The Roles of Electronic Dictionaries in Language Learning from 2010-2024: A Bibliometric Review

Maimanah Samsuri[1], Mazni Muslim[2], Nurma Abdul Manap[3], Siti Aisyah Mazlan[4*]

[1,2,3,4] Akademi Pengajian Bahasa, Universiti Teknologi MARA, Cawangan Pahang, Kampus Raub, 27600 Raub, Pahang, Malaysia
sitiaisyah370@uitm.edu.my
[*]Corresponding Author

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Abstract: Mastery of vocabulary is crucial in the teaching and learning process. Students need to memorise and identify words to complete their tasks. As a result, electronic dictionaries are essential. The current study identified research trends regarding the role of electronic dictionaries in language learning. By searching journals related to electronic dictionaries indexed in the Elsevier Scopus database between the 2010 and 2024 period, we collected 274 research articles in total. The results obtained by bibliometric analysis showed that the role of electronic dictionaries is still volatile in published journals. We concluded that the researchers are language experts, and the United States of America has the most linked countries in co-authorship. Also, the research gap mainly focuses on three critical keywords: electronic dictionaries, online dictionaries and lexicography. For further research, it is recommended that a more in-depth study be conducted on methods for the effectiveness of using electronic dictionaries in language learning.

Keywords: Bibliometric, data analysis, electronic dictionaries, language learning

Introduction

There are now more methods than ever before to access and engage with linguistic data, all thanks to electronic and online dictionaries. In contrast to their paper equivalents, digital resources make it simple to access definitions and pronunciations and use examples of words with the tap of a screen or button. From standalone portable devices in the 1970s to software programs for PCs, cell phones, and tablets, the history of electronic dictionaries is long (Nesi, 2009). This technical breakthrough has dramatically enhanced dictionaries' availability, searchability and user-friendliness.

When downloaded and installed on mobile devices, tablets, or PCs, electronic dictionaries provide a wealth of information to their users. To meet the demands of users even when they do not have access to the internet, these dictionaries often include features like audio pronunciations, sophisticated search, and multiple language settings (Li, 2019). Professionals and students may benefit from electronic dictionaries since they can be customised to include specialised subjects, such as medical or legal terms (Baker, 2020).

Online dictionaries, on the other hand, are accessible only via web browsers and internet connections. Videos, interactive quizzes, and user-generated material are just a few multimedia features, real-time updates and many resources (Chen, 2021). People learning a new language may benefit significantly from an online dictionary because of how up-to-date they are with current idioms and trends (Miller, 2020). On the other hand, restricted access could pose a problem due to their dependence on internet connectivity. According to research by Dziemianko (2010), having a dictionary helps with memory retention and general language proficiency. Moreover, many online dictionaries include advanced search tools that enable students to locate phrases by partial spellings, synonyms, or even the reverse search function, which allows them to discover the definitions of words before looking them

up. However, be wary of using any free online dictionary without verifying its accuracy and quality (Dziemianko, 2012).

While there are many benefits to using an electronic dictionary, there are also some downsides. People may be less inclined to engage in critical thinking and memorisation due to the abundance of easily accessible information. With the continuous development of technology, electronic dictionaries of the future may include artificial intelligence and natural language processing to provide even more personalised and context-aware language support.

Due to their numerous advantages over print dictionaries, electronic dictionaries have become an essential tool for students of contemporary languages. These digital reference books frequently include audio pronunciations, examples of use, and etymology information, making it simple to access massive vocabulary databases. When learning a second language, Levy and Steel (2015) noted that using an electronic dictionary makes it quick to look up new words, which improves reading comprehension and vocabulary expansion.

One significant aspect of electronic dictionaries is their interactive features and multimedia. These days, they provide audio pronunciations so users may hear how native speakers say the words. Some even employ moving pictures, cartoons, and visuals to illustrate their points further. In electronic dictionaries, students may also utilise advanced search options, such as wildcard searches, to find phrases based on their meaning rather than their spelling (Lew & de Schryver, 2014). Electronic dictionaries are vital tools for language learners and professionals who want quick and thorough reference.

Using electronic dictionaries, learners can access vocabulary, pronunciation, and context-based use quickly and easily, significantly improving their efficiency and understanding (Smith & Johnson, 2024). Compared to standard print dictionaries, these digital resources provide a more engaging learning experience because of multimedia features like audio pronunciations and sample sentences. As a bonus, students may practise using electronic dictionaries whenever and wherever they choose, which promotes a more adaptable language learning method (Smith & Johnson, 2024). Meanwhile, based on Li, Wang, and Xu's (2024) research, which was intended to modify and verify the S.I.E.D.U. (Strategy Inventory for Electronic Dictionary Use) questionnaire to evaluate the use of electronic dictionaries in a Chinese setting, it was found that improving students' tactics for making good use of electronic dictionaries is a crucial finding of their research, which also validates the S.I.E.D.U. in the Chinese setting.

The portability and convenience of electronic dictionaries are significant advantages. Students of current languages no longer struggle with the weight of significant books, thanks to the comprehensive dictionaries available on mobile devices. Despite their advantages, we must still consider the potential drawbacks of electronic dictionaries. The ease of electronic lookups, as opposed to the time-consuming process of checking print dictionaries, may lead to decreased retention, according to Dziemianko (2012). Students also risk developing an unhealthy reliance on instant translations, which might hinder their ability to deduce meaning from context or develop effective guessing strategies. Therefore, as with any other language learning tool, teachers should ensure their students know how to utilise electronic dictionaries properly.

