

 Review Article

Microlearning: A Bibliometric Analysis of Research Trends from 2002 to 2023

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Abstract

Microlearning is a highly efficient method of teaching that provides learners with focused, and brief learning. It offers learners more understandable and effective information by reducing complex topics into smaller, more easily understood parts. Microlearning is a new method of learning design that can improve learning ability. This study of the current status and trends of microlearning research was conducted with comprehensive bibliometric analysis over the period 2002-2023. Using quantitative methods to analyse the trend in microlearning and VOSviewer to identify relationship mapping between variables. Overall, 459 relevant publications from the Scopus database have been identified between 2002 to 2023. The results show that publications on microlearning are increasing. The most frequently occurring keywords in articles about microlearning are “microlearning”, “e-learning” and “micro-learning”. The two most cited papers as references were written by Schewn in 2003 and Edge in 2011. The top three authors who have published in microlearning are from the University of Wollongong; the most prolific institution is the University of Wollongong. Lecture Notes in Computer Science published by Springer; the United States is the most prolific country.

Keywords: Bibliometric analysis, microlearning, Scopus, trend analysis, VOSviewer

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Received

October 22, 2023

Accepted

January 21, 2024

Published

February 28, 2024

Citation: Mochamad, R. (2024). The trend of microlearning: A bibliometric analysis (2002-2023). *Journal of Computers for Science and Mathematics Learning*, 1(1), 14–26.

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Scientia Publica Media



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1. INTRODUCTION

Microlearning is a learning design that is gaining popularity among learning specialists in higher education also working environments (Sankaranarayanan et al., 2023). Microlearning breaks down knowledge into small parts and provides instructions that are easy to understand. Microlearning gives students access to the latest information flexibly, and in the form they need. Moreover, in the microlearning method, students can determine their learning pace (Mohammed, Gona Sirwan Wakil, Karzan Nawroly, 2018). Microlearning, which is characterised by short duration, small learning actions, small learning components, and specific learning outcomes, is flexibly applied in various contexts and disciplines (Lin et al., 2023).

Along with the needs of a rapidly changing world, microlearning also provides work-based learners with the opportunity to acquire new information or abilities. In addition, microlearning can help achieve specific, and actionable tasks (Leong et al., 2021). The process of microlearning is designed by associating microlearning steps (microcontent), each step of which is no more than 15 minutes in duration and can be assembled in three cycles: introduction, activities, and conclusion (Díaz Redondo et al., 2021). In the field of education, microlearning is considered a new teaching method that divides knowledge into small parts that are easy to understand (Mohammed, Gona Sirwan Wakil, Karzan Nawroly, 2018). Moreover, microlearning is an instructional technique that aims to facilitate students to process new concepts in small fragments (Díaz Redondo et al., 2021). Microlearning is always associated with e-learning such as mobile and digital technologies in education (Gill et al., 2020; Khong & Kabilan, 2022; Mohammed, Gona Sirwan Wakil, Karzan Nawroly, 2018).

Microlearning is a highly efficient method of teaching that provides learners with focused, and brief learning. The main idea of microlearning is to share knowledge and skills in a compact and easy-to-understand method. This is usually achieved through engaging videos, interactive tests, or bite-sized modules. The effectiveness and efficiency of this method in accommodating students' busy schedules and short attention spans has led to its increase in popularity.

Microlearning offers learners more understandable and effective information by reducing complex topics into smaller, more easily understood parts. Providing information accessible and understandable supports prolific learning and retention. Numerous platforms and technologies, including social media platforms, mobile applications, and learning management systems (LMS), can be utilised to provide microlearning. This will enhance the overall learning process and make it accessible to a variety of learners.

Previous evidence regarding microlearning implementation has been well recorded. A bibliometric study, Leong et al. (2021), identified the implementation of microlearning between 2006-2009 from Scopus and Google Trends. The research reviews seven distinct contexts, including total number of relevant publications, distribution of authors by countries, affiliate distribution, funding sponsorship, type of publication source, word frequency analysis I: observed in the titles, word frequencies analysis II: observed in the abstracts. Similarly, Sankaranarayanan et al. (2023) discussed the importance of this research and provided research and practice implications, particularly in encouraging in-depth examination of microlearning topics, enlarging the research context to include K-12 environments, and engaging in mobile-based microlearning. This study identified four primary themes in the publication, namely: microlearning design, implementation of microlearning as a learning strategy and intervention method, evaluation of microlearning, and use of mobile devices for microlearning.

