

An Investigation into Artificial Intelligence (AI) in the English as a Foreign Language (EFL) Context¹

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Abstract

Using data from Bibliometrix and Web of Science, this study examined articles in the subject of language and linguistics that dealt with artificial intelligence (AI). The study used bibliometrics to uncover historical trends in AI in EFL. The study utilized Biblioshiny, a web-based tool in the bibliometrix package that analyses bibliographic database data, to examine downloaded Web of Science (WoS) data. The Bibliometrix R Package and Biblioshiny software created tables and graphs. The study searched the WoS website for studies with "Artificial Intelligence (AI)" in the title, abstract, and keywords to find bibliographic data. From 2013 to 2023, WoS focused on Language and Linguistics in Language Education. There were 1693 EFL AI papers. The study chose open-access publications to read the entire text. The present analysis examined 177 publications. Different bibliometric analysis techniques were employed to get the most usable data from research publications. Authors, publishing years, universities, countries, preferred journals, trendy topics, and keyword citation rates were all considered in the analysis. Findings showed an increase in publications over time and a growing interest in AI. Leading universities and prominent authors were identified. Depending on the country, different levels of engagement were observed. The distribution of data was provided via preferred journals. This study helps researchers and decision-makers evaluate AI research in language and linguistics.

Keywords: bibliometrics, web of science (WOS), artificial intelligence, teaching English as a second language, machine learning

Yabancı Dil Olarak İngilizce (EFL) Bağlamında Yapay Zekâ (AI) Üzerine Bir Araştırma

Özet

Bibliometrik analiz ve Web of Science'tan elde edilen veriler kullanılarak yapılan bu çalışmada, dil ve dilbilim alanında yapay zekâ (YZ) ile ilgili makaleler incelenmiştir. Çalışma, İngilizce öğretiminde yapay zekanın tarihsel eğilimleri ortaya çıkarmak için bibliyometri kullanmıştır. Çalışmada, indirilen Web of Science (WoS) verilerini incelemek için bibliyografik veri tabanı verilerini analiz eden bibliometrix paketindeki web tabanlı bir araç olan Biblioshiny kullanılmıştır. Bibliometrix R Paketi ve Biblioshiny yazılımı tablolar ve grafikler oluşturmuştur. Çalışma, bibliyografik verileri bulmak için WoS web sitesinde başlığında, özetinde ve anahtar kelimelerinde "Yapay Zeka" olan çalışmaları taramıştır. WoS, 2013'ten 2023'e kadar Dil Eğitiminde Dil ve Dilbilim üzerine odaklanmıştır. Filtreleme öncesi 1693 adet İngiliz dili eğitimde yapay zekaya odaklanan çalışma bulunmuştur. Çalışma, tüm metni okumak için açık erişimli yayınları seçerek 177 yayını incelemiştir. Araştırma yayınlarından en kullanılabilir verileri elde etmek için farklı bibliyometrik analiz teknikleri kullanılmıştır. Yazarlar, yayın yılları, üniversiteler, ülkeler, tercih edilen dergiler, trend konular ve anahtar kelime atıf oranları analizde dikkate alınmıştır. Bulgular, zaman içinde yayınlarda bir artış ve yapay zekaya artan bir ilgi olduğunu göstermiştir. Önde gelen üniversiteler ve önde gelen yazarlar tespit edilmiştir. Ülkeye bağlı olarak, farklı katılım seviyeleri gözlemlenmiştir. Verilerin dağılımı tercih edilen dergiler aracılığıyla sağlanmıştır. Bu çalışma, araştırmacıların ve karar vericilerin dil ve dilbilim alanındaki yapay zeka araştırmalarını değerlendirmelerine yardımcı olmaktadır.

Anahtar Kelimeler: bibliyometrik analiz, web of science (WOS), yapay zeka, ikinci dil olarak İngilizce öğretimi, yapay zeka/makine öğrenimi

Introduction

Artificial Intelligence (AI) is a type of computational innovation that has enhanced interest in the growth of artificial intelligence (AI) technology (Cheng & Day, 2014). Various innovations in artificial intelligence have been utilized to help machines achieve creativity. According to Rahman (2009, p. 343), artificial intelligence (AI) develops software that analyzes data and does other independent operations such as computing or student search. Computers (online platforms) and programmed machines (robots) are examples of "intelligent" equipment that

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function and react in ways comparable to the way humans think (Karsenti, 2019). Artificial Intelligence (AI), defined by Mehrotra (2019), is a computer science technique that investigates the analysis and creation of intelligent machines and applications. It is a method of teaching a computer to process information and act like a rational individual. Intelligence is the cornerstone of the field of artificial intelligence (Wang, 2019). Whitby (2009) defines AI as the study of intelligent actions in individuals, creatures, and robots in order to identify ways to improve them.

