A Bibliometric Analysis: The Use of Artificial Intelligence in Foreign Language Learning

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Abstract. This bibliometric analysis of research publications aimed at highlighting trends in the use of Artificial Intelligence in foreign language learning. The study aims to analyze the distribution of published research results, identify the most productive authors, explore authorship patterns, and examine citation patterns. The data was collected from the Scopus database using the keywords: "Artificial Intelligence", "foreign language learning" OR "foreign language" and keywords that have the same meaning. Search results were filtered to ensure relevance to the entered keywords, and the analysis was conducted using the R Studio program. A total of 310 publications, spanning from 2010 to October 2023, were analyzed. The analysis results demonstrate that the use of Artificial Intelligence in foreign language learning is prevalent. The presence of AI offers numerous benefits and enhances learning methods, making lessons more varied and engaging. The *ACM International Conference Proceeding Series* emerged as the primary source for these publications, with twenty-four papers attributed to it. China stands out as a prominent player in this field and followed by Spain. The insights gained from this study can serve as a valuable resource for researchers interested in foreign language instruction. Based on these findings, it is recommended that further research be conducted on the application of Artificial Intelligence in other scientific domains. Additionally, this study provides recommendations for future research endeavors.

Keywords: Artificial Intelligence, Foreign Language, Bibliometric Analysis, R Programs, Research Trends

1   INTRODUCTION

In the contemporary era market, the influence of artificial intelligence (AI) is progressively permeating various facets of life, garnering significant public attention in recent years. The concept was initially introduced at the Dartmouth conference in 1956 and was formally recognized as a distinct discipline [1]. Over time, the utilization of artificial intelligence (AI) technology has experienced rapid growth across various global sectors, including its application in the field of education [2]. Presently, developed countries worldwide are expediting the innovation process in education and teaching, actively creating intensive educational products within the education sector.

The use of AI has introduced new perspectives that enhance education, especially in terms of teaching. With its revolutionary potential in various sectors, artificial intelligence (AI) has emerged as a promising tool in enhancing the teaching and learning experience in 21st-century education [3][4] and can play a role in identifying elements that can be included in lesson plans to meet standards and expectations and adapt to the individual needs of each student [5]. In addition, many researchers have described the possible educational assistance that AI can provide in providing feedback [6] and accommodating student differences [7]. One field experiencing growing influence due to the swift progress of AI is education, especially in the realm of foreign language teaching. AI can facilitate personalized learning that emphasizes individual needs, efficiency, and the quality of collaborative learning experiences [2].

Foreign language teaching faces various challenges in meeting the needs of diverse students, so the use of AI has become increasingly important in foreign language teaching. In China, the government has emphasized the importance of integrating AI technologies in the education sector, especially in the context of foreign language learning [8]. Therefore, it is important to explore the extent to which AI can be effectively used in language teaching to explore new opportunities in language education. such as speech recognition systems and virtual tutors, have proven to be effective in improving learners' speech and pronunciation. Learners who received feedback from AI showed considerable progress compared to those who did not [6].

Not only that, but research also conducted by Chen et al [9], showed that learners who interacted with virtual tutors and chatbots experienced significant improvements in speaking ability, fluency, and confidence in using a foreign language. These AI-based conversational agents provide opportunities for learners to practice language authentically and get immediate feedback, which contributes to their communication skills. The feedback provided in real-time by the AI system enables learners to identify and correct errors in their pronunciation, resulting in more accurate and clear pronunciation of the foreign language [3]. Therefore, it can be said that integrating technology into the foreign language learning process is an attempt to utilize technology to improve students' learning experience [10]. In the future, we can expect that the deep integration of artificial intelligence and foreign language teaching will become commonplace. Artificial intelligence will improve the accuracy and individualization of foreign language learning [1].

2   METHODS

This research uses the bibliometric analysis method. By this method, we can dig deeper into developments in a particular field and gain insight into emerging fields [11].

2.1   Literature search and data collection

This stage refers to the process of searching, identifying, and collecting scientific publications that will be the subject of analysis. The database used is Scopus. The Scopus database was chosen because it can provide access to a variety of research information, and also prioritizes high-quality standards in indexing by conducting

rigorous content selection [12]. In searching for publications related to the use of Artificial Intelligence in foreign language learning using keywords: ("Artificial Intelligence" OR ai OR "virtual Reality" OR vr OR "Chatbots for Language Learning" OR "Translation Tools" OR "Language Learning Apps" OR "Virtual Language Teachers" OR "Gamification in Language Learning" OR "Language Learning Platforms" OR "AI for Writing Correction" OR "Conversational AI" OR "Conversational AI") AND "foreign language learning" OR "foreign language".