1.1 Aim of the Study

In this study, we analysed data obtained from Scopus. In this review, we proposed the aim to widely capture the dynamics and pattern of existing research on microlearning. This study identified growth rate, authors' keywords, cited papers, prolific authors, most prolific journals, most prolific institutions, and most prolific countries. This research questions (RQs) are organized as below:

- RQ1. Publications in microlearning are published and cited;
- RQ2. Keyword most frequently used by authors in the application of microlearning;
- RQ3. Research documents most frequently cited by the authors;
- RQ4. Authors most cited in publications on microlearning;
- RQ5. Most prolific sources of published research documents in microlearning;
- RQ6. Institutions that contribute most publications; and
- RQ7. Most prolific countries in regards to research publications.

2. METHODS

2.1 Study Design

This systematic analysis provided to recognise research on microlearning. We took the journal literature about microlearning as the research object. In the bibliometric analysis, using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; (Moher et al., 2010) gives a comprehensive overview of microlearning.

2.2 Procedure

The documents in this research were selected from the Scopus database (<https://scopus.com/>) on September 21, 2023. By using the advanced search function, using the keyword combination with OR and AND operators. The keywords used in the search are “micro-learning” OR “micro-learning” OR “micro learning”. The criteria for selected articles were articles that contained one of the keywords in the title, abstract, or keywords. Year of publication and citation, keywords cited documents, authors cited, prolific journals, and prolific countries were the variables studied. We performed quantitative analysis for each identified variable.

We obtain data to analyse microlearning from the Scopus database between 2002-2023. We chose the Scopus database because it contains the largest number of journals in a variety of fields including Computer Science, Social Science, Engineering, Mathematics, and Medicine. In the initial search, a total of 574 papers in English were accessed from 2002-2023. We exclude databases based on document type, conference papers, books, book chapters, corrections, and notes. After excluding those works, the article abstract assessed for eligibility were 459 documents in English. Then, the files were uploaded to the Visualization of Similarities (VOS) viewer.

2.3 Data Analysis

Data analysis on bibliometric software, we extracted data from the Scopus database into comma-separated values (file .csv) and research information system (file .ris) formats files. Afterwards, the data were examined using co-citation analysis, citation analysis, and descriptive statistics. Using quantitative data, including percentages and frequencies, we were able to identify the seven primaries using topic modelling. We identified growth rate, authors' keywords, cited papers, prolific authors, most prolific journals, most productive institutions, and most prolific countries. We ran a VOS viewer to get a visual representation of keywords, collaboration authors, and prolific countries. VOSviewer is a programme developed to create and display bibliometric maps with multidimensional scaling (van Eck & Waltman, 2010). In addition, we examine tables and graphs in Microsoft Excel to find the total number of publications each year, most frequently referenced papers, prolific authors, related journals, prolific institutions, and prolific countries.

3. RESULTS

3.1 Annual Publication

To explain how publications in microlearning were published, we describe annual scientific publications in the field of microlearning. The results show a variety of numbers from 2002 to 2023. The year 2022 has the highest number of publications ($n = 73$) while 2002, 2003, 2005, and 2009 have the lowest number of publications ($n = 1$). Based on Figure 2, research on microlearning emerged in 2002 ($n = 1$; 11 citations) with the work of Paiva and Machado being the first article recorded in that year. The article discusses the problem of providing a web-based training environment with a synthetic pedagogical agent to combine four modules: a set of microlearning environments, a training model, learning materials, and Vincent – a pedagogical agent (Paiva & Machado, 2002).

Figure 2 shows that the majority of publications regarding microlearning were published after 2016. This shows a steady growth since that year. Publications containing microlearning started to increase from 2017 to 2023. From 2002 to 2023, the most number of citations occurred in 2019, with a result of 387 citations (13.31%). Trendline analysis of citations indicates an increase in the impact of microlearning. Between 2019 and 2023, there will be 316 works, representing 68.85% of total publications. The year 2022 shows the highest number of publications to date (i.e. 73 articles, mean 15.90% of total publications). Research in the field of microlearning shows a strong growth trend, representing a positive response to microlearning. Until 2023, the determination value (R^2) resulted in a value of 0.875. This represents the reliability of the exponential trend line. This data was collected in September 2023, in which year there were 63 documents (43 citations; 0.015%). This data was collected in the third quarter of 2023, which is predicted to be published.