Finally, introducing electronic dictionaries has revolutionised how lexical information is accessible to language learners. These dictionaries offer multimedia capabilities and lightning-quick search engines and are generally easy to use. Although they do not have any issues, they are excellent for assisting to develop a more extensive vocabulary and improving one's language skills. Technological advancements expect electronic dictionaries to provide learners with personalised and context-aware linguistic assistance in the future. Such dictionaries might incorporate technologies like augmented reality and artificial intelligence.

Electronic dictionaries have changed the game regarding language learning resources because of the benefits they can provide for students and teachers. Etymologies, definitions, pronunciations, and usage examples are only some language materials easily accessible using these digital tools. Nesi (2009) suggests that students could benefit from using electronic dictionaries because of how fast and straightforward it is to look up new concepts without breaking their study flow.

There is only one better tool for teachers than digital dictionaries. Teachers may use these materials to demonstrate proper dictionary usage, demystify nuances in word meaning, and study language trends. Loucky (2010) finds that using electronic dictionaries in vocabulary lessons improved

students' word recall and language proficiency. Teachers can tailor their lectures to their students' needs using electronic dictionaries, which often include features that make learning the words more accessible, such as word difficulty ratings and customisable vocabulary lists.

Students can take a more active role in their education thanks to electronic dictionaries. These tools' multimedia elements, such as visual aids and audio pronunciations, make them accessible to students with varying learning styles and can improve their comprehension. Students who used electronic dictionaries with multimedia enhancements expanded their vocabulary more rapidly than traditional print dictionaries (Chen, 2011). Electronic dictionaries, accessible via smartphone apps, also allow students to learn languages at their own pace and in their own time.

Remember that proper use of electronic dictionaries requires training and practice. Ranalli (2013) emphasises the requirement of instructing students in strategic dictionary use, as having access to dictionaries does not guarantee improved learning outcomes. Teachers play a crucial role in assisting students develop critical thinking skills by examining dictionary content and selecting the most applicable meanings for specific contexts.

It is imperative to note that training and practice are necessary for the correct use of electronic dictionaries. Since having access to dictionaries does not ensure higher learning results, Ranalli (2013) stresses the need to teach students how to utilise them strategically. By analysing dictionary definitions and choosing the most relevant ones for specific situations, teachers greatly aid their pupils in developing critical thinking abilities.

The research focuses on the role of electronic dictionaries in language learning as a primary criterion for identifying relevant publications in Scopus-indexed journals. The research addresses various research questions.

1. What is the research trend in the roles of electronic dictionaries in language learning according to years?
2. What are the most cited articles, and who writes the most cited articles?
3. Who and how much has been published about the authors, their affiliated organisations, and countries?
4. What are the research themes in electronic dictionaries' roles in language learning?
5. What are co-citation and co-authorship countries' collaboration?

Methodology

According to Verbeek et al. (2022), the field is known as bibliometrics when scientific publications' bibliographic information is combined, organised, and studied. In addition to basic descriptive statistics like journals, years of publication, and significant author categorisation (Wu & Wu, 2017), it also includes more advanced approaches like document co-citation analysis. An iterative sequence of appropriate keywords, literature search, and analysis is necessary for a successful literature review, building a bibliography, and achieving defendable findings (Fahimnia et al., 2015). The following section covers search result refining, initial search result screening, and search term adoption. Meier (2011) states that a high-quality publication will include the Clarivate Analytics Citation Reports (JCR) impact factor. Therefore, the study focused on high-quality publications since they may shed light on the theoretical viewpoint on the research topic's development.

To gather evidence and achieve the research objectives, this study relied on extracted data from the Elsevier Scopus database. Created by Elsevier in 2004, this database currently holds more than 77.8 million records (post-1969) from which over 23,000 are peer-reviewed journals, 294 trade journals, over 852 book series, and over 120,000 worldwide scientific events (Elsevier, 2020, as cited in Martins, Goncalves & Branco, 2022). The Scopus database contains relatively 11,000 publishers and 36,000 titles, which makes it the most extensive database for peer-reviewed literature (Rusly et al., 2019, as cited in Ida Rahayu & Anuar Shah, 2023).

Data search strategy

This study employed a screening sequence to determine the search terms for article retrieval. This study was initiated by querying the Scopus database with electronic dictionary TITLE-ABS-KEY (electronic AND dictionary) AND PUBYEAR > 2018 AND PUBYEAR < 2025 AND (LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "ARTS") AND (LIMIT-TO (LANGUAGE, "English"), creating a total of 274 articles. Afterwards, the query string was adjusted to specifically target students as learners by adding the phrases "electronic dictionary" OR "e-dictionary" to the search. After this procedure, 274 results were further reviewed to ensure that they included only research papers written in English and removed reviews of these articles. This bibliometric study used 274 articles for the final search string refinement. The research included all publications published in 2010, followed by electronic dictionaries and language learning in the Scopus database.