2.2   Data extraction, loading, and conversion

In total, 737 documents were found, after going through the selection process according to language, document type, and discussion area, 310 documents were selected after the screening process based on the inclusion and exclusion criteria in Table 1. In this study, the collected data was exported in CSV format from the Scopus database.

Table 1. Inclusion-exclusion criteria for retrieving datasets.

No.	Inclusion-Exclusion Criteria
1	Articles that contain both keywords either in the title, abstract, or keywords.
2	Research conducted in 2010-2023
3	Documents written in English
4	Journal and conference articles
5	Articles with subject areas around computer science, social sciences, Art and humanities, Decision sciences, Psychology and Multidisciplinary

2.3   Bibliometric analysis and software package

Bibliometric is a bibliometric analysis tool that has been developed in the R programming language. R is software that operates in an integrated ecosystem and includes open libraries, open algorithms, and open graphics software. [13]. Before analyzing, it is necessary to install the bibliometric package by writing "install.packages('bibliometrix')" on the console tab [14]. Furthermore, to run biblioshiny, you can write "library(bibliometrix)" and then press enter or run, after that continue by writing "biblioshiny()" still on the console tab and continue with 'run' again. [15].

3   FINDINGS AND DISCUSSION

In the findings and discussion, we will examine (i) the growth and trends of research related to the use of Artificial Intelligence in foreign language teaching in three main aspects: publication output, main reference journals, and citations; (ii) exploring the most instrumental authors, affiliations and collaborations; (iii) mapping of keywords expected in the use of Artificial Intelligence in foreign language teaching, analysis of collaborations and recommendations for future research.

3.1   General Information and Research Trends

The most essential information that has been collected regarding the use of Artificial Intelligence in foreign language teaching is shown in Table 2. The publications listed range from 2010 to 2023 with a total of 310 Scopus-indexed publications.

Table 2. The Collection's General Information

Description	Results
Timespan	2010:2023
Sources (Journals, Books, etc)	177
Documents	310
References	9514
Authors	773
Authors of single-authored docs	79
Co-Authors per Doc	2.91
International co-authorships %	18.06
Article	162
Conference paper	148

Based on the information in Table 2, there are a total of 773 authors who have published in 310 studies (with an equivalent of 2.91 authors per document). Articles on the application of artificial intelligence in foreign language teaching experienced fluctuations in the period 2010 to 2019 as shown in Figure 1. then experienced growth until 2023. The years 2011 and 1017 saw the lowest number of publications with only seven articles published, but the following year, 2020, saw a significant increase with 28 articles published. The year 2021 recorded forty articles, signaling the beginning of an impressive growth in publications on the application of artificial intelligence in foreign language teaching. This growth continued until 2023 with sixty-three articles published, which is the highest number of publications per year ever recorded. Thus, it can be concluded that the utilization of artificial intelligence in foreign language teaching continues to grow. From the results of this analysis, it can be expected that its scientific contribution will continue to increase every year.
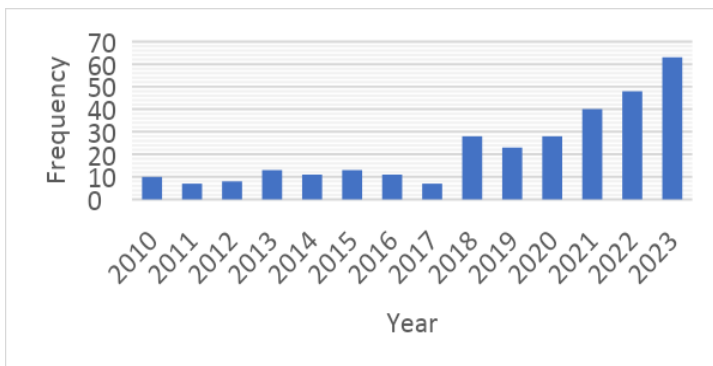

Fig. 1. Annual Production

3.2   **The Most Instrumental Authors, Affiliations and Collaborations**

The results of the analysis of 310 articles published in the range of 2010 to 2023 are shown in Table 3. The main source of reference related to the use of Artificial Intelligence in foreign language learning is the ACM International Conference Proceeding Series with a total of 24 articles.