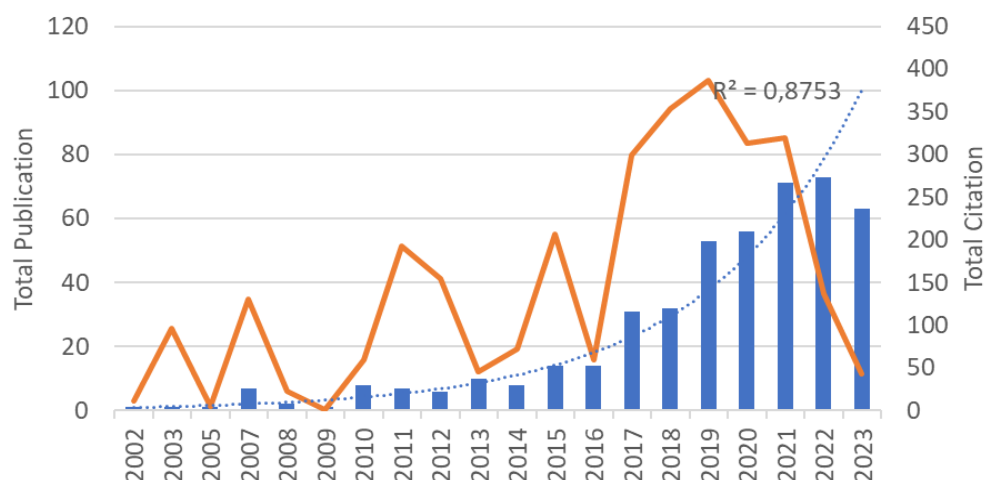


Figure 2. The Evolution of Publications and Citations

3.2 Most Used Keyword

The analysis of co-occurrence keywords is reviewed to identify words in the published articles. By using VOSviewer, we use a threshold of 5 to set a minimum number of occurrences, the number of keywords to be selected was given as 32. The Co-occurrence of the authors' keywords is shown in Figure 3. The most used keyword by authors was microlearning with 142 occurrences and 122 link strength. We also observed that “microlearning”, “e-learning” and “micro-learning” are the most used keywords by authors. “e-learning” showed 44 occurrences and 59 link strength. While “micro learning” delivered 82 occurrences and 56 link strengths.