Artificial Intelligence (AI) has been a topic of interest in various fields, including education. In the field of English as a Foreign Language (EFL), AI has been utilized to enhance language learning and teaching. AI has the potential to provide personalized learning experiences, facilitate language assessment, and improve language proficiency. This literature review aims to explore the current state of research on AI in the EFL context. Several studies have investigated the use of AI in the EFL context. For instance, Wang et al. (2021) explored the effectiveness of AI-based writing feedback on EFL learners' writing performance. The study found that AI-based feedback improved learners' writing accuracy and fluency. Similarly, Li et al. (2020) investigated the use of AI-based chatbots in EFL speaking practice. The study found that learners who used the chatbot showed significant improvement in their speaking proficiency. Another area of research on AI in the EFL context is language assessment. For example, Zhang et al. (2019) developed an AI-based automated scoring system for EFL writing assessment. The study found that the system's scores were highly correlated with human raters' scores. Similarly, Liu et al. (2020) developed an AI-based speaking assessment system for EFL learners. The study found that the system's scores were reliable and valid. Moreover, AI has been utilized to provide personalized learning experiences in the EFL context. For instance, Li et al. (2021) developed an AI-based adaptive learning system for EFL vocabulary learning. The system provided personalized vocabulary learning materials and activities based on learners' proficiency levels and learning preferences. The study found that the system improved learners' vocabulary learning outcomes. In conclusion, AI has been utilized in various ways to enhance language learning and teaching in the EFL context. The studies reviewed in this paper demonstrate the potential of AI to provide personalized learning experiences, facilitate language assessment, and improve language proficiency. However, further research is needed to explore the effectiveness of AI in different EFL contexts and to address potential ethical concerns related to the use of AI in education.

In broad terms, artificial intelligence operations with the goal of creating computer systems that are intelligent (Nilsson, 2011), and as explained in many other recommended interpretations (e.g., Kurzweil, 1990; Luckin et al., 2016; Rich, 1983; Stone et al., 2016), the intelligence thus encompasses the intelligence of humans. In a nutshell, artificial intelligence (AI) tools are simulations of human thought and activity. According to that hypothesis, AI would operate like a language teacher in instruction, particularly in language learning and instruction (Bailin, 1987; Matthews, 1993). AI and language teaching research should concentrate on the functions of instructors. The implementation of AI technology to assist students in learning language should be guided by what instructors practice in language instruction and learning settings.

Bibliometric Analysis in Various Fields

Bibliometric analysis has been used in various studies to examine the progress and trends in different fields, including AI (Niu et al., 2016). In the field of EFL, emotional intelligence has

been studied in relation to reading comprehension skills and reading anxiety (Ateş, 2019). Moreover, bibliometric analysis has been used to examine the trends and future of AI in business and economics research (Ruiz-Real et al., 2020). In terms of language learning, AI-based programs have been used to enhance EFL listening skills among primary-stage pupils (Ghoneim & Elghotmy, 2021).

The Purpose of the Study

Despite the growing interest in AI in the EFL context, there is a need to conduct a bibliometric analysis to identify the research gaps and highlight the importance of a bibliometric study. This study will contribute to the existing literature by providing a comprehensive overview of the current state of research on Bibliometric Analysis on Artificial Intelligence in the EFL context.

Research Questions

1. What are the publishing and citation preferences in the EFL context of Artificial Intelligence (AI)?
2. Which countries, institutes, and scholars are the most active in the field of Artificial Intelligence (AI) in the context of EFL?
3. Which journals do scholars choose to publish their Artificial Intelligence (AI) work in the context of EFL?
4. What are the most popular keywords and trending themes in Artificial Intelligence (AI) in the context of EFL?

Method

The study utilized the bibliometric method to identify historical trends in Artificial Intelligence (AI) in the context of English as a Foreign Language (EFL). Bibliometrics involves the application of statistical analyses to various forms of communication media, including articles and books (Borgman, 1989). It encompasses a wide range of laws and methods (McBurney & Novak, 2002). From the researchers' perspective, Bibliometric methods estimate the influence of a research article on future research by counting the number of times it is cited (Cooper, 2015).