Table 3. Most Relevant Source

Sources	Articles
ACM International Conference Proceeding Series	24
Interactive Learning Environments	14
Workshop Proceedings	11
Computer Assisted Language Learning	9
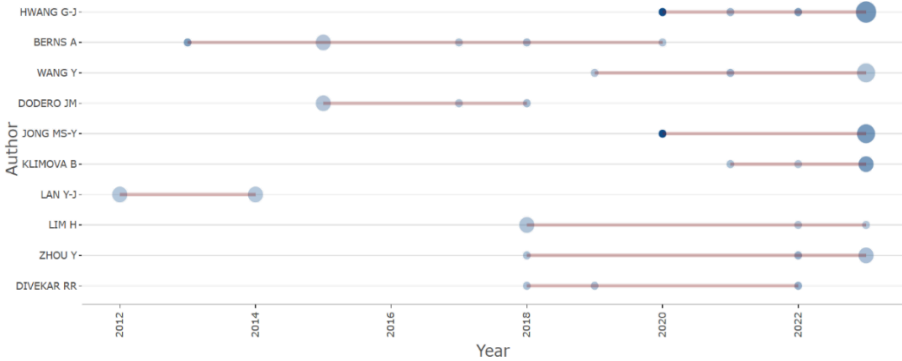
Fig. 2. Author's production over time

Based on the results shown in Figure 2, the ten most productive authors in the field of artificial intelligence in foreign language teaching from 2010 to 2023 revealed that Hwang from China produced seven documents that were consistently written from 2020 to 2023. Although Hwang's first article was published in 2020, he became one of the authors who had the highest H index of four. Another author, Bernis from Spain also has an H index of four with six documents that were first published in 2013 to 2020. This shows that Hwang and Bernis are the most impactful authors in the field of artificial intelligence in foreign language teaching.

Based on the affiliations of authors in the field of artificial intelligence in foreign language teaching, this study analyzed the publication output of ten leading institutions. The results reveal that the National Taiwan University of Science and Technology, China, tops the list with fourteen documents. Followed by Beijing Normal University, also from China, with a total of twelve documents. Likewise, other institutions can be seen in Figure 3.
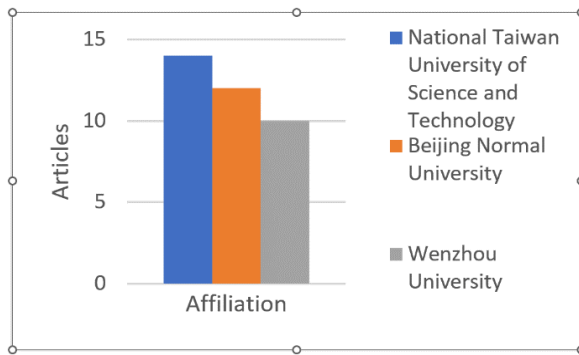
Fig. 3. Most relevant affiliation

Table 4. Fig. 4. Top 5 Countries

Country	TC	Average AC	F
CHINA	603	8.40	221
SPAIN	200	28.60	136
USA	198	15.20	64
SWEDEN	157	78.50	45
KOREA	96	9.60	41

Note:
TC   : Total Citation
AC   : Average Citation
F   : Frequency

Based on the data in Table 4, the author with the most productive title comes from China, with 221 articles with 603 citations. In second place is Spain with 136 articles with two hundred citations. These two countries are the most influential or most cited countries in related articles in the field of artificial intelligence in foreign language teaching.
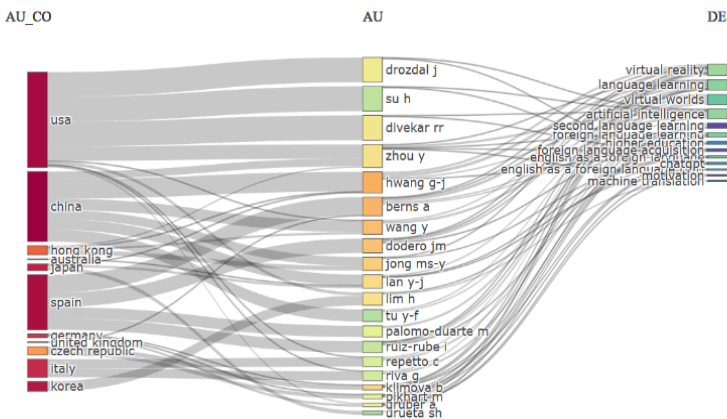
Fig. 5. Three-field of article contributions by country, author, and theme

Figure 4 presents a more comprehensive representation of the plot of article contributions by country, author, and theme in the field of artificial intelligence in foreign language teaching. The visualization consists of three sections where the first column reflects the active countries, the second column displays the contributing researchers from those countries, and the third column shows the most frequently used keywords by the authors. The frequency of occurrence of keywords used in this research is henceforth known as the research theme.