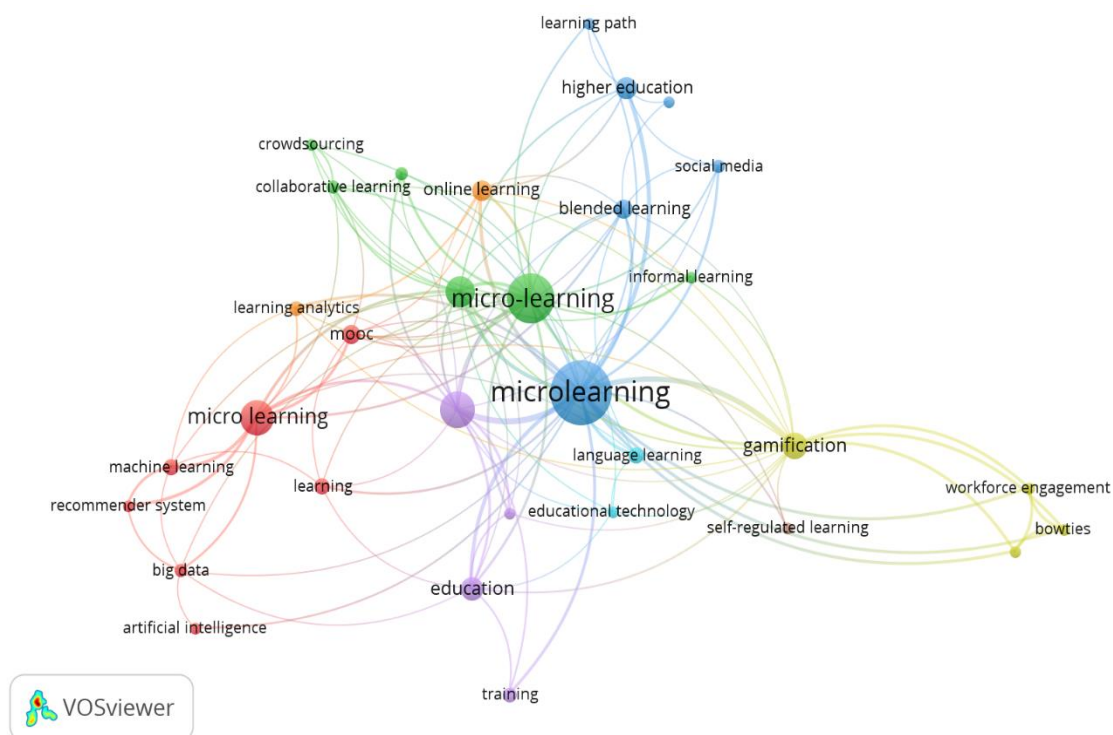


Figure 3. Bibliometric Map of Co-Occurrences of Authors' Keywords

As shown in Figure 3, we can review co-occurrence keywords by different colour reveals. In Figure 3, there are overall 8 clusters with 32 items and 124 links. The figure shows that the topics that frequently appear in publications about microlearning are “microlearning”, “e-learning” and “micro-learning”. This shows that microlearning is the main keyword in this field of research.

3.3 Most Cited Documents

The most cited documents were identified and shown in Table 2.

Table 1. Top 10 Most Cited Documents

Author	Title	Year	Source	Cites
Schwen T.M.; Hara N.	Community of practice: A metaphor for online design?	2003	Information Society	96
Edge D. et al.	MicroMandarin: Mobile language learning in context	2011	Conference on Human Factors in Computing Systems - Proceedings	96
Nikou S.A.; Economides A.A.	Mobile-Based micro-Learning and Assessment: Impact on learning performance and motivation of high school students	2018	Journal of Computer-Assisted Learning	89
Bruck P.A. et al.	Mobile learning with micro-content: A framework and evaluation	2012	25th Bled eConference - eDependability: Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future, Proceedings	67
Fozdar B.I.; Kumar L.S.	Mobile learning and student retention	2007	International Review of Research in Open and Distance Learning	65
Dessi D. et al.	Bridging learning analytics and Cognitive Computing for Big Data classification in micro-learning video collections	2019	Computers in Human Behaviour	61
Yin J. et al.	Conversation Technology With Micro-Learning: The Impact of Chatbot-Based Learning on Students' Learning Motivation and Performance	2021	Journal of Educational Computing Research	56
Wen C.; Zhang J.	Design of a Microlecture Mobile Learning System Based on Smartphone and Web Platforms	2015	IEEE Transactions on Education	54
Sun G. et al.	MLaaS: A Cloud-Based System for Delivering Adaptive Micro Learning in Mobile MOOC Learning	2018	IEEE Transactions on Services Computing	52
Beaudin J.S. et al.	Context-sensitive microlearning of foreign language vocabulary on a mobile device	2007	Lecture Notes in Computer Science	50

This table shows the 10 most cited documents. In addition, we also identified cited by and cited per year. As shown in Table 1, the most cited document is “Community of Practice: A Metaphor for Online

Design?” which was published in 2003 (cited by 96 and cited per year is 4.8). This article uses microlearning theory to examine four cases and identifies several issues (Schwen & Hara, 2004). Then the second-ranked document titled “MicroMandarin: Mobile language learning in context” published in 2011 presented a mobile-based application for microlearning in learning languages that encourages using the language in interactions with native speakers, with 96 citations (8.00) (Edge et al., 2011). Behind it is “Mobile-Based Micro-learning and Assessment: Impact on learning performance and motivation of high school students” Mobile-based microlearning and assessment (MBmLA) to enhance students’ learning performance and motivation, published in 2018 (Nikou & Economides, 2018). The most cited document per year was titled “Conversation Technology With Micro-Learning: The Impact of Chatbot-Based Learning on Students’ Learning Motivation and Performance” published in 2021 with 56 citations (28 cited per year). The document studies the effect of a chatbot-based microlearning system on students’ learning motivation as well as performance using the content and curriculum in Conversation Technology (Yin et al., 2021).