Data analysis

Using VOSviewer software version 1.6.15, we combed through data sets extracted from the Scopus database that covered 2010–2024. The datasets included PlainText formatted information such as research publication year, publication title, author name, journal, citation, and keyword. This program was used for analysis and map construction using the VOS clustering and mapping methodologies. The goal of VOSViewer, like that of the Multidimensional Scaling (MDS) method (Van Eck & Waltman, 2010), is to arrange objects in a two-dimensional space so that the distance between them accurately reflects their relatedness and similarity (Appio et al., 2014). In contrast to MDS, which is primarily concerned with computing similarity measures like cosine and Jaccard indexes, VOS uses a more appropriate method for normalising co-occurrence frequencies, such as the association strength (ASij), which is computed as:

$$ASij = \frac{Cij}{Wiwj}$$

This is "in direct proportion to the ratio between the number of times i and j occur together as observed and the number of times they occur together as expected, assuming that they are statistically independent" (Van Eck & Waltman, 2010, p. 531). As a result, VOSviewer uses this index to arrange objects on a map by minimising the weighted sum of squared distances between each item pair. Appio et al. (2016) established LinLog/modularity normalisation. Analyses such as keyword co-occurrence, citation analysis, and co-citation analysis were conducted, and patterns based on mathematical correlations were discovered by applying visualisation methods using VOSviewer to the data set.

Consequently, VOSviewer uses this index to arrange objects on a map after minimising the weighted sum of squared distances between each item pair. It was established that the LinLog/modularity normalisation was used (Appio et al., 2016). Analyses such as keyword co-occurrence, citation analysis, and co-citation analysis were conducted, and patterns based on mathematical correlations were discovered by applying visualisation methods using VOSviewer to the data set. Using the term co-occurrence analysis, one may trace the evolution of a study area over time (Zhao, 2017) and discover hot subjects across disciplines (Li et al., 2018). In contrast, citation analysis may help uncover essential research topics, trends, and methods while shedding light on the area's historical significance (Allahverdiyev & Yucesoy, 2017). An often-used bibliometric tool, document co-citation analysis (Appio et al., 2016; Fahimnia et al., 2015; Liu et al., 2015), uses a map based on network theory to isolate data structures that are important to the study (Liu et al., 2015).

Findings and Discussion

Research Question 1:
What is the research trend in the roles of electronic dictionaries in language learning according to years?

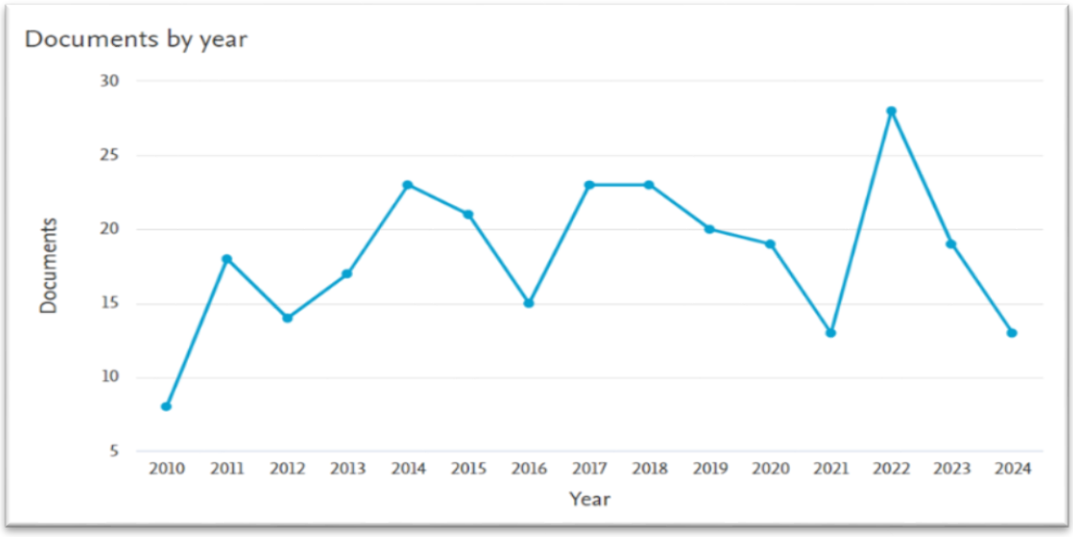

Fig. 1 Trend in using electronic dictionaries in language learning by year of publication

Table 1. Number of documents by year of publication

Year	Document
2024	13
2023	19
2022	28
2021	13
2020	19
2019	20
2018	23
2017	23
2016	15
2015	21
2014	23
2013	17
2012	14
2011	18
2010	8

Figure 1 and Table 1 show the number of electronic dictionaries published each year between 2010 and 2024. They indicate that the usage of electronic dictionaries for language learning is significant and relatively volatile, ranging from 8 (2010) to 19 (2023). The trend peaked in 2022 as 28 of these articles were published. Contributing factors could relate to the widespread use of the Internet and, most importantly, the worldwide spread of the COVID-19 pandemic. In 2010, only a handful of articles were published, suggesting that people still needed to embrace the convenience of electronic dictionaries fully. A similar number of publications were published in several years. 23 publications were published in 2014, 2017 and 2018 while in 2021 and 2024, 13 documents were published. As of 2020 and 2023, 19 documents were published.

Research Question 2:
Who and how much has been published about the authors, their affiliated organisations and countries?