Database Selection

To analyze the downloaded data from the Web of Science (WoS), the study used Biblioshiny, a web-based app included in the bibliometric package that analyses data from bibliographic databases, such as WoS (Aria & Cucurullo, 2017). The WoS database was selected for the study because it is globally recognized and preferred by many researchers. The Bibliometrix R Package and Biblioshiny app were used to convert the data into tables and graphs.

Data Collection (Search Terms/ Queries on Bibliometrics)

To retrieve the bibliographic data, the study accessed the WoS website and used a search strategy that included the keyword "Artificial Intelligence (AI)" in the title, abstract, and keywords of the studies. The time span was set from 2013 to 2023, and the field in WoS was narrowed down to Language and Linguistics in the circle of Language Education. There was found to be a total of 1693 papers related to the field of AI in EFL setting. The study selected articles with open access to access the full text of the papers. Overall, a total of 177 papers were selected to investigate in the current study.

Data Analysis

Various bibliometric analysis tools were used to obtain the most useful data from the research articles. Firstly, all published papers indexed in WoS were detected with related keywords. Secondly, the study used the Biblioshiny (version 2.0) through the R tools package, which shows all information and statistics about publications. Lastly, the study examined all the results one by one, such as numbers, graphics, and charts, using MS Excel (V.18.0) (Liu et al., 2020).

Findings

General Information and Historical Background of the Papers on Artificial Intelligence in EFL Context

The primary goal of this study was to create a generic map of relevant research. The data show that 177 publications on Artificial Intelligence (AI) in the EFL setting were published between 2013 and 2023. Table 1 shows the crucial gathered information regarding the publicly available document types.

Table 1. General Information about the Papers on Artificial Intelligence in EFL Context

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2013:2023
Sources (Journals, Books, etc)	59
Documents	177
Annual Growth Rate %	11.61
Document Average Age	3.95
Average citations per doc	9.379
References	1
DOCUMENT CONTENTS	
Keywords Plus (ID)	161
Author's Keywords (DE)	557
AUTHORS	
Authors	473
Authors of single-authored docs	31
AUTHORS COLLABORATION	
Single-authored docs	35
Co-Authors per Doc	3.15
International co-authorships %	37.29
DOCUMENT TYPES	
article	108
article; book chapter	4
article; early access	8
biographical-item	1
book review	1
correction	1
editorial material	6
proceedings paper	47
review	1

Artificial Intelligence in EFL Context Papers

It was also critical for the current study to determine whether research in Artificial Intelligence (AI) in the EFL setting increases, stabilizes, or decreases, and, if there has been an alteration in the recent past, which year academics were most productive. Figure 1 depicts the annual publication numbers for research on Artificial Intelligence (AI) in the EFL setting. The study's period of time spans 11 years of scientific production, and data reveal that the number of papers has increased over time, with a key maximum in 2022 with 34 papers. Studies expand at a pace of about 16% per year. According to the findings, annual publications began increasing significantly after 2016 and progressed gradually and evenly until 2021, with a significant increase of studies starting in 2022. The most noteworthy finding, nevertheless, is that there is a high jump between 2021 and 2022.

