabic to non-native speakers, emphasizing the importance of bibliometric analysis to identify crucial factors such as authors, citations, nations, keywords, publications, universities, and journals. This methodology has been extensively employed in scholarly investigations over the past decade, particularly in studying educational strategies for vocabulary enhancement using augmented reality. To address the identified gaps, this study explores advancements and trends in literature focusing on vocabulary instruction and learning, with a specific emphasis on augmented reality technology, covering the period from 2003 to December 2023.

Based on the above-mentioned context, the following set of research questions have been formulated to fill the knowledge gap identified in this study:

RQ1 :   Who are top ten authors that managed to publish the paper in the study area
RQ2 :   What is the research publication trend by year
RQ3 :   What is the most cited paper in the past relating to the topic studied
RQ4 :   What are the popular keywords related to the study
RQ5 :   What is the trend of co-authorship countries' collaboration that is able to transform into meaningful cluster according to the research study

5. Methodology

The process of compiling, organising, and analysing bibliographic data from scientific publications is known as bibliometrics (Verbeek et al., 2002). To conduct a thorough evaluation of the literature, create a bibliography, and produce credible results, an iterative process involving appropriate keyword selection, literature search, and analysis is necessary (Fahimnia et al., 2015). Therefore, the study made an effort to limit its scope to prestigious publications because they could help to clarify the theoretical framework pertaining to the progress of the research field. The study relied on the SCOPUS database to acquire data for the previously stated reasons (Di Stefano et al., 2010; Tan et al., 2014). Furthermore, only papers published in rigorously peer-reviewed, scholarly journals of the highest calibre were taken into consideration, with books and lecture notes purposefully excluded in order to ensure the

inclusion of top-tier publications (Liu et al., 2015). Notably, the widely regarded Scopus database from Elsevier made it easier to gather papers from 2003 to December 2023 for further examination.

6. Data Search Strategy

The research employed a screening stage to ascertain the suitable search phrases for obtaining pertinent publications. In order to compile papers, the study was started by running an online TITLE-ABS-KEY query across the Scopus database with the terms "augmented reality" and vocabulary, word, or language, as well as learning, teaching, or education. There were 1,210 outcomes from this process. Publications produced between 2003 and 2023 that were further reviewed to contain just research articles in English and Arabic, and articles reviews were also removed were included to the search to make it even more comprehensive. 359 articles were found in the final search string refinement, which was utilised for bibliometric analysis. As of December 2023, every publication on augmented reality in vocabulary focus that was found in the Scopus database was included in the research.

Table 1.
The search string

Scopus	TITLE-ABS-KEY (*augmented AND reality* AND vocabulary OR word OR language AND learning OR teaching OR education) AND PUBYEAR > 2002 AND PUBYEAR < 2024 AND (LIMIT-TO (LANGUAGE , "Arabic") OR LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (DOCTYPE , "ar"))

Table 2.
The selection criterion is searching

Criterion	Inclusion	Exclusion
Language	English and Arabic	Non-English
Time line	2003 – 2023	< 2003
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press

7. Data Analysis

Data sets covering the years 2003 to December 2023 that were obtained from the Scopus database and included the research publication year, publication title, author name, journal, citation, and keyword in PlainText format were analysed using the VOSviewer programme version 1.6.15. Using the VOS clustering and mapping techniques, this software was used for analysis and map generation. An alternative to the Multidimensional Scaling (MDS) approach is VOSViewer (Van Eck and Waltman, 2010). Its objective is the same as the MDS approach: place objects in low-dimensional spaces such that the distance between any two items fairly represents their similarity and relatedness (Appio et al., 2014). In contrast to MDS, which focuses on calculating similarity metrics like cosine and Jaccard indices, VOS uses a better method for normalising co-occurrence frequencies (Van Eck and Waltman, 2007), such as, the associatio strength (ASij) and it is calculated as:

$$ASij \frac{1}{4} Cij$$
$$Wiwj$$

which is "proportional to the ratio between the expected number of co-occurrences of I and j under the assumption that co-occurrences of I and j are statistically independent and the actual number of co-occurrences of I and j on the one hand" (Van Eck and Waltman, 2010, p. 531). Thus, after lowering the weighted total of the squared distances between each pair of items,