The representation of Figure 4 can be interpreted by paying attention to the height of the box and the thickness of the line connecting it. Based on country, the USA has more authors affiliated with the country with 127 authors followed by China with ninety-three authors. These results are different when viewed from the number of scientific productions and citations as previously described. Although China is ranked first in the number of scientific production and citations, it is ranked second in author affiliation. Likewise, Spain is ranked third with seventy-three authors.

Based on the thickness of the line connecting countries and authors, Hwang remains the main contributor from China as well as Berns from Spain. Meanwhile, Drozdal, Suh, Divakar, and Zhou Y are the main authors who play a role in the field of artificial intelligence in foreign language teaching from the USA. Meanwhile, the most used keyword by the author is Virtual reality which comes from authors such as Hwang, Repetto, Riva, and Urueta. Followed by the keyword language learning from authors such as Hwang, Wang Y, and Tu YF. In addition, the keyword Artificial Intelligent is used by authors such as Hwang, Zhou Y, Wang Y, and Tu YF.

3.3 Mapping of Keywords, Analysis of Collaborations, and Recommendations for Future Research.
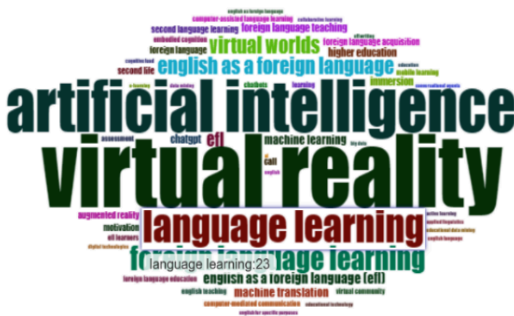

Fig. 6. Word-cloud of keyword

The mapping of keywords that are widely used in the use of Artificial Intelligence in foreign language learning can be seen in WordCloud. From WordCloud in Figure 5, it can be said that the most used keywords by researchers in research are "Virtual Reality" as many as fifty-one, "Artificial Intelligence" as many as thirty-five, "language learning" as many as 23 and "foreign language learning" as many as 17.

WordCloud is a simple but effective tool for summarizing and visualizing information from a large amount of text in an easy-to-understand format. From WordCloud, it can be said that virtual reality is one of the most researched types of artificial intelligence from 2010 to 2023 in foreign language learning. In addition, based on Words' Frequency over Time, the four keywords are experiencing a significant increase in 2023.

Figure 6 shows the relationship between keywords, the similarity of colors indicates the relationship between keywords, and the thicker the connecting line indicates a strong relationship and vice versa. In this study, the three main keywords "virtual reality" "artificial intelligence" and "language learning" have a relationship with other keywords according to color, but all three have a strong association.
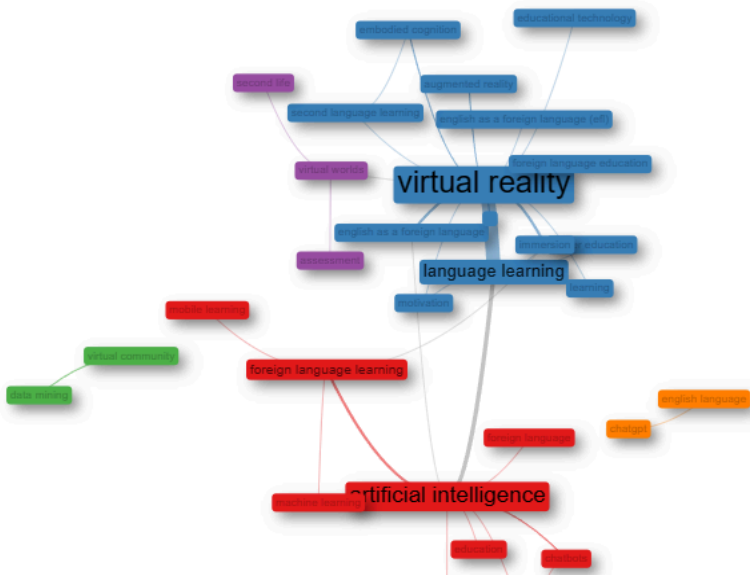

Fig. 7. Co-Occurrence network

In addition, there are also some keywords that are not directly connected such as "virtual community" and "data meaning". However, this does not mean that these keywords have no relationship at all, this can happen because there is not much research involving these keywords directly. Another thing that is no less important in bibliometric analysis research is the thematic map in the use of Artificial Intelligence in foreign language learning in Figure 7. This aims to get a picture of current research and research needed in the future. This analysis will certainly be useful to provide knowledge to researchers and stakeholders to see the potential for research development that can be conducted in certain fields. And for the analysis of future research needs will be discussed on thematic maps.