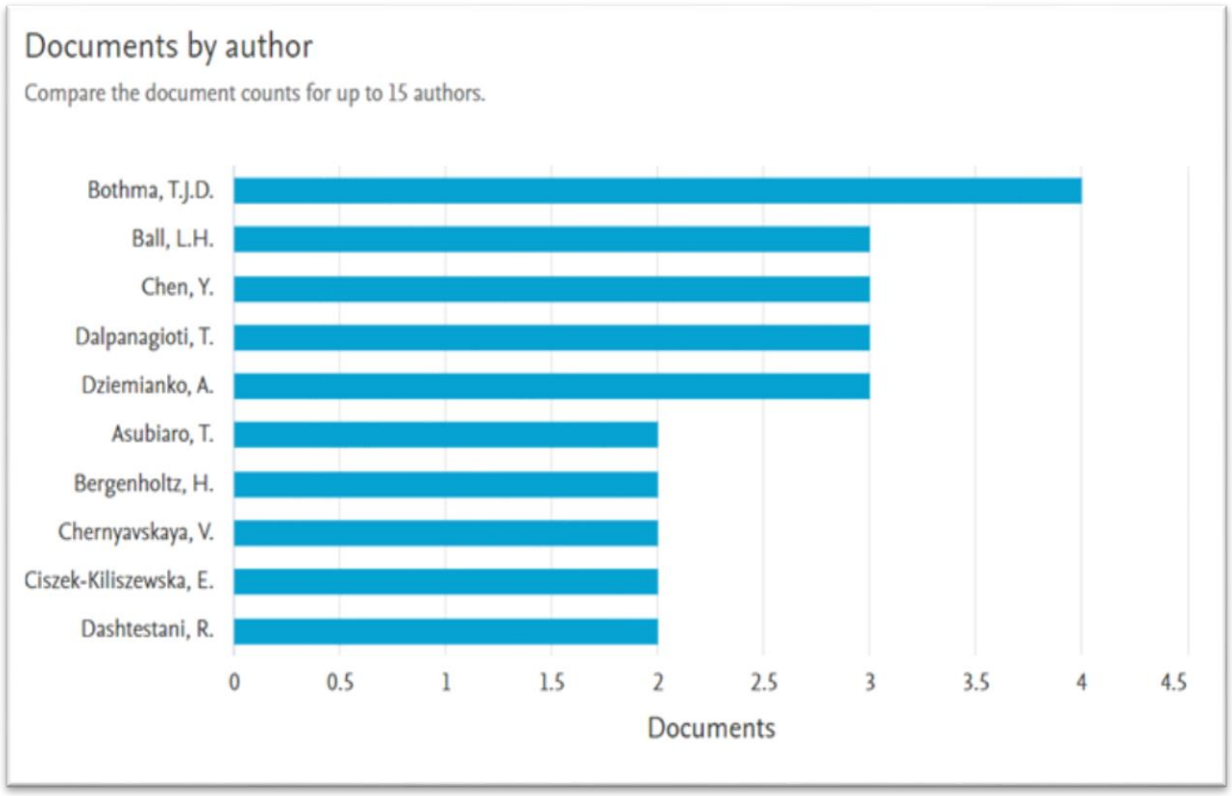

Fig. 2 The number of documents by author

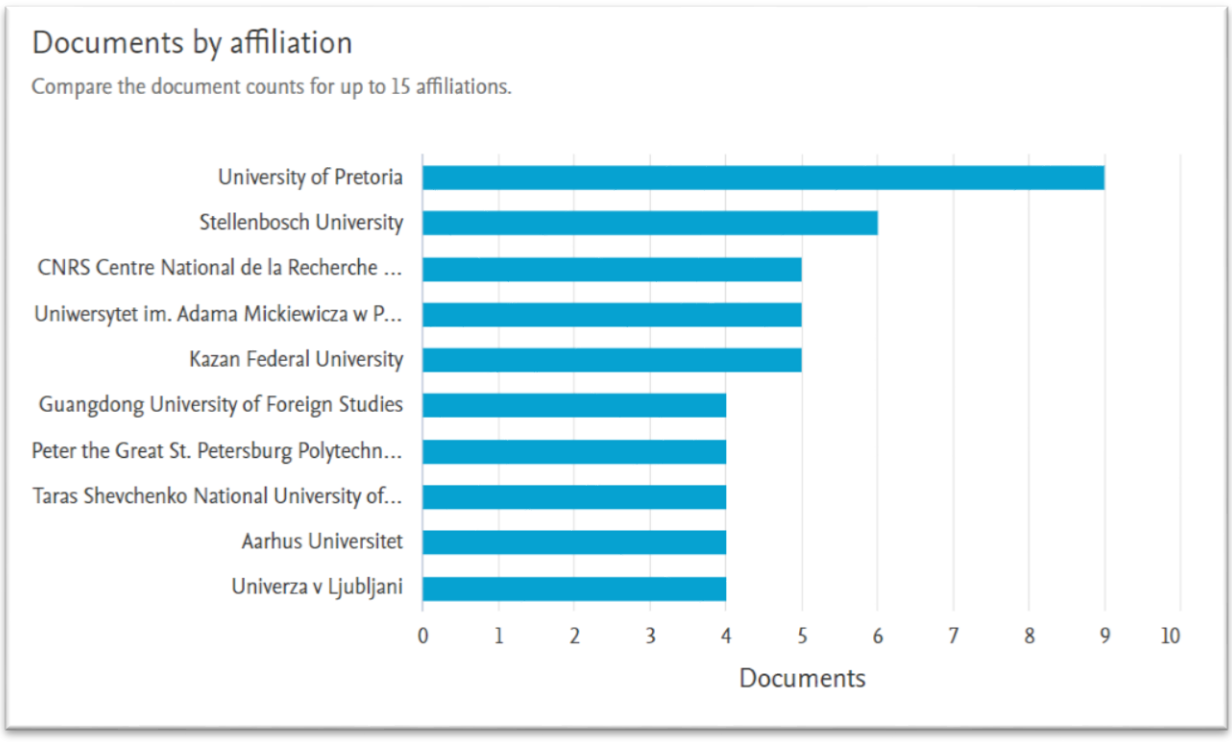

Fig. 3 The number of documents by affiliation

Figures 2 and 3 illustrate the number of documents by affiliation, highlighting the top 10 authors and their affiliations who have contributed to the role of electronic dictionaries in language learning over the past 13 years (2010-2023). Figure 2 refers to the number of documents published by the authors; the range of documents produced by these authors is between 2-4 documents. Bothma, T.J.D., is the top author with 4 documents, while the writers Ball, L.H., Chen, Y., Dalpanagioti, T. and Dziemianko, A., each authored 3 documents over the period. The 5 writers who are language experts have the lowest number of writings with 2 documents are Asubiaro, T., Bergenholtz, H., Chernyavskaya, V., Ciszek-Kiliszewska, E., and Dashtestani, R. Meanwhile, Figure 3 refers to the top 10 highest affiliations in writing the theme of the research title. The University of Pretoria has the highest affiliation, with 9 documents, followed by Stellenbosch University with 6 documents, all from South Africa. While the lowest affiliation consists of 4 documents from Guangdong University of Foreign Studies, Peter the Great St. Petersburg Polytechnic University, Taras Shevchenko National University of Kyiv, Aarhus Universitet and Univerza v Ljubljani. These affiliated countries are China, Russia, Ukraine, Denmark and Slovene.

Research Question 3:
What are the most cited articles and who writes the most cited articles?

Table 2. The number of author citations

Cites	Authors	Title	Source	CitesPerYear	CitesPerAuthor
166	G.M. De Schryver	Lexicographers' dreams in the electronic-dictionary age	International Journal of Lexicography	7.9	166
91	M. Hill	Type of task, time-on-task and electronic dictionaries in incidental vocabulary acquisition	IRAL - International Review of Applied Linguistics in Language Teaching	4.33	91
83	A.P. Quimbaya	Named Entity Recognition over Electronic Health Records Through a Combined Dictionary-based Approach	Procedia Computer Science	10.38	83
80	A. Dziemianko	Paper or electronic? the role of dictionary form in language reception, production and the retention of meaning and collocations	International Journal of Lexicography	5.71	80
