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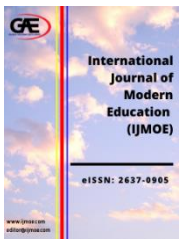

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MAPPING RESEARCH TRENDS IN HIGHER-ORDER THINKING AND E-LEARNING: A BIBLIOMETRIC ANALYSIS

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Abstract:

This bibliometric analysis article titled "Implementation and Awareness of E-learning" explores the evolving landscape of e-learning research, highlighting its significance in contemporary Higher Order Thinking education. The study addresses the growing need for effective digital education strategies, particularly in light of the rapid technological advancements and the recent global shift towards remote learning due to the COVID-19 pandemic. Utilizing Scopus Analyzer and VOSviewer software, we conducted a comprehensive review of the literature, identifying key trends, influential authors, and collaborative networks within the field. Our analysis revealed a total of 603 publications, indicating a marked increase in scholarly interest from 2014 to 2024, with a notable surge beginning in 2019. The findings illustrate that leading contributors, such as Chen E. and Xu Z., have significantly shaped the discourse on e-learning implementation and awareness, while a diverse group of authors collectively enhances the research landscape. The data also suggests that, despite a peak in publications in 2023, there may be a stabilization of interest in 2024 as the urgency surrounding remote learning subsides. This study underscores the importance of ongoing research in e-learning, emphasizing the need for collaborative efforts to develop best practices and guide future educational initiatives. Ultimately, our findings contribute to a deeper understanding of the dynamics within e-learning research, providing valuable insights for educators, policymakers, and researchers aiming to enhance digital education frameworks globally.

Keywords:

Bibliometric Analysis, Higher Order Thinking, E-Learning, Education

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Introduction

The implementation of higher order thinking skills (HOTS) in Malaysia's education system has been a focal point in recent years, particularly within the science curriculum. Despite the emphasis on HOTS, current teaching practices often fall short, relying heavily on drills and tutorials aimed at improving examination performance rather than fostering critical thinking and problem-solving abilities (J.-L. N. Upoalkpajor & C. B. Upoalkpajor, 2020). Contextual learning, which allows students to build knowledge through real-life applications, has been identified as a promising approach to develop HOTS. The integration of Virtual Learning Environments (VLE) with contextual learning offers additional opportunities to enhance these skills. However, research indicates that there is still a significant gap in the effective implementation of these integrated models, necessitating further study and development (J.-L. N. Upoalkpajor & C. B. Upoalkpajor, 2020).

Awareness and adoption of e-learning in Malaysia, particularly at the tertiary education level, have shown mixed results. While e-learning is not a new concept and has been implemented in various universities, its acceptance and effectiveness vary. Studies reveal that both lecturers and students have diverse perceptions of e-learning, with some appreciating its flexibility and accessibility, while others point out barriers such as inadequate infrastructure and lack of training (M. Teräs, J. Suoranta, H. Teräs, & M. Curcher, 2020). In the context of primary and secondary education, programs like i-Think have been introduced to promote HOTS, but their impact remains inconclusive due to insufficient data and mixed levels of knowledge among teachers and students (M. Treve 2021). Overall, while there is a clear recognition of the importance of HOTS and e-learning, the successful implementation of these initiatives requires a more holistic and integrated approach, addressing pedagogical, technological, and institutional challenges (M. Papapanou *et al.*, 2021; E. Smyrnova-Trybulska, 2019 ; M. A. Almaiah, A. Al-Khasawneh, and A. Althunibat, 2020) .