VOSviewer arranges the items in the shape of a map with the aid of this index. Appio et al. (2016) state that the LinLog/modularity normalisation was used. Additionally, patterns based on mathematical correlations were found by applying visualisation techniques to the data set using VOSviewer, and analyses such keyword co-occurrence, citation analysis, and co-citation analysis were carried out.
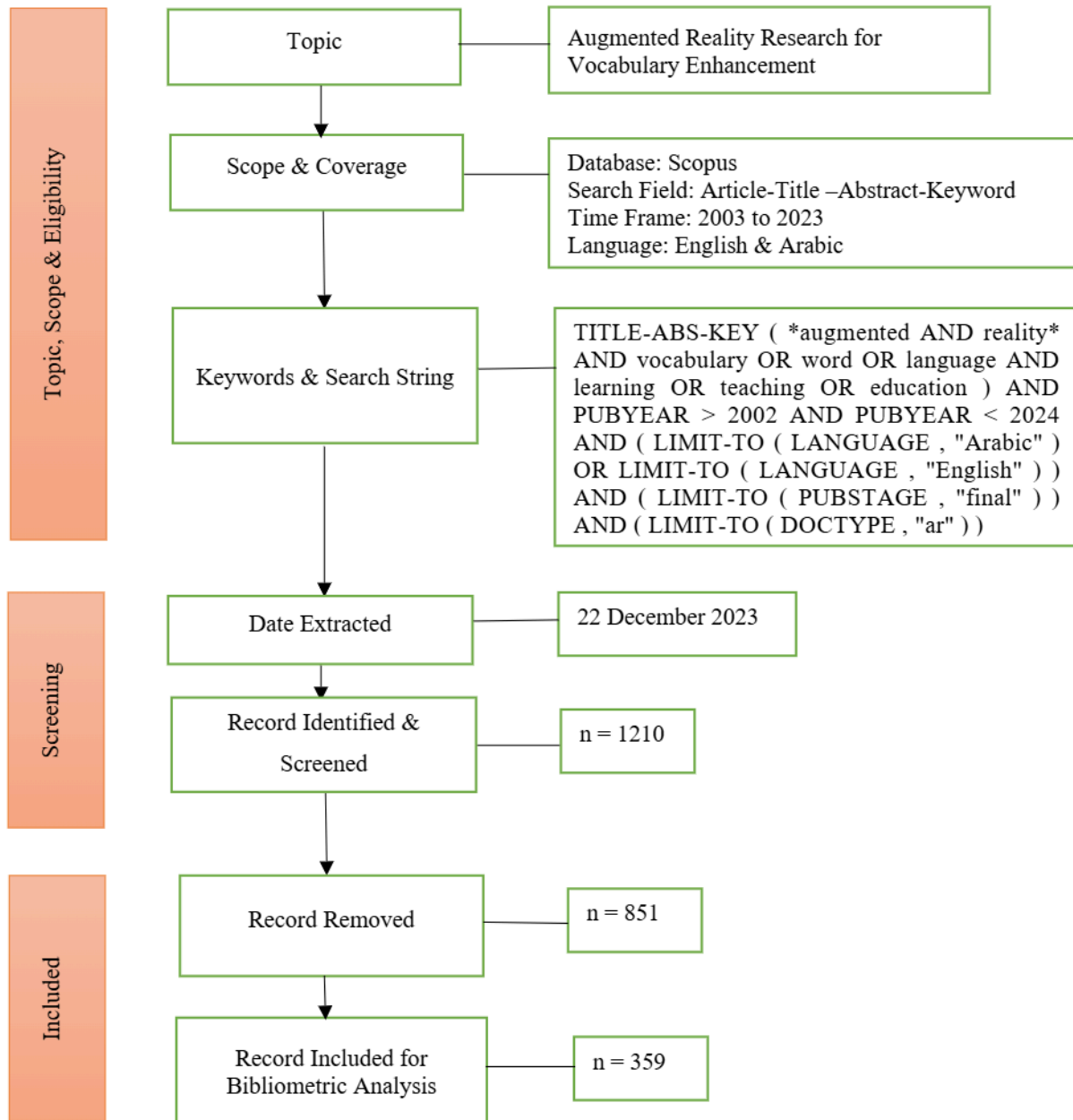