Thematic maps can provide information based on density and centrality quadrants. Based on the thematic map show in Figure 7, it can be understood that in the Motor Themes quadrant, the driving themes are still developing such as: "data mining",

"social networking", "big data". As for the Emerging or Declining Themes quadrant, research related to "learning" has begun to decline and shifted to "e-learning". Research on Basic Themes such as "artificial Intelligence" "foreign language" and "learning system" has been done a lot and is particularly important to be further developed.

Few research is related to "computational linguistics" "natural language processing system" and "semantic" because the density is still low, and the centrality is high. In addition, it can also conduct research on "context aware" "open source" and "ambient intelligence" but requires higher effort to correlate with Basic Themes, so this research will make a significant contribution to foreign language learning in the future.
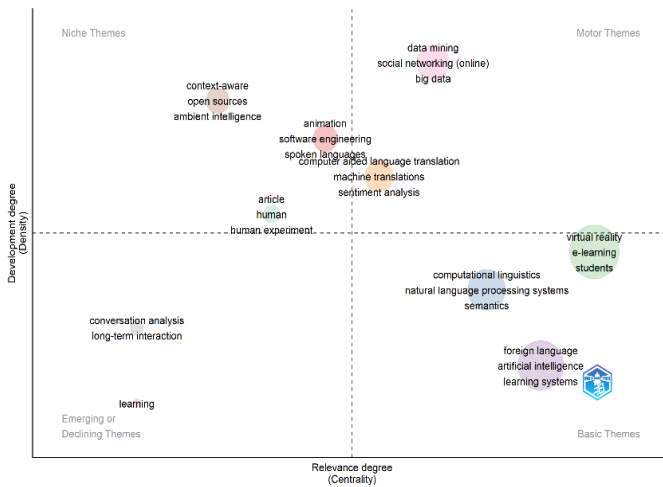

Fig. 8. Thematic Map based on density and centrality

In the context of foreign language learning, the three concepts of "context aware," "open source," and "ambient intelligence" have the following relevance: (1) in foreign language learning, "context aware" refers to the use of technology or devices that can recognize and understand the learning context or needs of users while they are learning a foreign language. For example, a "context aware" language learning app can customize content, exercises or quizzes based on the language proficiency level, learning objectives or current situation. This can ensure that students get materials that match their ability level and can maximize learning efficiency. (2) In the context of foreign language learning, "open source" refers to software or learning resources that are available for free and with open-source code. This means that students and teachers can access, modify, and develop language learning resources according to their needs. For example, open-source e-learning platforms, such as Moodle, allow educational institutions to create language courses tailored to their policies and support various teaching methods [3]. In foreign language learning, "ambient intelligence" can refer to the use of technology integrated in physical and virtual environments that support language learning. For example, digital learning spaces

equipped with intelligent software and hardware that can identify student presence, provide appropriate learning content, and support better interaction in a foreign language. Ambient intelligence can also be used to create stimulating learning environments that support various learning methods.

4   CONCLUSION

The application of AI technology in foreign language teaching presents both challenges and opportunities. By exploring significant trends and developments in research related to artificial intelligence in foreign language teaching through bibliometrics, it will provide more insight and predict research that may be needed in the future. Based on the results of the analysis, research on "context-aware", "open source", and "ambient intelligence" is expected to make significant contributions to foreign language learning in the future.

    This research has limitations in terms of research coverage, which is still very broad. Researchers do not limit studies to certain levels of education, for example, basic education or higher education. So, it is hoped that future research can map research trends on the application of AI technology in teaching foreign languages, more specifically at certain levels of education.

AUTHORS CONTRIBUTIONS.
The first author made contributions throughout the research process for collection and data analysis. The second author contributed to completing the research methodology. The third author contributed to the discussion of the data and the fourth author contributed to coordinate the final manuscript.

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