3.4 Most Prolific Authors

Table 2 informs the top 10 productive authors with the highest number of publications in microlearning. We can observe that Geng Sun and Jun Shen were the most prolific authors with 22 publications in microlearning, followed by Tingru Cui with 21 publications in this field. Most of the top 10 authors are from Australia with 31 publications (6.75%). Table 2 also shows the most prolific authors based on h-index. h-index represents the characteristics of the researchers’ scientific output (Hirsch, 2005). In Table 2, the three most prolific authors are Chen (h-index = 32), Beydoun (h-index = 26), and Shen (h-index = 23).

Table 2. Number of Publications in the Top 10 Authors

Author	Institution	Country	N	H-Index
Sun, G.	University of Wollongong	Australia	22	11
Shen, J.	University of Wollongong	Australia	22	23
Cui, T.	University of Wollongong	Australia	21	13
Xu, D.	University of Queensland	Australia	16	21
Chen, S.	The Commonwealth Scientific and Industry Research Organization	Australia	15	32
Lin, J.	University of Wollongong	Australia	10	5
Beydoun, G.	University of Technology Sydney	Australia	10	26
Javorcik, T.	University of Ostrava	Czech	9	3
Polasek, R.	University of Ostrava	Czech	7	3
Li, L.	Southwest University	China	7	5

We also found the collaboration network of the author database in microlearning. And we set the lowest possible number of documents at 3. Figure 3 shows that 23 authors were selected.

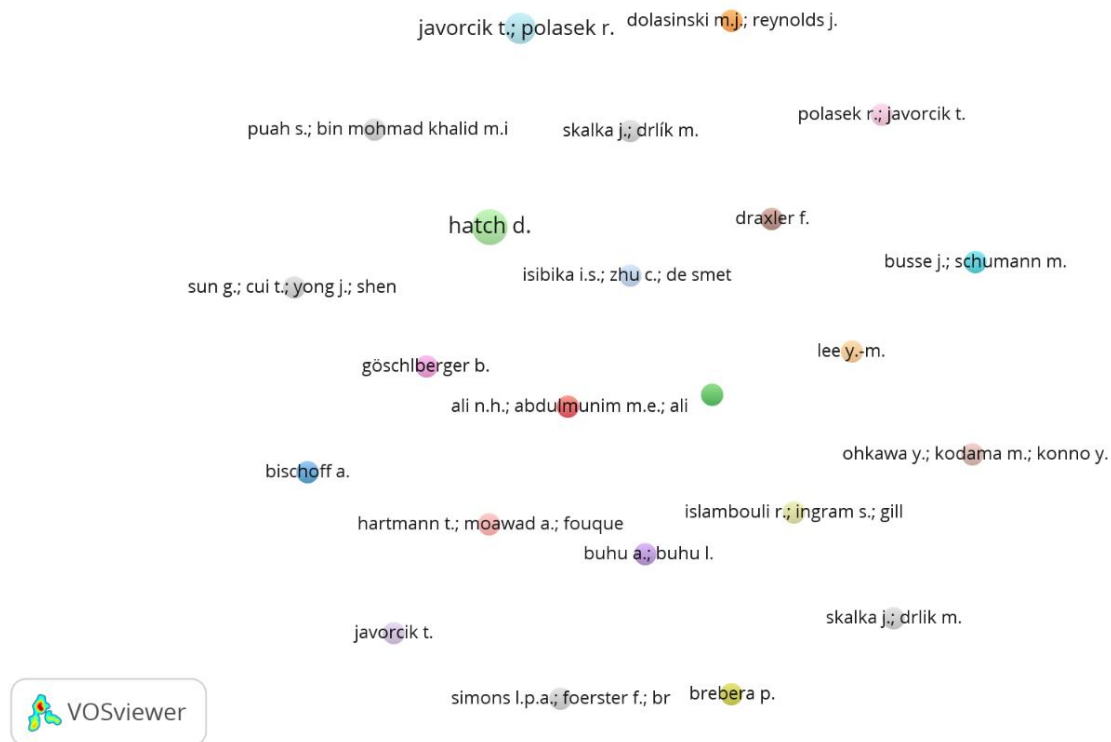


Figure 4. Collaboration Network of Authors

3.5 Most Relevant Sources

The top 10 prolific sources based on of publications, h-index, Scopus quartile (Q), SCImago Journal Rank, and publisher can be shown in Table 3. As summarised in Table 3, Lecture Notes in Computers Science is the most prolific source with 17 documents. It also shows that the source has the highest h-index (446). In addition, the highest sources in the Scopus journal rankings are Education And Information Technologies (Q1) and Techtrends (Q1). Education And Information Technologies are also the sources with the highest values by SJR (1.25).