Figure 1. Flow diagram of the search strategy

Thus, after lowering the weighted total of the squared distances between each pair of items, VOSviewer arranges the items in the shape of a map with the aid of this index. Appio et al. (2016) state that the normalisation of LinLog/modularity was used. Additionally, patterns based on mathematical correlations were discovered and studies including keyword co-occurrence, citation analysis, and co-citation analysis were carried out by applying visualisation techniques through VOSviewer to the data set. Keyword co-occurrence analysis can be used to investigate the evolution of a research area over time (Zhao, 2017) and is effective in discovering hot topics across a variety of fields (Li et al., 2016). On the other hand,

citation analysis can be helpful in determining important research questions, trends, and methodologies as well as investigating the historical significance of a discipline's primary focus (Allahverdiyev and Yucesoy, 2017). One of the often used bibliometric techniques is document co-citation analysis (Appio et al., 2016; Fahimnia et al., 2015; Liu et al., 2015). Its output depends on network theory to determine the pertinent data structure (Liu et al., 2015).

8. Findings and Discussion

This study aims to present an overview of the characteristics and trends on augmented reality technology in vocabulary enhancement over the past twenty years. The findings in this review were discussed the following research questions. The analysis of the findings in the review was carried out in alignment with the research inquiries.
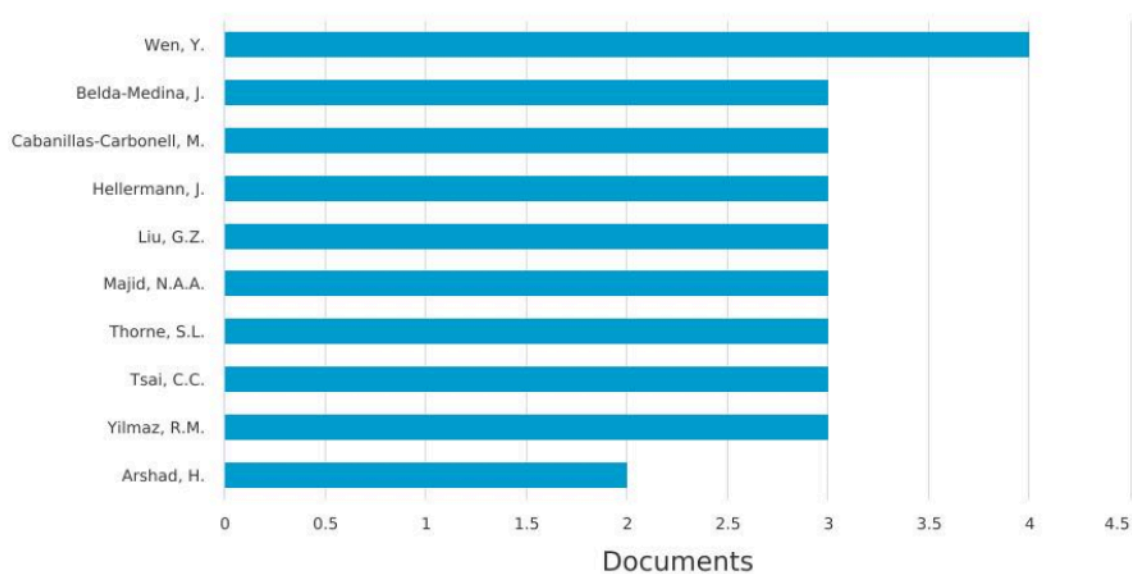
8.1. Publication by Author

This paper asserts that authors may engage in original research through studies, experiments, or surveys within their respective domains. They formulate methodologies, gather data, conduct analyses, and draw conclusions. Some authors emphasize literature reviews, synthesizing existing research, identifying gaps, and suggesting new research directions. Theoretical contributions are another crucial aspect, wherein authors may develop new theories or frameworks based on existing knowledge and empirical evidence. Contributions to a paper can vary based on authors' expertise, research nature, and collaborative roles. Collaboration often involves multiple authors specializing in different aspects, such as statistical analysis, experimental design, or theoretical background. Additionally, research implications for industry practices play a significant role, showcasing accountability, relevance, and value to funders, practical applications, policy recommendations, or industry implementations. This is illustrated in Figure 2.