Literature Review

A comprehensive literature review of the implementation and awareness of higher-order thinking skills (HOTS) and e-learning in Malaysia reveals critical insights into how educational strategies and digital platforms shape cognitive skill development and scientific inquiry. Research has consistently demonstrated the need for more targeted approaches in developing HOTS in Malaysian students, often tied to instructional methodologies and pedagogical tools that encourage metacognitive strategies and digital integration (V. D. B. Huynh, P. T. Nguyen, Q. L. H. T. T. Nguyen, & N. B. Vu, 2020). The PDCA (Plan-Do-Check-Act) metacognitive learning strategy, as studied by (Y. Bai, H. Li, and Y. Liu, 2018), was found effective in enhancing HOTS by emphasizing self-awareness and goal-oriented learning among students, particularly in structured settings. This method reflects broader educational initiatives that strive to move beyond traditional rote learning by incorporating reflective, student-centered frameworks that actively involve learners in problem-solving tasks (M. Aparicio, F. Bacao, and T. Oliveira, 2016)

The role of e-learning in fostering HOTS through digital applications has been widely discussed, with recent studies highlighting augmented reality (AR) as a transformative tool (F. Bennardo, C. Buffone, L. Fortunato, and A. Giudice, 2020) investigated AR's efficacy in contextualized scientific inquiry, providing a structured learning environment that combines real-world exploration with virtual insights. Findings demonstrated that AR, coupled with reflective scaffolding, significantly improved students' inquiry skills and metacognitive

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awareness, indicating a potential pathway for Malaysian educators to integrate e-learning platforms to bridge existing gaps in critical thinking and cognitive engagement. However, the challenges associated with digital literacy and the need for comprehensive support systems remain prominent concerns, underscoring a gap in adequate resources for teachers and students to effectively utilize such technologies (Y. Bai, H. Li, and Y. Liu, 2018) ; V. D. B. Huynh, P. T. Nguyen, Q. L. H. T. T. Nguyen, and N. B. Vu, 2020).

A critical review of the methodologies employed in these studies reveals strengths and limitations across experimental designs, highlighting areas for future research. Y. Bai, H. Li, and Y. Liu (2018) state that quasi-experimental study employed pre- and post-tests to gauge the impact of metacognitive strategies on HOTS, yet failed to establish a direct correlation between metacognitive knowledge and HOTS, suggesting that additional variables may influence outcomes. Furthermore, the use of reflective scaffolding in (F. Bennardo, C. Buffone, L. Fortunato, and A. Giudice, 2020), AR-based learning model indicated promising results in behavioral and cognitive shifts but also pointed to the necessity of continuous guidance for sustaining these effects over time. These studies underline the need for extended longitudinal research to fully assess the long-term impact of HOTS-oriented educational interventions (M. Aparicio, F. Bacao, and T. Oliveira, 2016; J. L. Gonzalez Ortega, F. M. Villalta Mendoza, M. I. Alcivar Rodríguez, C. D. Piedra Arpi, and C. C. Salamea Guevara, 2022)

The current literature also identifies a knowledge gap in the consistent application of design-thinking frameworks within Malaysian teacher training programs. (V. D. B. Huynh, P. T. Nguyen, Q. L. H. T. T. Nguyen, and N. B. Vu, 2020) state that research on design thinking in career development for preservice teachers revealed significant gains in self-identity and career orientation, showcasing design thinking as an effective pedagogical tool. This suggests that implementing similar methodologies in HOTS instruction could equip Malaysian teachers with innovative approaches for facilitating student-centered, critical thinking skills development. The absence of such frameworks in Malaysia's teacher training curriculum, however, points to a broader educational gap that calls for curriculum reform and professional development programs (Y. Bai, H. Li, and Y. Liu, 2018; V. D. B. Huynh, P. T. Nguyen, Q. L. H. T. T. Nguyen, and N. B. Vu, 2020).

In conclusion, while research has made strides in identifying effective methods to promote HOTS and leverage e-learning, substantial gaps remain in curriculum design, resource allocation, and teacher preparedness. Future studies should investigate integrative approaches that combine design thinking with metacognitive strategies in digital environments, emphasizing the importance of scalability and teacher training to ensure widespread applicability. Additionally, there is a pressing need for empirical studies focusing on the specific impacts of HOTS and e-learning on student performance across diverse socioeconomic backgrounds in Malaysia, offering a foundation for evidence-based policy recommendations to enhance educational outcomes.