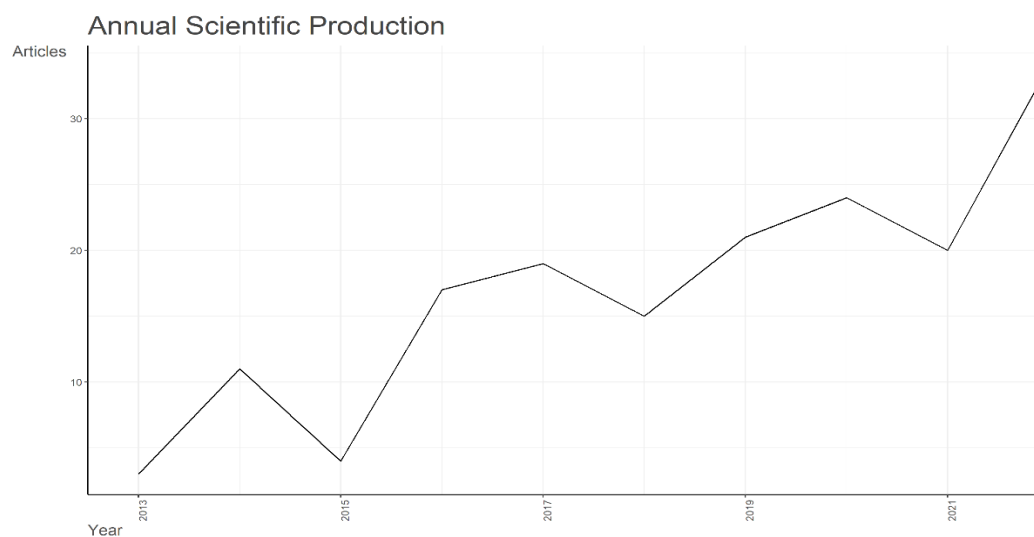


Figure 1. The Number of Papers Published Per Year

Receiving Citations

It was attempted to cover the citation metrics as a comprehensive overview because it provides the most advocated studies. Citation analytics is vital in Scientometrics, as stated by Pech and Delgado (2020). According to the statistics, *Joshi M* is the most cited author (460 citations), being followed by *Belinkov Y* (2015) (126 citations), and *Jadoul Y* (115), who are the three most referred articles in terms of citations for publications. The citation structure of Artificial Intelligence (AI) in EFL context documents is shown in Table 2.

Table 2. The Citation Information on Artificial Intelligence in EFL Context Papers

Paper	Title of the Paper	Total Citations
JOSHI M, 2020, T ASSOC COMPUT LING	Spanbert: Improving pre-training by representing and predicting spans	460
BELINKOV Y, 2019, T ASSOC COMPUT LING	Analysis methods in neural language processing: A survey	126
JADOUL Y, 2018, J PHONETICS	Introducing parselmouth: A python interface to praat	115
DAS D, 2014, COMPUT LINGUIST	Frame-Semantic Parsing	115
SUN K, 2019, T ASSOC COMPUT LING	Dream: A challenge data set and models for dialogue-based reading comprehension	70
GUAN J, 2020, T ASSOC COMPUT LING	A knowledge-enhanced pretraining model for commonsense story generation	67
WANG XZ, 2021, T ASSOC COMPUT LING	KEPLER: A unified model for knowledge embedding and pre-trained language representation	63
ELAZAR Y, 2021, T ASSOC COMPUT LING	Amnesic probing: Behavioral explanation with amnesic counterfactuals	31
RAVIGNANI A, 2017, J LANG EVOL	Measuring rhythmic complexity: a primer to quantify and compare temporal structure in speech, movement, and animal vocalizations	28
ZHU Q, 2020, T ASSOC COMPUT LING	Crosswoz: A large-scale chinese cross-domain task-oriented dialogue dataset	28

Countries and Universities

In terms of organizations, the leading institutions are Hong Kong Polytechnic University in Hong Kong and University Kebangsaan Malaysia in Malaysia, both of which have 15 publications. The Allen Institute for Artificial Intelligence comes in second with 14 publications. Figure 2 depicts the other universities and their publication statistics. Furthermore, it was attempted to identify the leading countries in Artificial Intelligence in the field of EFL. This form of analysis could be beneficial for different bibliometric systematic evaluations of a scientific discipline's expansion, advancement, and alterations. The study gathers the total amount of papers of the universities (the top ten affiliations) from the evaluation of connections. Countries' scientific production chart was provided in Table 3, and most relevant affiliations were shown in Figure 2.

Table 3. Countries' Scientific Production Chart

Region	Freq	Region	Freq	Region	Freq	Region	Freq
USA	62	ITALY	13	DENMARK	5	UKRAINE	2
CHINA	51	INDIA	12	SOUTH AFRICA	5	VIETNAM	2
NETHERLANDS	22	AUSTRIA	11	JAPAN	3	ALGERIA	1
BELGIUM	17	FRANCE	10	THAILAND	3	BRAZIL	1
UK	17	HUNGARY	9	CHILE	2	EGYPT	1
ISRAEL	16	POLAND	9	CZECH REPUBLIC	2	JORDAN	1
CANADA	15	FINLAND	8	OMAN	2	MOROCCO	1
MALAYSIA	15	IRELAND	8	PORTUGAL	2	SUDAN	1
SPAIN	15	AUSTRALIA	7	QATAR	2	SWEDEN	1
RUSSIA	14	SINGAPORE	6	SAUDI ARABIA	2		
GERMANY	13	TURKEY	6	SWITZERLAND	2		