Figure 2. Publication by author

8.2. Research Publication Trend by Year

The figure shows the number of documents published by authors in the field of augmented reality (AR) in vocabulary learning from 2003 to 2023. The data was obtained using Scopus, a popular database for scientific literature. As the figure shows, there has been a steady increase in the number of documents published on AR in vocabulary learning over the past few years. This suggests that there is growing interest in this field among researchers and educators.

There are several possible explanations for this increase in interest. First, AR technology has become more sophisticated and affordable in recent years, making it more accessible to educators and learners. Second, there is growing evidence that AR can be an effective tool for vocabulary learning. Studies have shown that AR can help learners to better understand and remember new words, particularly when it is used to create immersive and interactive learning experiences.

The future of AR in vocabulary learning is promising. As AR technology continues to develop, we can expect to see even more innovative and effective AR-based vocabulary learning tools. Additionally, as more research is conducted on the use of AR in vocabulary learning, we will gain a better understanding of its benefits and limitations. This will help educators to make informed decisions about how to use AR in their classrooms.
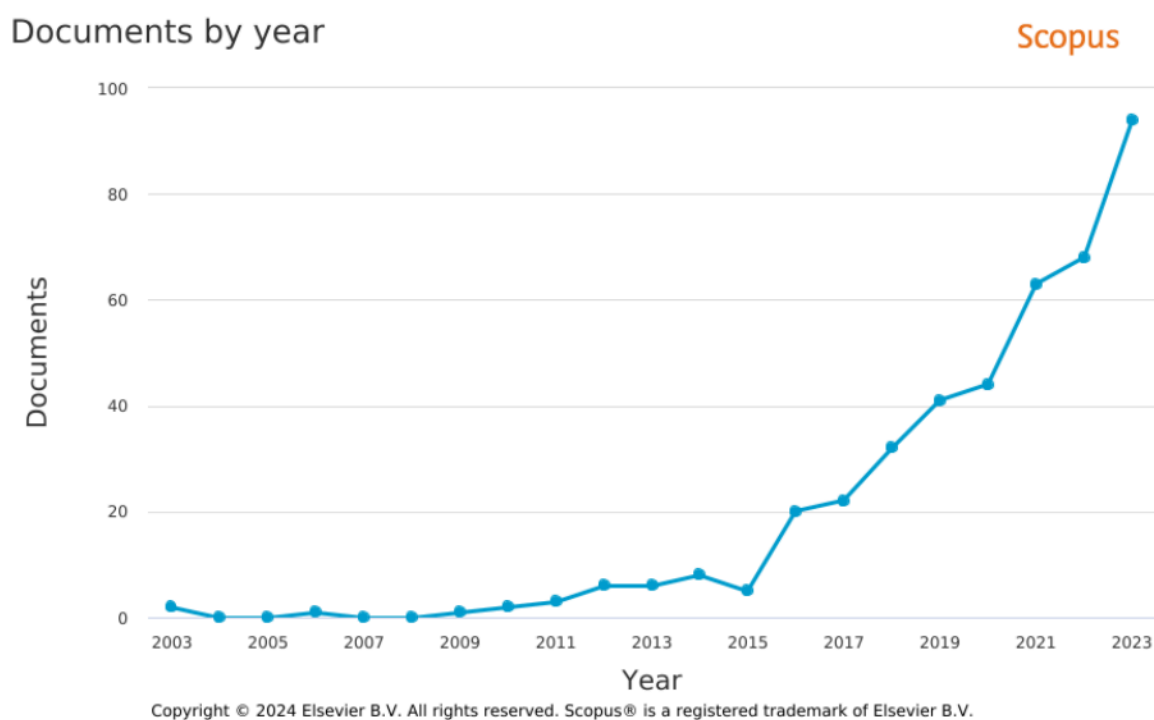
Figure 3. Trend of research on augmented reality by years