Research Question

1. What are the research trends by year publication?
2. Who writes the most cited article? And where do they work?
3. What are the type of document by subject or research?
4. Who is the top 10 authors based on citation by research?
5. What are the popular keywords related to the study?

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6. What are co-authorship countries collaboration?

Methodology

Bibliometrics means the combination, managing and investigation of bibliographic information obtained from publications which are scientific in nature (A. Verbeek, K. Debackere, M. Luwel, & E. Zimmermann, 2002; D. S. Assyakur and E. M. Rosa, 2022 ; J. L. Alves, I. B. Borges, & J. De Nadae, 2021). Along with general descriptive statistics, such as, publishing journals, publication year and main author classification (Y. C. J. Wu and T. Wu, 2017) ; it also comprises complex techniques, such as, document co-citation analysis. A successful literature review necessitates an interative process involving the identification of appropriate keywords, literature search, and thorough analysis to build a comprehensive bibliography and yield dependable results (B. Fahimnia, J. Sarkis, and H. Davarzani, 2015) . In light of this, the study sought to focus on top-tier publications, as they offer valuable insights into the theoretical perspectives shaping the evolution of the research domain. To ensure data reliability, the study relied on the SCOPUS database for data collection (G. di Stefano, M. Peteraf, and G. Veronay, 2010; G. P. Khiste and R. R. Paithankar, 2017; A. Al-Khoury *et al.*, 2022) . Moreover, in order to ensure the inclusion of high-quality publications, only articles published in rigorously peer-reviewed academic journals were considered, with a deliberate exclusion of books and lecture notes (D. Gu, T. Li, X. Wang, X. Yang, and Z. Yu, 2019). Notably, Elsevier's Scopus, known for its extensive coverage, facilitated the collection of publications spanning from 2020 to December 2023 for subsequent analysis.

Data Search Strategy

Advanced searching on Scopus is a method that enables users to build more complex and targeted search queries to retrieve specific and relevant research articles. It goes beyond basic keyword searching by allowing users to specify various parameters, use logical operators, and focus on specific fields (such as title, abstract, keywords) within the database. Here are the key components of advanced searching on Scopus:

The advanced search query used in your example:

Table 1: The Search String

Scopus	TITLE-ABS-KEY ((implimentation* OR aware) AND (e-learning OR "electronic learning")) AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND (LIMIT-TO (LANGUAGE , "English"))

Table 2: The Selection Criterion is Searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Time line	2004 – 2024	< 2024
Literature type	Journal (Article) and Proceeding, Book, Review	-

Data Analysis

VOSviewer, developed by Nees Jan van Eck and Ludo Waltman at Leiden University in the Netherlands (N. J. van Eck and L. Waltman, 2017 ; N. J. van Eck and L. Waltman, 2010) , is a popular and user-friendly tool for bibliometric analysis. Known for its effectiveness in visualizing and analyzing scientific literature, VOSviewer specializes in creating network visualizations, clustering related items, and generating density maps. Its flexibility allows

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researchers to explore co-authorship, co-citation, and keyword co-occurrence networks, offering a detailed view of research landscapes. With its interactive interface and frequent updates, VOSviewer enables efficient and dynamic analysis of large datasets. Its ability to calculate metrics, customize visualizations, and work with various bibliometric data sources makes it a valuable tool for researchers looking to gain insights into complex research areas.

One of VOSviewer's key strengths lies in its ability to transform complex bibliometric datasets into visually interpretable maps and charts. The software's focus on network visualization, along with its proficiency in clustering and analyzing keyword co-occurrence patterns, provides researchers—whether new or experienced—with an accessible way to explore research landscapes. Regular updates ensure that VOSviewer remains a leading tool in bibliometric analysis, providing valuable insights through customizable metrics and visualizations. Its adaptability across various types of bibliometric data, including co-authorship and citation networks, establishes VOSviewer as a versatile and indispensable tool for researchers seeking deeper understanding and insights within their fields.