61	Y. Chen	Dictionary use and EFL learning. A contrastive study of pocket electronic dictionaries and paper dictionaries	International Journal of Lexicography	4.36	61
61	W.S. Maki	Semantic distance norms computed from an electronic dictionary (WordNet)	Behavior Research Methods, Instruments, and Computers	3.05	61
57	T. Yokoi	The EDR Electronic Dictionary Toshio Yokoi	Communications of the ACM	1.97	57
51	M. Levy	Language learner perspectives on the functionality and use of electronic language dictionaries	ReCALL	5.1	51
38	H. Nesi	A user's guide to electronic dictionaries for language learners	International Journal of Lexicography	1.52	38
37	R. Lew	Multimodal lexicography: The representation of meaning in electronic dictionaries	Lexikos	2.64	37

Table 2 shows the 10 most cited articles in the "electronic dictionary." Most research articles mainly dealt with electronic dictionaries related to lexicography and their use in teaching and learning. The authors of the 10 most cited articles refer to the ones published from 2010 to 2023, where the number of citations is between 166 and 37 in the Scopus database. The author who has the most citations, with a total of 166 citations and an average citation of 7.9 citations per year, is G.M. De Schryver, with his article titled "Lexicographers' Dreams in the electronic-dictionary Age", which was published in the *International Journal of Lexicography*. In addition, 3 other writers have a different number of citations but have all published their research in the *International Journal of Lexicography*, namely A. Dziemianko, whose research titled "Paper or electronic? The role of dictionary form in language reception, production and the retention of meaning and collocations" with 80 citations (5.71 per year); Y. Chen, whose article titled "Dictionary use and EFL learning. A contrastive study of pocket electronic dictionaries and paper dictionaries" had 61 citations (3.05 per year), and finally, H. Nesi, whose article is titled "A user's guide to electronic dictionaries for language learners" with 38 citations (1.52 per year). The lowest number of citations, with a total of 37 citations and an average citation per

year of 2.64, was written by R. Lew in his article "Multimodal lexicography: The representation of meaning in electronic dictionaries," published in *Lexikos*.

Research Question 4:
What are the research themes in electronic dictionaries' role in language learning?