8.3. The Most Cited Articles

Undoubtedly, the volume of citations stands out as a crucial metric denoting scholarly importance. The quantity of citations an article accumulates from other papers serves as a key determinant of its quality, holding particular significance for the author and its relevance to the study's field, as demonstrated in Table 3 below. These articles traverse multiple disciplines, tackling vital subjects encompassing language education, such as language listening and speaking, and vocabulary learning. This diversity underscores the expansive range of research

scopes and methodologies, offering valuable insights to their respective fields and exemplifying the extensive and profound nature of scholarly research across diverse domains.

Table 3.
Numbers of citatition of the article

Authors	Title	Year	Journal	Cited by
Arici F.; Yildirim P.; Caliklar Ş.; Yilmaz R.M.	Research trends in the use of augmented reality in science education: Content and bibliometric mapping analysis	2019	Computers and Education	206
Liu T.-Y.	A context-aware ubiquitous learning environment for language listening and speaking	2009	Journal of Computer Assisted Learning	199
Tom Dieck M.C.; Jung T.H.	Value of augmented reality at cultural heritage sites: A stakeholder approach	2017	Journal of Destination Marketing and Management	191
Hsu T.-C.	Learning English with Augmented Reality: Do learning styles matter?	2017	Computers and Education	191
Kessler G.	Technology and the future of language teaching	2018	Foreign Language Annals	178
Marín R.; Sanz P.J.; Nebot P.; Wirz R.	A multimodal interface to control a robot arm via the web: A case study on remote programming	2005	IEEE Transactions on Industrial Electronics	140
Holden C.L.; Sykes J.M.	Leveraging mobile games for place-based language learning	2011	International Journal of Game-Based Learning	139
Santos M.E.C.; Lübke A.W.; Taketomi T.; Yamamoto G.; Rodrigo M.M.T.; Sandor C.; Kato H.	Augmented reality as multimedia: the case for situated vocabulary learning	2016	Research and Practice in Technology Enhanced Learning	137
Sun Z.; Zhu M.; Shan X.; Lee C.	Augmented tactile-perception and haptic-feedback rings as human-machine interfaces aiming for immersive interactions	2022	Nature Communications	128
Godwin-Jones R.	Augmented reality and language learning: From annotated vocabulary to place-based mobile games	2016	Language Learning and Technology	122
McMahon D.D.; Cihak D.F.; Wright R.E.; Bell S.M.	Augmented reality for teaching science vocabulary to postsecondary education students with intellectual disabilities and autism	2016	Journal of Research on Technology in Education	104

8.4. Frequently Used Keywords in the Study

Utilizing VOSviewer Analyzer and considering a minimum of ten occurrences, the author keywords were visualized, as depicted in Figure 3. This figure presents a network of keywords with the following characteristics:

• Keywords are organized into distinct clusters, signifying topics or themes commonly addressed together in the literature.

• The size of a node (circle) is proportional to the frequency of the respective keyword.

• The colour of a node corresponds to the cluster it is associated with.