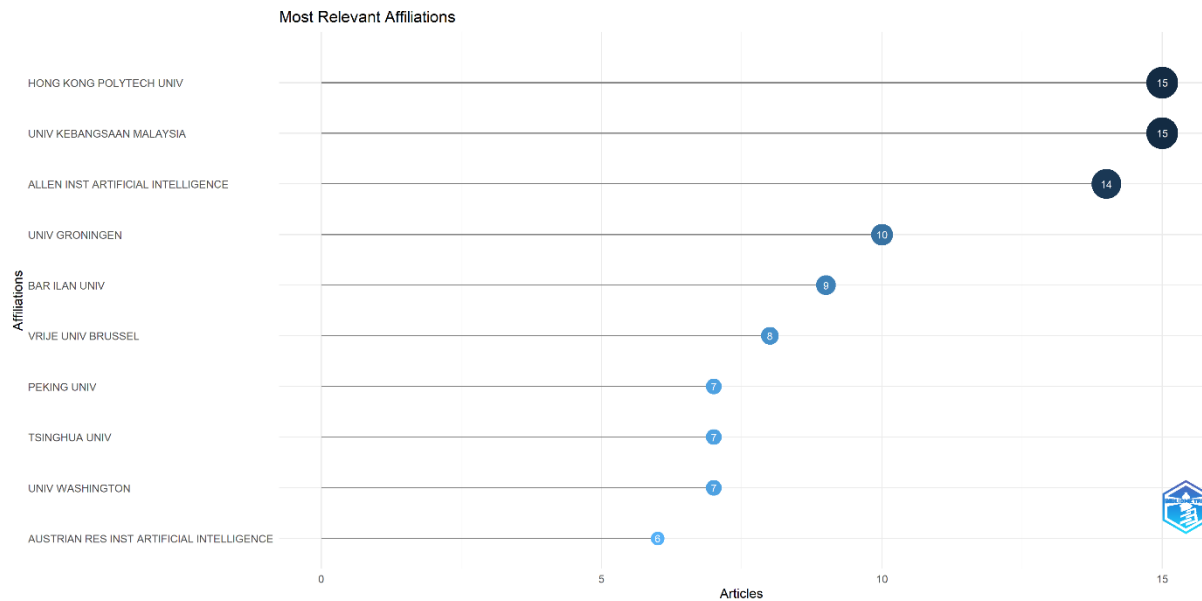


Figure 2. Most Relevant Affiliations

Authors’ Productivity

On the basis of gathered data from the Web of Science (WoS), the researchers published 177 artificial intelligence studies that were set in an EFL setting. *Huang Cr.* is the most productive author with seven papers to their credit. The following Table and Figure provide a summary of certain writers and their output: Table 4 and Figure 3.

Table 4. Author Productivity on Papers Published

Author	Papers
HUANG CR	7
ELAZAR Y	6
GOLDBERG Y	6
HALLMAN P	5
DE BOER B	4
SMITH NA	4
TIUN S	4
FUERTES-OLIVERA PA	3
HEINO E	3
HYVONEN E	3