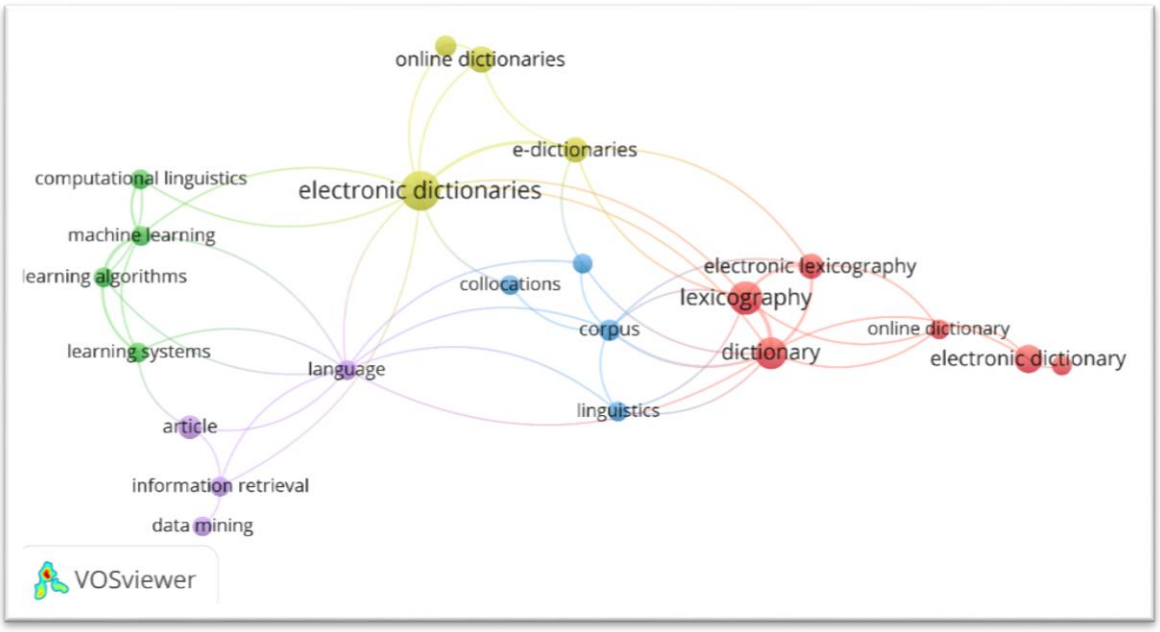

Fig. 4 Network visualisation map of keywords' co-occurrence

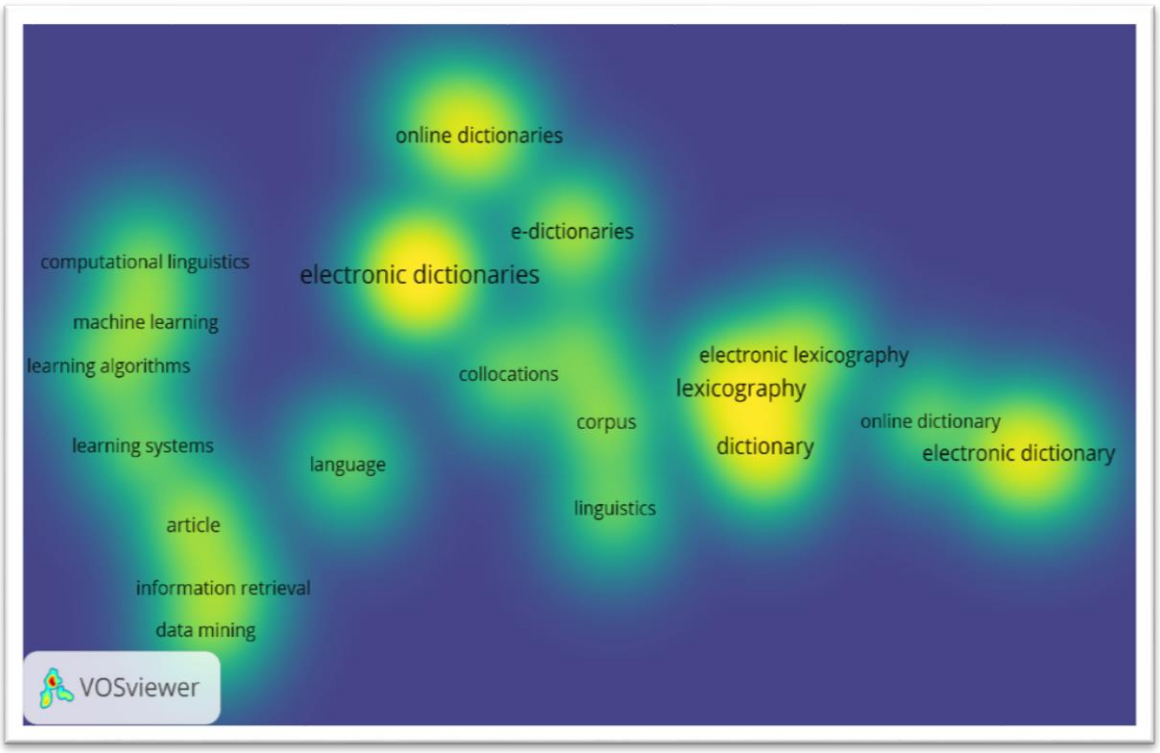

Fig. 5 Co-occurrence density visualisation

The following figure shows the co-occurrence network visualisation (Figure 4). It is possible to verify that there are 5 clusters:

- C1: dictionary, e-dictionary, electronic dictionary, electronic lexicography, lexicography and online dictionary.
- C2: computational linguistics, learning algorithms, learning systems and machine learning. The blue cluster, the third one, has 4 keywords: collocations, corpus, linguistics and vocabulary.
- C3: dictionary use, e-dictionaries, electronic dictionaries and online dictionaries.
- C4: article, data mining, information retrieval and language.
- C5: dictionary, e-dictionary, electronic dictionary and online dictionary.