• Connections between nodes represent keywords that frequently appear together in the same documents, with the thickness of the link indicating the strength of this co-occurrence relationship.
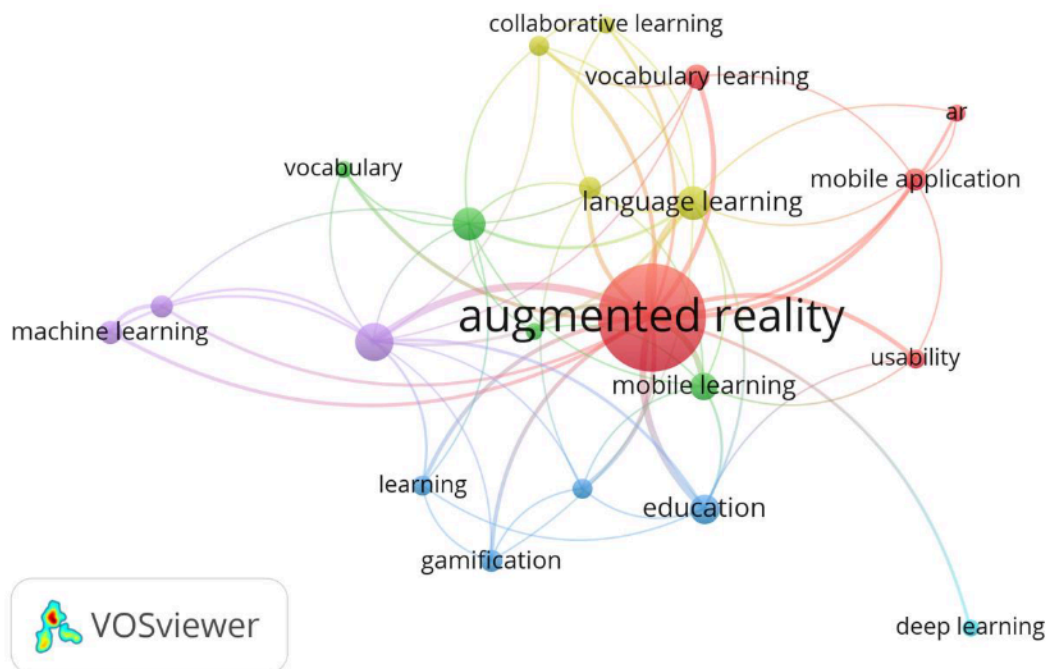

Figure 4. Bibliometric network map based keywords' co-occurrence of publication

The figure indicates the strength of the association among clusters and central keywords. This article makes an inference based on the image as below:

(a) Cluster 1: This cluster focuses on the educational aspects of AR in vocabulary learning, with keywords like "mobile learning," "usability," "gamification," and "education." The central keyword in this cluster is "learning," suggesting that this is a primary concern for researchers in this area.

(b) Cluster 2: This cluster focuses on the technological aspects of AR, with keywords like "augmented reality," "deep learning," "machine learning," and "mobile application." The central keyword here is "augmented reality," highlighting its importance as the core technology driving this field.

(c) Cluster 3: This cluster is smaller and focuses on the linguistic aspects of vocabulary learning, with keywords like "vocabulary learning," "language learning," and "vocabulary." The central keyword here is "vocabulary learning," emphasizing the specific target domain for AR applications.

8.4.1. Relationships between Keywords

• The strong connections between "augmented reality" and "learning" in different clusters bridge the gap between the technological and educational aspects, suggesting that researchers are interested in how AR can be used to effectively support learning outcomes.

- The connections between "mobile learning" and "usability" indicate that researchers are concerned with developing AR applications that are accessible and user-friendly for learners on the go.

- The connections between "gamification" and "education" suggest that researchers are exploring the potential of game-based elements to motivate and engage learners in AR vocabulary learning experiences.

8.4.2. Implications of the Network Map

Overall, the network map highlights the interdisciplinary nature of research on AR in vocabulary learning, drawing from fields like education, technology, and linguistics. It suggests that the field is still in its early stages of development, with a focus on exploring the potential and feasibility of AR for vocabulary learning. There is a need for further research on the effectiveness of AR in comparison to traditional vocabulary learning methods and on the development of evidence-based best practices for using AR in the classroom.