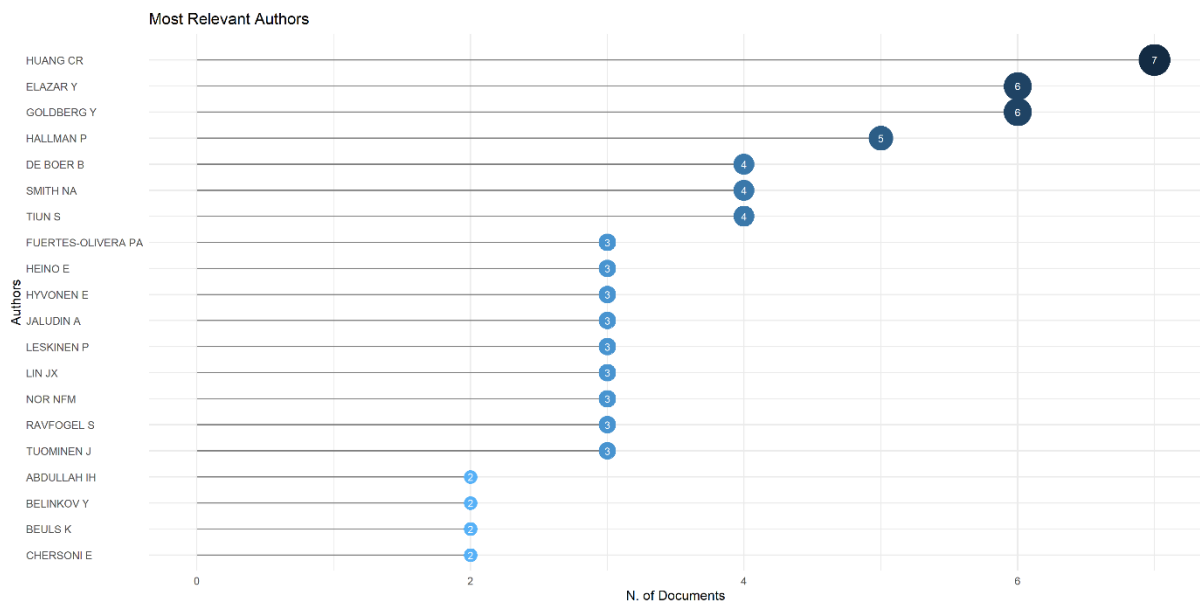


Figure 3. Most Relevant Authors

Most Influential Sources

The current study included an additional objective, which was to identify the resources that academics favor for conducting Artificial Intelligence study reviews and publishing their findings. Articles have been distributed over a total of 55 different publications. It was collected through the sources specified in WoS, which are associated with the field of Artificial Intelligence as it pertains to EFL literature. It was discovered that the Transactions of the Association for Computational is the source that has the most relevant documents, totaling 29. Figure 4 provides an in-depth look at the sources that had the largest impact. Second, to examine the relationship between the source and the source growth, an attempt was made to uncover the source growth on an annual basis. Figure 5 provides a visual representation of the yearly output of the source as it relates to time.