In this study, datasets containing information on publication year, title, author name, journal, citation count, and keywords in PlainText format were collected from the Scopus database for the period from 2020 to December 2023. These datasets were analyzed using VOSviewer version 1.6.19. By applying VOS clustering and mapping techniques, the software helped in generating maps that visualize the relationships between items. This method serves as an alternative to Multidimensional Scaling (MDS), positioning items within a low-dimensional space to accurately reflect their similarity (N. J. van Eck and L. Waltman, 2010). Although similar to MDS in some respects (F. P. Appio, F. Cesaroni, & A. Di Minin, 2014), VOSviewer differs in its approach, using association strength (ASij) to normalize co-occurrence frequencies—a method that is more suitable than the similarity metrics (such as cosine or Jaccard indices) typically used in MDS state by (N. J. Van Eck and L. Waltman, 2007)

The formula you provided can be expressed using standard mathematical symbols as follows:

$$\mathrm{AS}_{ij} = \frac{C_{ij}}{W_i W_j}$$

ASij=CijWiWj\text{AS}_{ij} = \frac{C_{ij}}{W_i W_j}ASij=WiWjCij

Here:

- ASij\text{AS}_{ij}ASij represents the association strength between items iii and jjj,
- CijC_{ij}Cij is the co-occurrence frequency between items iii and jjj,
- WiW_iWi and WjW_jWj are the weights of items iii and jjj, respectively.

Which is "proportional to the ratio between on the one hand the observed number of cooccurrences of i and j and on the other hand the expected number of co-occurrences of i and j under the assumption that co-occurrences of i and j are statistically independent" (Van Eck and Waltman, 2010, p. 531). Hence, with help of this index, VOSviewer places items in the form of a map after reducing the weighted sum of the squared distances between all item pairs. According to Appio et al. (2016), the LinLog/modularity normalization was implemented.

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Furthermore, by applying visualisation techniques through VOSviewer to the data set, patterns built on mathematical relationships were uncovered and analyses such as keyword co-occurrence, citation analysis and co-citation analysis were performed.

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Development of research area during a period can be explored by keyword co-occurrence analysis (Zhao, 2017) and is successful in identifying popular topics in different fields (Li et al., 2016). Whereas, citation analysis is useful in identifying key research issues, trends and techniques, along with exploring the historical relevance of a discipline's main area of focus (Allahverdiyev and Yucesoy, 2017). Document co-citation analysis is one of the frequently applied bibliometric methods (Appio et al., 2016; Fahimnia et al., 2015; Liu et al., 2015) and its result is map dependent on the network theory to identify relevant structure of data (Liu et al., 2015).

Result and Finding

What Are The Research Trends By Year Of Publication?