Table 3. Top 10 Most Prolific Sources

Sources	N	H-Index	Q	SJR 2022	Publisher
Lecture Notes in Computer Science	17	446	Q3	0.32	Springer
ACM International Conference Proceeding Series	14	137	-	0.21	Association for Computing Machinery
Proceeding of the European Conference on e-Learning ECEL	10	10	-	0	Nation Centre for the UK
Education And Information Technologies	7	61	Q1	1.25	Kluwer Academic Publishers
Conference On Human Factors In Computing Systems Proceedings	7	216	-	0.71	Association for Computing Machinery
Techtrends	6	48	Q1	0.8	Springer

Sources	N	H-Index	Q	SJR 2022	Publisher
Journal Of Physics Conference Series	6	91	-	0.8	IOP Publishing Ltd.
Advances In Intelligent Systems And Computing	6	58	-	0	Springer
Communications In Computer And Information Science	5	62	Q4	0,12	Springer
Lecture Notes In Networks And Systems	4	27	Q4	0.15	Springer International Publishing AG

3.6 Most Prolific Institutions

Table 4 presents the distribution of countries, institutions, and the number of documents of the most prolific institution.

Table 4. Top 10 Most Prolific Institutions

Institution	Country	N
University of Wollongong	Australia	25
The University of Queensland Business School	Australia	16
Massachusetts Institute of Technology	US	15
Ostravska Univerzita v Ostrave	Czech	10
University of Technology Sydney	Australia	9
Commonwealth Scientific and Industrial Research Organisation	Australia	8
CSIRO Data61	Australia	7
Southwest University	China	7
University of Missouri	Columbia	6
Constantine the Philosopher University in Nitra	Slovakia	6

The most prolific institution in microlearning is the University of Wollongong, Australia with 25 documents. The second was The University of Queensland Business School, Australia with 16 documents. There are non-university institutions. Commonwealth Scientific and Industrial Research Organisation with 8 documents and CSIRO Data16 with 7 documents.

3.7 Most Prolific Country

The most prolific countries are presented in Table 6. The highest country that publishes papers was the United States ($n = 88$; 19.17%). China is the second-ranked ($n = 60$; 13.07%) and Germany is the third-ranked ($n = 45$; 9.80%).

Figure 5 presents a bibliography of coupling the most prolific countries that published in microlearning. We set the minimum number of documents at 5 and the number of countries given at 35. The figure shows 5 clusters with 35 items and 5085 link strength. The largest cluster has 17 countries, there were Belgium, Colombia, Ecuador, France, Germany, India, Indonesia, Iran, Italy, Japan, Malaysia, Norway Romania, Singapore, Sweden, Switzerland, and the United States. Furthermore, four countries had the biggest circle. The countries were the United States (89 documents, 1566 link strength), China (60

documents, 1133 link strength), Germany (45 documents, 513 documents), and Australia (31 documents, 786 link strength)

Table 5. The Most Prolific Countries

Country	N of Papers	%
United States	88	19.17%
China	60	13.07%
Germany	45	9.80%
Australia	31	6.75%
United Kingdom	21	4.58%
Austria	19	4.14%
Japan	15	3.27%
Spain	14	3.05%
Czech Republic	14	3.05%
Canada	13	2.83%