The co-occurrence density visualisation in Figure 5 implies that the darker yellow and larger circle diameter means the denser the keywords. This means that the frequency of research on the subject is increasing. Meanwhile, the faded green background shows the decreasing amount of research. This indicates that keywords such as lexicography, electronic dictionary, electronic dictionaries, and online dictionaries are the most used. Additionally, the words that have a low frequency are online dictionary, vocabulary, linguistics, learning systems and computational linguistics.

Research Question 5:
What are co-citation and co-authorship countries' collaboration?

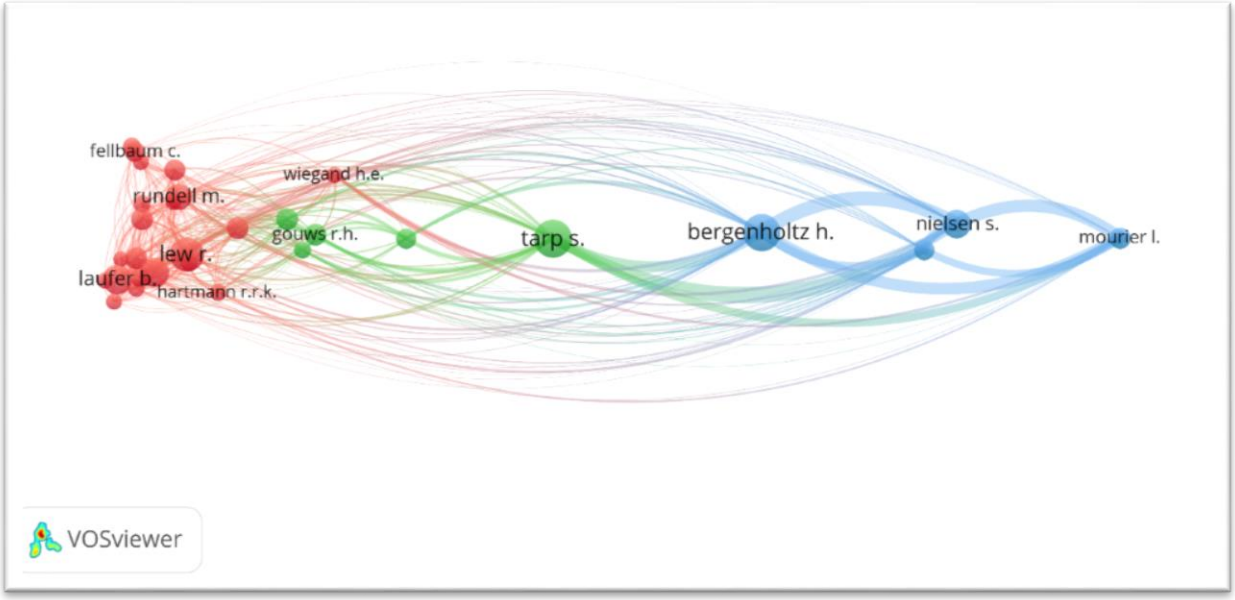

Fig. 6 Co-citation author network visualisation

In general, Figure 6 refers to the author's co-citation in network visualisation. Co-citation analysis is a highly effective method for knowledge mapping, addressing the limitations of bibliometric coupling by evaluating a document's incoming citations to determine similarity. This metric may fluctuate over time. Meanwhile, the author co-citation analysis is defined as a bibliometric method that examines the link between pairs of cited authors inside source documents. This figure shows 3 clusters and 30 items that connect with 368 links and 17,363 total link strengths. The node size represents the most citations of authors and the more excellent proximity and frequency the nodes show of citation authors. It can be observed that the positions of the red nodes are close to each other, which indicates a frequent citation relationship, followed by the green node, and the farthest is the blue node. However, when looking at the frequency of citations, Trap, S. (green node) has the most citations which is 115, followed by

Bergenholtz, H. (blue node) with a total of 112 citations, compared to the red node which represents Cluster 1 with the highest number of citations by Lew, R. with 94 citations.