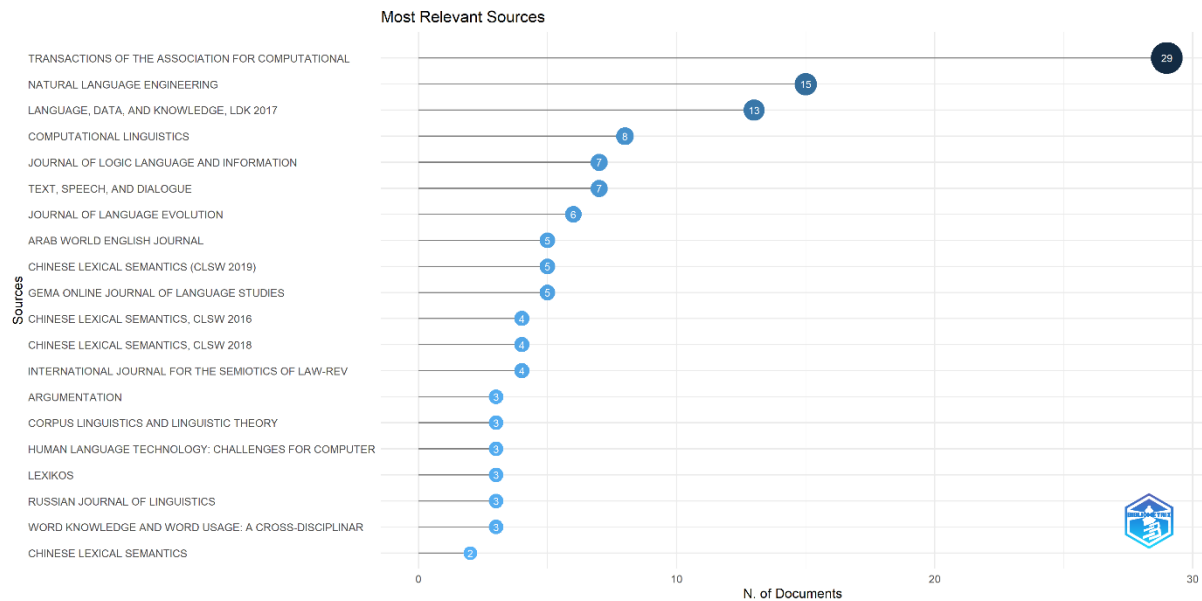


Figure 4. Most Relevant Sources

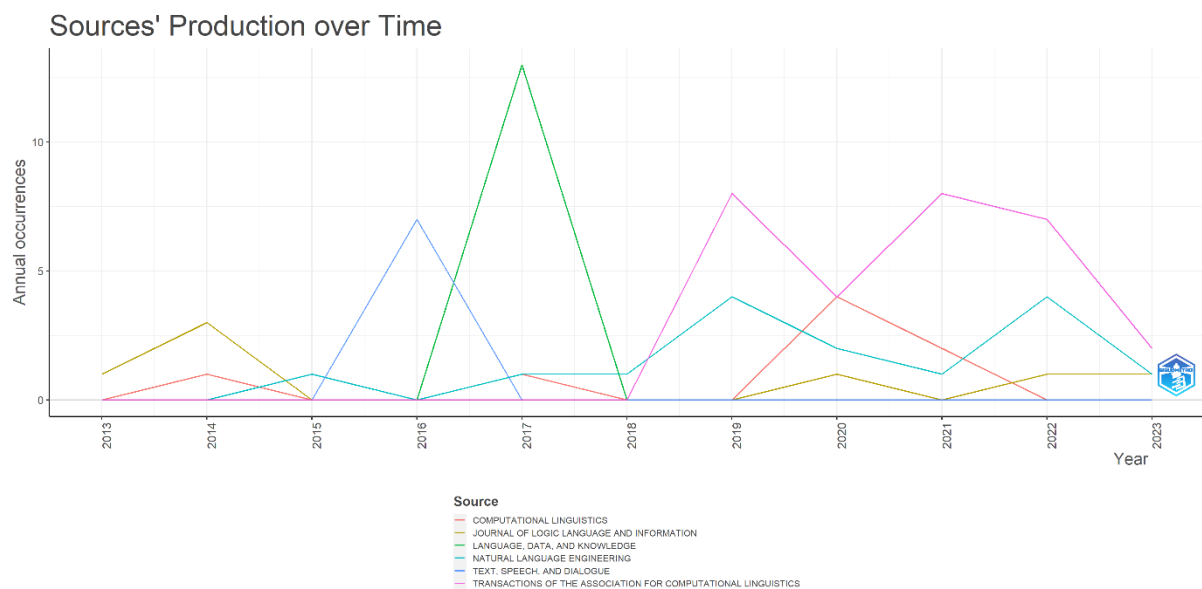


Figure 5. Sources' Production Over Time

Major Themes and Most Frequent Words

It was found in the study that the three most frequently used words are *language* (5 times), *corpus*, *english*, *inference*, *logic*, *speech* (3 times for each) are the mostly preferred keywords by the researchers. Figure 6 illustrates the most frequent words and top twenty themes in second language pronunciation assessment publications. As for the author’s keywords, there are 161 keywords in total. Researchers use multiple keywords in their articles, and it gives significant findings to determine the research trend. In addition, the most common title word is *language* with 3 occurrences.