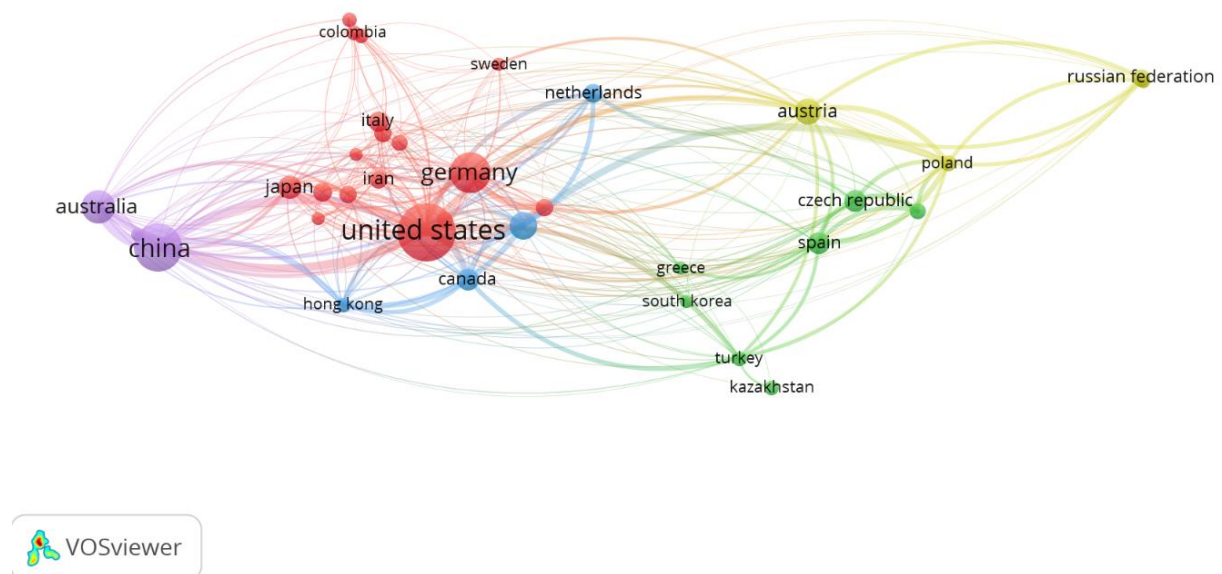


Figure 5. Bibliographic Coupling of the Most Productive Countries

4. DISCUSSION

To explain how publications on microlearning are published, we describe annual scientific publications on the topic of microlearning. Based on Figure 2, research on microlearning first emerged in 2002 ($n = 1$; 11 citations) with the work of Paiva and Machado as the first article noted in that year. The article discusses the problem of providing a web-based training environment with a synthetic pedagogical agent to combine four modules: a set of microlearning environments, a training model, learning materials, and Vincent – a pedagogical agent (Paiva & Machado, 2002). Publications containing microlearning started

to increase from 2017 to 2023. Trendline analysis of citations suggests an increased impact of microlearning. Between 2019 and 2023, there were 316 works, which represents 68.85% of the total publications. The year 2022 shows the highest number of publications to date (i.e. 73 articles, mean 15.90% of total publications). Research in the field of microlearning shows a strong growth trend, this shows a positive response to microlearning. Until 2023, the determination value (R^2) produces a value of 0.875. This shows the reliability of the exponential trend line. The finding in this context is validated by previous research (Leong et al., 2021; Samala et al., 2023; Sankaranarayanan et al., 2023). In 2022 shows the highest number of publications in microlearning. Shamir-Inbal & Blau, (2022) exposed ICT management to advanced technological pedagogical knowledge and practices by investigating self-regulated learning processes, techniques, and issues within the context of a microlearning, hybrid TDP course.

The most keyword that authors used was microlearning with 142 occurrences and 122 link strength. We also observed that “microlearning”, “e-learning” and “micro-learning” are the most used authors’ keywords. “e-learning” showed 44 occurrences and 59 link strength. While “micro learning” gave 82 occurrences and 56 link strength. We can review co-occurrence keywords by different colour reveals. In Figure 3, overall there are 8 clusters with 32 items and 124 links. The figure shows that the topics that often appear in publications regarding microlearning are “microlearning”, “e-learning” and “micro-learning”. This shows that microlearning is the main keyword in this field of research. In the second place, e-learning becomes most keyword authors used. This is due to one of the effective solutions today the transformation of classic e-learning courses into microlearning (Shamir-Inbal & Blau, 2022). In addition, the microlearning strategy is applied in an e-learning environment using a learning management system for distance learning (Díaz Redondo et al., 2021).