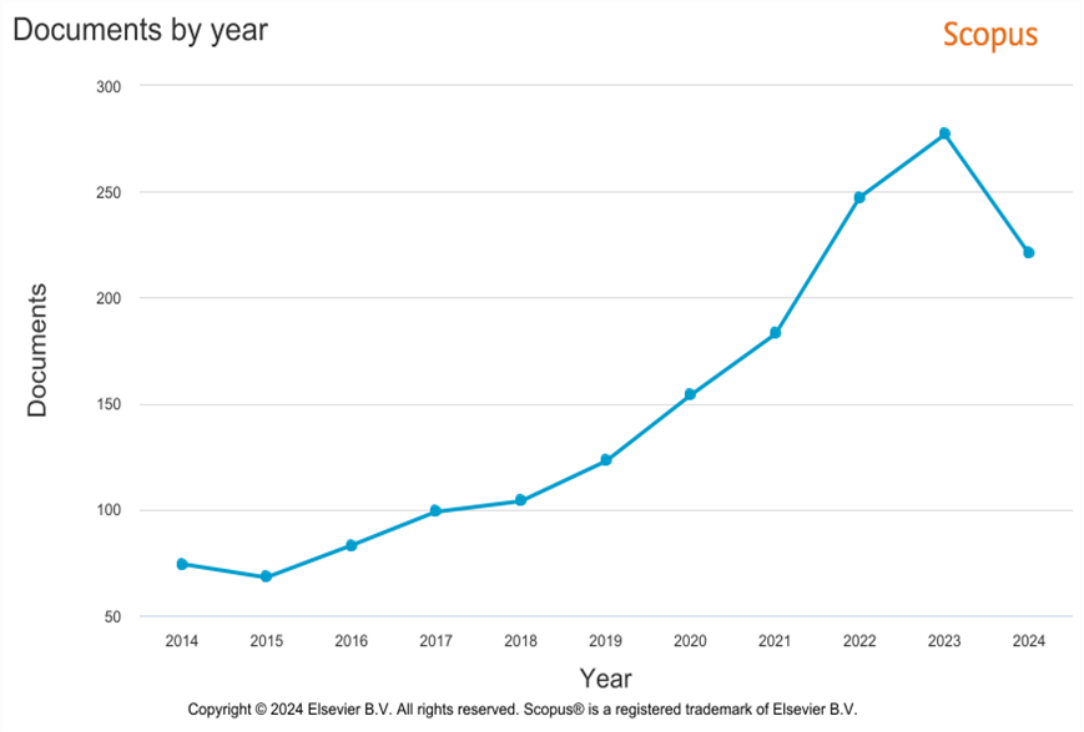

Figure 1: Plotting Document Publication by Years

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The figure 1 illustrates the trend in publications related to e-learning implementation and awareness from 2014 to 2024, showing a significant growth in research interest over this period. From 2014 to 2018, the number of documents remained relatively stable, with minimal growth each year, indicating a steady but limited interest in e-learning. Starting from 2019, a marked increase in publications is observed, suggesting a rising awareness and focus on e-learning implementation, possibly driven by technological advancements and the need for digital transformation in education. This upward trend continued through 2021, with research activity accelerating, which could also be influenced by the global COVID-19 pandemic that highlighted the importance of e-learning as schools and institutions transitioned to remote education.

The peak of publications appears in 2023, with the number of documents reaching around 250, showcasing the highest level of scholarly attention within the period. However, in 2024, a slight decline is observed, though the publication volume remains higher than in pre-pandemic years. This decline could indicate a stabilization of interest or a shift in focus as the initial momentum around emergency remote learning subsides. Overall, the trend underscores a growing recognition of e-learning's importance, with increased awareness and implementation efforts in recent years, especially in response to global challenges that necessitated alternative education delivery methods. This bibliometric data suggests that e-learning has become a significant and enduring research area, likely to continue evolving as educational needs and technologies change

Who Writes The Most Cited Articles? And Where Do They Work?