8.5. What Are Co-Authorship Countries' Collaboration

Figure 4 shows the countries whose authors collaborate on augmented reality in vocabulary enhancement. Based on VOSviewer analyzer analysis, the figure illustrates a network of countries with the following characteristics:
• Individual nodes symbolize countries, with their size indicative of the total collaboration strength, determined by the sum of weights from all links;
• Interconnecting links symbolize collaborations among countries, with link thickness representing collaboration strength, gauged by the quantity of co-authored documents shared between the two countries; and
• Node colour designates the cluster to which a country belongs, signifying a set of countries more inclined to collaborate with each other than with those outside the cluster.
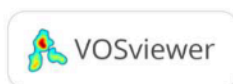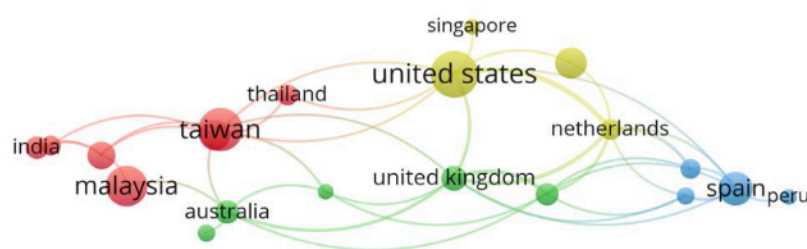

Figure 5. Bibliometric map based on co-authorship countries' collaboration

In addition, based on Figure 5, this paper makes an inference based on image as below:

(a) The map reveals several central countries in the network, indicating their active role in research collaborations:

- Singapore: Stands out as the most central node, suggesting its prominent role in driving international collaborations in AR vocabulary learning research.

- United States, Thailand, Taiwan, and Spain: These countries also occupy central positions, highlighting their active participation in collaborative research efforts.

(b) Three main clusters can be identified based on the density of connections between countries:

- Southeast Asia cluster: This cluster includes Singapore, Thailand, Malaysia, and Indonesia. The strong connections within this cluster suggest a high degree of collaboration among these Southeast Asian nations in AR vocabulary learning research.

- East Asia cluster: This cluster comprises Taiwan, China, and South Korea. The connections within this cluster indicate active collaboration in AR vocabulary learning research among these East Asian countries.

- Europe and North America cluster: This cluster includes the United States, Spain, the United Kingdom, and several European countries. The connections within this cluster suggest collaboration in AR vocabulary learning research between Europe and North America.

(c) Relationships between countries:

- The strong connections between Singapore and other countries in the Southeast Asia and East Asia clusters highlight its role as a central hub for AR vocabulary learning research collaborations in these regions.

- The connections between the United States and countries in the Europe and North America cluster, as well as its weaker connections to the East Asia and Southeast Asia clusters, suggest its primary focus on collaborations within its own region.

- The relatively weaker connections between the three main clusters indicate that there is still room for further inter-regional collaboration in AR vocabulary learning research.

Overall, the map highlights the increasing internationalization of research in AR vocabulary learning, with researchers from different countries actively collaborating on projects. It suggests the emergence of regional research hubs, such as Singapore in Southeast Asia, that play a central role in facilitating collaborations within their respective regions. There is a need for stronger inter-regional collaboration to bridge the gaps between the identified clusters and to promote the exchange of knowledge and expertise across different countries.

9. Conclusion

In conclusion, this study provides a comprehensive bibliometric analysis of augmented reality (AR) research in the context of vocabulary enhancement from 2003 to 2023, offering valuable insights into the evolving landscape of AR in education. By mapping the trends in publication, citation patterns, and collaborative networks, the study highlights the growing interest and potential of AR technology to transform vocabulary learning experiences. The findings reveal significant contributions to the field, including the identification of leading authors, influential papers, and emerging research themes, which together form a nuanced understanding of the intellectual structure of AR-enhanced vocabulary learning.

The study's contributions extend to informing educators, researchers, and policymakers about current trends and facilitating interdisciplinary collaboration. However, it is essential to

acknowledge the limitations of this research. The reliance on the Scopus database, while comprehensive, may overlook relevant studies indexed elsewhere. Additionally, the scope of the analysis was limited to articles published in English and Arabic, potentially excluding insights from other linguistic and cultural perspectives.

Future research should explore these areas to further validate and expand the findings. Despite these limitations, this study sets a foundation for future research and development, encouraging innovative approaches to integrating AR in educational settings and optimizing vocabulary learning outcomes.

Acknowledgement

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