The most cited document that was published in 2003 (cited by 96 and cited per year is 4,8). This article uses microlearning theory to examine four cases and identifies several issues (Schwen & Hara, 2004). Then the document in second rank that was published in 2011 presented the mobile-based application for microlearning in learning languages that encourages using the language in interactions with native speakers, with 96 citations (8,00%) (Edge et al., 2011). Behind it, the study of Mobile-Based microlearning and assessment (MBmLA) to enhance students’ learning performance and motivation, was published in 2018 (Nikou & Economides, 2018). The result of the most cited document per year was a chatbot-based microlearning system on students’ learning motivation and performance using the content and curriculum in Conversation Technology (Yin et al., 2021).

We can observe that Geng Sun and Jun Shen were the most prolific authors with 22 publications in microlearning, followed by Tingru Cui with 21 publications in this field. Most of the top 10 authors are from Australia with 31 publications (6.75%). Table 2 also shows the most prolific authors by h-index. h-index shows the characteristics of the researchers’ scientific output (Hirsch, 2005). Table 2, the three most prolific authors are Chen (h-index = 32), Beydoun (h-index = 29), and Shen (h-index = 23). In Figure 4, we can identify that authors have not collaborated in microlearning research. Geng Sun in “MLaas: A Cloud System for Mobile Micro Learning in MOOC” developed a system that can help learners using microlearning resources (Sun et al., 2018). Meanwhile, Javorcik and Polasek in “Comparing the Effectiveness of Microlearning and eLearning Course in the Education of Future Teachers” integrated microlearning course for future educators in the Pedagogical Faculty, University of Ostrava. In addition, Skalka in “Conceptual Framework of Microlearning-based Training Mobile Application for Improving Programming Skills” integrated benefits of web-based learning environment and microlearning approaches into the educational organizations’ established virtual learning environment infrastructure (Skalka & Drlik, 2018). So it can be concluded that the authors in microlearning have different research focus.

The most prolific source is Lecture Notes in Computers Science with 17 documents. It also shows that the source has the highest h-index (446). Furthermore, the most of highest sources in the Scopus journal rankings are Education And Information Technologies (Q1) and Tech trends (Q1). Education And Information Technologies also was the journal with the highest values by SJR (1.25). Lecture Notes in Computer Science became the first place in the most prolific source because it has an impact score. It has similar findings to Sankaranarayanan et al. (2023) that Lecture Notes in Computer Science has 9 publications and gain impact score 1.36.

The most prolific institution in microlearning was the University of Wollongong, Australia with 25 documents. The second was The University of Queensland Business Scholl, Australia with 16 documents. There were non-university institutions. Which is the Commonwealth Scientific and Industrial Research Organisation with 8 documents and CSIRO Data16 with 7 documents. The University of Wollongong became the most prolific institution because four of the top ten authors are from there. The four authors are Geng Sun, Jun Shen, Tingru Cui, and Jian Lin from the University of Wollongong.

The highest country that publishes papers are the United States, China, and Germany. As the most prolific institution in Australia, it is in the fourth rank of the prolific country. Furthermore, four countries had the biggest circle. The countries were the United States (89 documents, 1566 link strength), China (60 documents, 1133 link strength), Germany (45 documents, 513 documents), and Australia (31 documents, 786 link strength). It is a surprise that the United States is the highest country. The finding is similar to Leong et al., (2021) “A Review of the Trend of Microlearning” that publication engaging the Unites States scholars.

5. CONCLUSIONS

This study provides an in-depth analysis of the growth of publications on the use of microlearning from 2002 to 2021 using the Scopus database. The result analysis includes published and cited documents, most frequent keywords, cited research documents, most cited authors, most prolific sources, institutions that contributed the most publications, and most prolific countries. We found that publications in microlearning are increasing. Based on author collaboration, we found that publications in microlearning have a huge range of topic research. Australia is one of the most prolific countries as most of the prolific authors in microlearning are from Australia.

This review has limitations such as we only use a database single database to analyse, and only documents from the Scopus database were examined. Future studies can use more applicant interdisciplinary databases, such as WoS, ScienceDirect, Google Scholar, etc., to confirm our findings. Microlearning is therefore related to the field of education, so we might limit documents that discuss microlearning in education.

Conflict of Interest

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author received no financial support for the research, authorship, and/or publication of this article.

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