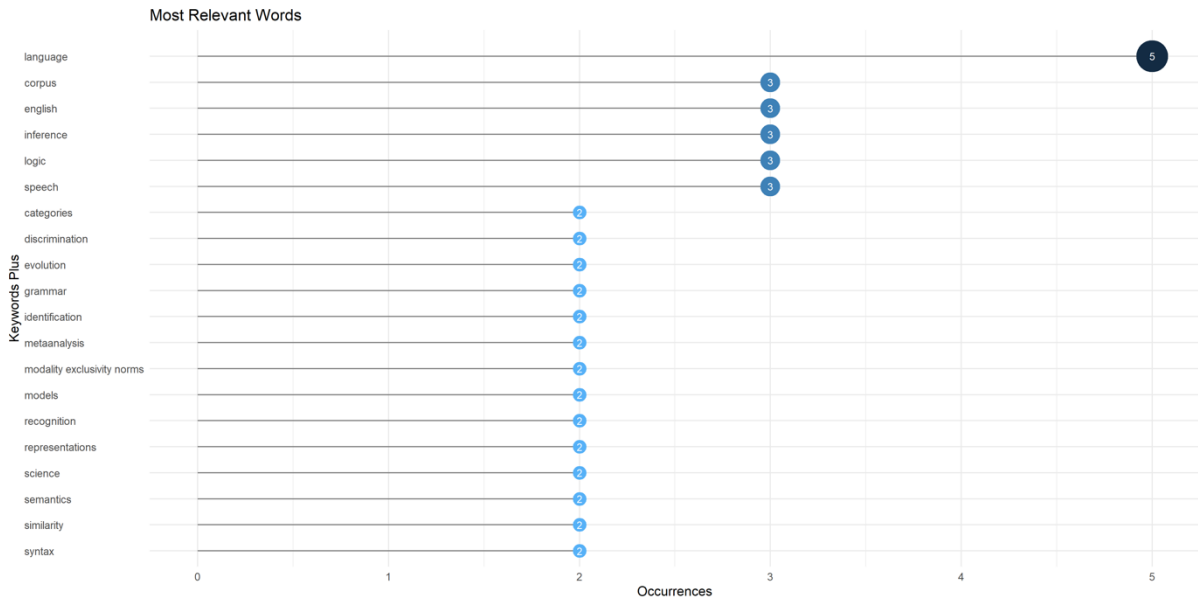


Figure 4. Most Relevant Words

Trend Topics Per Year

The study demonstrates that the trend topics in investigating Artificial Intelligence in EFL context differed all over the span of time; whilst *backward induction* was the trend topic in 2014, it transferred to *carneades* 2016. Yet, in 2017, the most popular trend topic was *Bayesian models*, and in 2018, it was *categories*, and in 2019, it was *semantics*, and in 2020 it was *language*, and in 2021 it was *English*, and in 2022 it was *logic*, and finally in 2021 it was *emergence*. The researchers' favorite choices for trend themes are shown in Figure 7, which can be seen below.

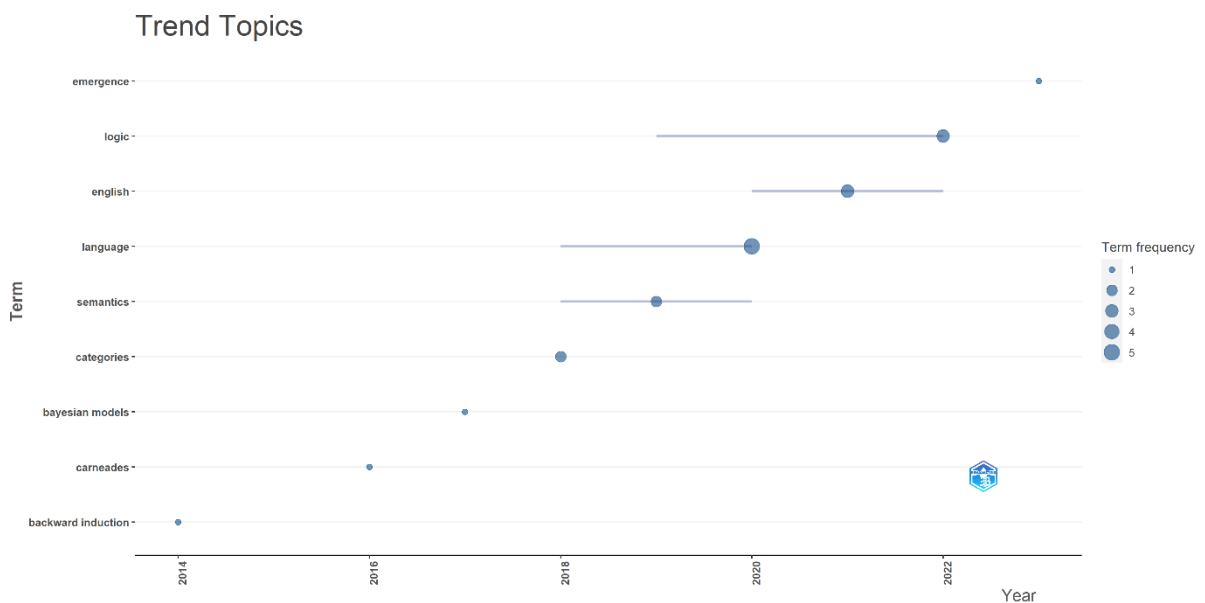


Figure 7. The Most Preferred Trend Topics

Conclusion and Discussion

The purpose of this research was to carry out a bibliometric examination of the papers that were indexed in the Web of Science (WoS) database that were pertinent to the use of artificial intelligence to the teaching of the English language. A comprehensive review of the relevant research found that various studies have been conducted on artificial intelligence in the context of English as a Foreign Language (EFL). The results of all of these inquiries have shown that this is an important and promising area of inquiry. However, there have only been a handful of bibliometric studies conducted on the works in this topic. This work is essential because it does a comprehensive analysis of AI-based English teaching research that has been published in the literature between the years 2013 and 2023. This study is distinct from others in that, rather than merely assessing the influence that artificial intelligence has had on the field of education, it analyses previously conducted research and provides a glimpse into the field's potential future.

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Author Contributions

All of the authors have contributed equally to this article.

Conflict of Interest

The authors declare there is no conflict of interest in this study.

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