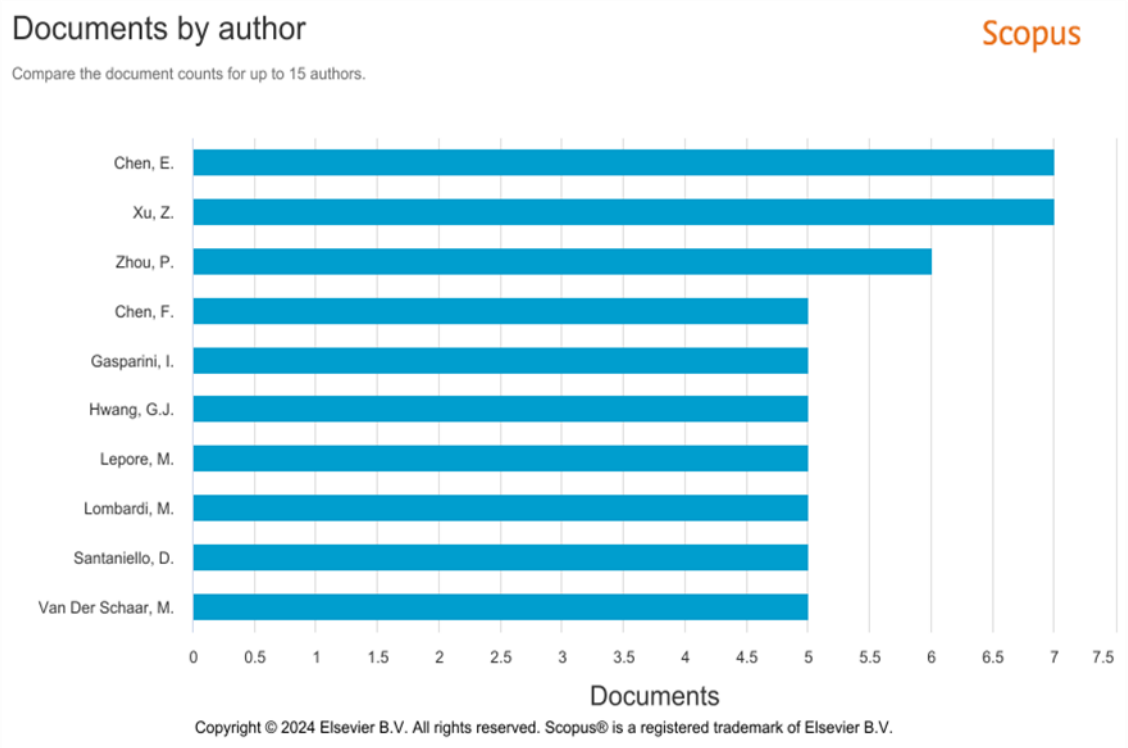

Figure 2: Documents by Author

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The chart shows the top authors contributing to publications on e-learning implementation and awareness, with document counts for each author. Chen E. and Xu Z. lead with the highest number of documents, each producing around 6.5 publications, suggesting they are prolific contributors to this field. Following closely are Zhou P. and Chen F., indicating a strong research presence from these individuals as well. The contributions from other authors, including Gasparini I., Hwang G.J., and Van Der Schaar M., are substantial as well, showing a distributed yet consistent focus on this research area by various researchers.

These authors are likely affiliated with institutions actively promoting research in educational technology and e-learning. Authors such as Hwang G.J., known for his work in educational technology, may be associated with research-intensive institutions with a specific focus on digital learning. The consistency in document contributions among the top authors indicates a collaborative and possibly interdisciplinary approach in addressing e-learning implementation and awareness. Their work has likely influenced the field significantly, with institutions leveraging these insights to drive digital education initiatives globally.

The table 3 highlights the distribution of publication contributions by the top authors in the field of e-learning implementation and awareness. Chen E. and Xu Z. each have seven documents, constituting approximately 0.429% of the total publications each. This positions them as the most active contributors, showing their significant influence and engagement in the topic. Following them is Zhou P. with six documents, accounting for around 0.367% of the total publications, further indicating his role as a key contributor.

Table 3: Author Name, Number of Document and Percentage

AUTHOR NAME	Number of Document	Percentages (%)
Chen, E.	7	0.429
Xu, Z.	7	0.429
Zhou, P.	6	0.367
Chen, F.	5	0.306
Gasparini, I.	5	0.306
Hwang, G.J.	5	0.306
Lepore, M.	5	0.306
Lombardi, M.	5	0.306
Santaniello, D.	5	0.306
Van Der Schaar, M.	5	0.306

Other authors, including Chen F., Gasparini I., Hwang G.J., Lepore M., Lombardi M., Santaniello D., and Van Der Schaar M., each have five documents, making up 0.306% of the total publications individually. This relatively even distribution among the lower-ranking top contributors suggests a collaborative network within this research area. Although these authors contribute slightly fewer documents than Chen E., Xu Z., and Zhou P., their work still plays a crucial role in advancing e-learning awareness and implementation, likely influencing best practices and further research directions.