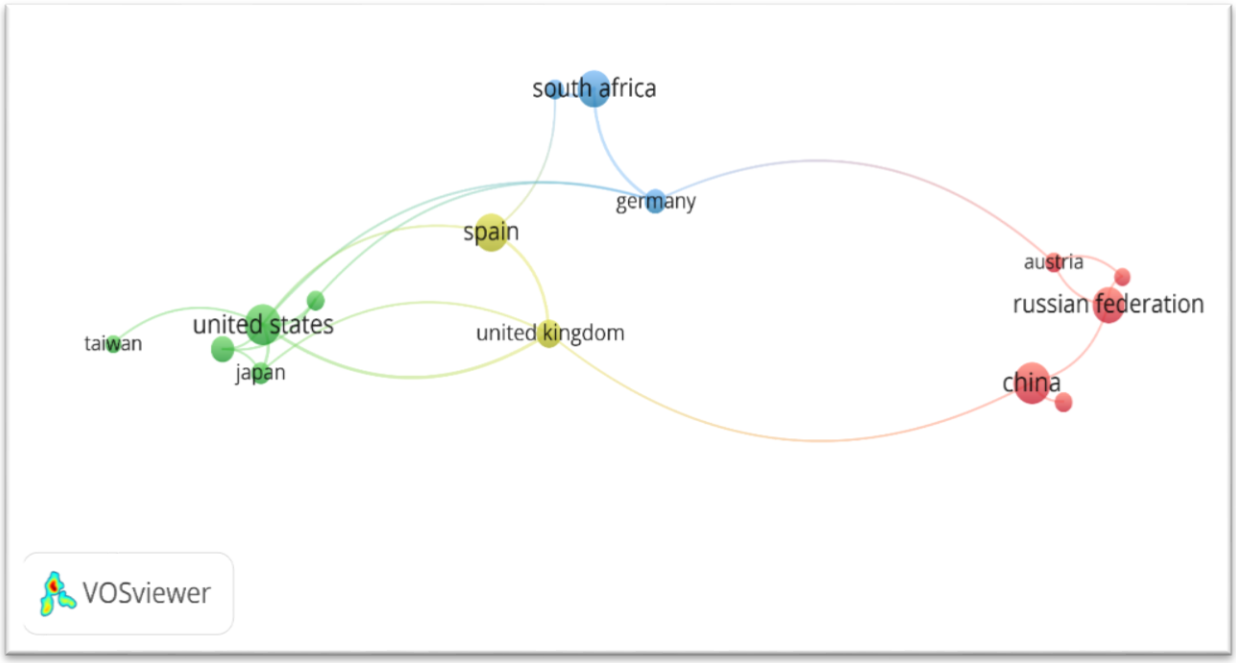

Fig. 7 Country co-authorship by network visualisation

The country co-authorship refers to the country with the most significant influence in the study. Figure 7 shows the country's co-authorship in the role of electronic dictionaries in teaching and learning. The size of the node represents the influence of the largest country. The link's thickness and distance also play an essential role in demonstrating cooperation between countries. Among the countries with the most significant nodes are China (26), the United States of America (24), Spain (21), South Africa (20), and the Russian Federation (19). The country with the most links is the United States of America (10), which has strong relationships with Taiwan, France, Japan, Italy, Spain, Germany, and the United Kingdom, with a total link strength of 10.

Discussion

Overall, the results of the study found that the records that have been reported by Scopus show that the annual trend is uneven from 2010-2024, where the highest trend shows in 2022, as many as 28 articles were published. This happens because research related to the research topic is still new and less used, and there is an overlap with another type of dictionary, which is an online dictionary or e-dictionary. In addition, it proves that research awareness of the use of electronic dictionaries in teaching and learning is very important and is becoming more widespread, especially in Scopus-indexed journals. This can be proven by the authors who get the highest number of citations from titles related to lexicography, and among the titles of articles written in the *International Journal of Lexicography* are:

1. Lexicographers' dreams in the electronic dictionary age
2. Paper or electronic? The role of dictionary form in language reception production
3. The retention of meaning and collections
4. Dictionary use and EFL learning: A contrastive study of pocket electronic dictionaries and paper dictionaries

In the cluster keyword records related to this study, most researchers use clusters that revolve around language, linguistics, and lexicography clusters. However, there is another cluster that has a significant standing with the other clusters, which is the learning cluster. This is due to the influence or

need in foreign language learning that requires the use of dictionaries, especially bilingual. Accordingly, the writers in the top 10 do have expertise in related themes, namely lexicography and linguistics. There are also writers with expertise in cognitive science, anthropology, and informatics who are very connected to the study of humans and their development.

This study concerning the role of electronic dictionaries in language learning has been carried out using bibliometric analysis. It is essential in language teaching and learning to get comprehensive pronunciation and text comprehension data. Based on the Scopus database, 274 related articles from 2010-2024 were identified using electronic and dictionary keywords.

The research trend has shown a volatile pattern, with 166 as the highest number of citations published in the *International Journal of Lexicography*. Then, the data was analysed using VOSviewer to create network and density visualisations that link elements based on keywords: co-occurrence, co-citation author, and country co-authorship.

The main keywords used in this study are lexicography, electronic dictionaries, online dictionaries, and dictionaries. Even though the author co-citation mapping showed that Cluster 1 is the largest, it did not reflect the many co-citations author relationships. Trap, S. holds the highest number of citations within Cluster 2.

In addition, the United States of America has the highest collaborations with other countries that show cooperation based on research and studies related to the topic and can gather various ideas to solve problems, build a multinational research network, and contribute to the production of new innovations with 10 strength relationships and 24 published articles.

Conclusion

In summary, electronic dictionaries offer substantial benefits that enhance language learning by providing instant access to comprehensive lexical resources, incorporating multimedia features, and allowing for personalised learning experiences. Their portability and ease of use facilitate frequent reference and support vocabulary acquisition, while multimedia elements and personalisation features contribute to a more engaging and effective learning process.

Further Research

This research requires further study; apart from the general debate, it can be focused on specific languages in the same field of study. Some potential directions for future research that might expand upon current studies on the electronic dictionaries on second language acquisition are as follows:

1. Multimedia features and their effects determine how various forms of multimedia (such as audio pronunciations, pictures, sample sentences, and interactive activities) affect language learners' success.
2. Methods and approaches to education in creating and assessing methods for effectively using electronic dictionaries in language classrooms.
3. Creating an interface and user experience to examine the relationship between electronic dictionaries' usefulness and the quality of their user experience and interface design.

Co-Author Contribution

The authors confirmed that there is no conflict of interest in the article. Author 1 carried out the analysis of the result and interpreted the data. Author 2 prepared the abstract and references. Author 3 drafted the introduction and conclusion. Author 4 prepared the methodology and refined the figures and tables.

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