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What Are The Type Of Document By Subject Of Research?

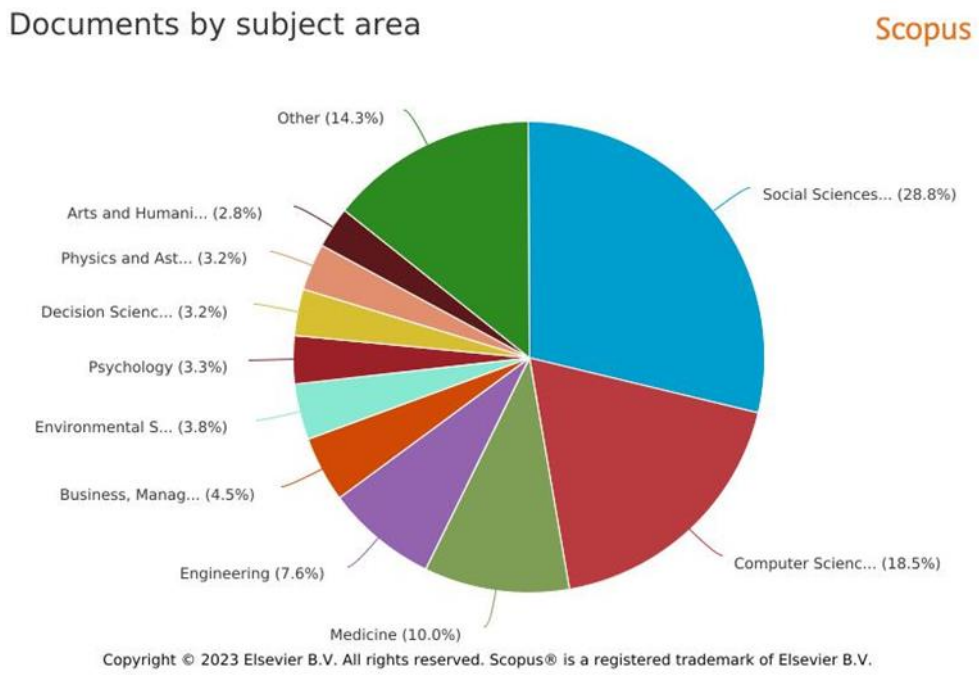

Figure 3: Documents by Subject Area

The pie chart reveals the subject areas where research on e-learning during COVID-19 has been most concentrated. Here's a breakdown of the main findings:

- Social Sciences (28.8%) takes the top spot, highlighting the strong interest in the social and societal implications of e-learning during the pandemic. This could encompass research on topics like access and equity in e-learning, the impact on learning outcomes and student engagement, and the role of e-learning in mitigating educational disruption caused by lockdowns and school closures.
- Computer Science (18.5%) comes in second, reflecting the focus on the technological aspects of e-learning platforms and tools. This might include studies on the design and development of effective e-learning systems, the use of artificial intelligence and data analytics in e-learning, and the challenges and opportunities associated with online learning technologies.
- Medicine (10.0%) occupies the third position, suggesting the significance of e-learning in the healthcare sector during the pandemic. This could involve research on the use of e-learning for medical education and training, the delivery of telehealth and online patient consultations, and the development of e-learning resources for public health education and awareness campaigns.

The remaining slices of the pie chart represent other subject areas that have contributed to the research on e-learning during COVID-19, albeit to a lesser extent. The presence of these diverse subject areas underscores the multifaceted nature of e-learning research during COVID-19. It goes beyond the purely technological and delves into the social, psychological, economic, and environmental aspects of this rapidly evolving field. By analyzing the distribution of research across these subject areas, you can gain valuable insights into the key

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trends and priorities in e-learning research during the pandemic. You can also identify potential gaps and areas for future research, contributing to a more comprehensive understanding of the impact and implications of e-learning in the COVID-19 era and beyond.

Who Is The Top 10 Authors Based On Citation By Research?

Table 4: Top 10 Authors based on Citation by Research?

Authors	Title	Year	Source title	Cited by
Brisimi T.S.et al.	Federated learning of predictive models from federated Electronic Health Records	2018	International Journal of Medical Informatics	618
Zydney J.M.; Warner Z.	Mobile apps for science learning: Review of research	2016	Computers and Education	271
Pejovic V.; Musolesi M.	InterruptMe: Designing intelligent prompting mechanisms for pervasive applications	2014	UbiComp 2014 - Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing	227
Javed U.et al.	A Review of Content-Based and Context-Based Recommendation Systems	2021	International Journal of Emerging Technologies in Learning	193
Alsabawy A.Y.et al.	Determinants of perceived usefulness of e-learning systems	2016	Computers in Human Behavior	184
Aljawarneh S.A.	Reviewing and exploring innovative ubiquitous learning tools in higher education	2020	Journal of Computing in Higher Education	177
Liu H.et.al	ARHPE: Asymmetric Relation-Aware Representation Learning for Head Pose Estimation in Industrial Human-Computer Interaction	2022	IEEE Transactions on Industrial Informatics	171
Zhang Y. et al.	Graph Information Aggregation Cross-Domain Few-Shot Learning for Hyperspectral Image Classification	2024	IEEE Transactions on Neural Networks and Learning Systems	150
Mujahid M. et.al	Sentiment analysis and topic modeling on tweets about online education during covid-19	2021	Applied Sciences (Switzerland)	139
Sun J.C.-Y. et al.	The effect of the flipped classroom approach to OpenCourseWare instruction on students' self-regulation	2017	British Journal of Educational Technology	136

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The bibliometric analysis of e-learning in the table shows the most highly cited publications related to e-learning and educational technology from various authors and journals. In the real of e-learning and higher-order thinking, the selected literature underscores the growing significance of innovative educational technologies and methodologies. The study by Brisimi et al. (2018) on federated learning from electronic health records highlights the potential of collaborative data-driven approaches to enhance predictive modeling in healthcare, which can be extrapolated to educational contexts where personalized learning experiences are paramount. Similarly, Zydney and Warner's (2016) review of mobile apps for science learning illustrates how technology can facilitate interactive and engaging learning environments, fostering higher-order thinking skills among students. These findings collectively suggest that integrating advanced technologies into educational frameworks can significantly improve learning outcomes and promote critical thinking.

The exploration of various e-learning determinants is further emphasized by Alsabawy et al. (2016), who identify perceived usefulness as a critical factor influencing the adoption of e-learning systems. This aligns with Aljawarneh's (2020) investigation into innovative ubiquitous learning tools, which reveals that the effectiveness of these tools in higher education is contingent upon their ability to engage students and enhance their cognitive skills. The interplay between technology and pedagogy is crucial, as highlighted by Javed et al. (2021), who review content-based and context-based recommendation systems that can tailor learning experiences to individual needs, thereby promoting higher-order thinking through personalized learning pathways and supported by M. A. Almaiah, A. Al-Khasawneh, and A. Althunibat, (2020)

Moreover, the recent studies by Liu et al. (2022) and Zhang et al. (2024) delve into advanced methodologies such as asymmetric relation-aware representation learning and cross-domain few-shot learning, respectively. These approaches not only contribute to the technical advancement of educational tools but also emphasize the importance of data-driven insights in understanding student behavior and learning patterns. Mujahid et al. (2021) further illustrate the relevance of sentiment analysis in gauging student perceptions during the COVID-19 pandemic, highlighting the need for adaptive learning environments that respond to student feedback. Collectively, these studies advocate for a holistic approach to e-learning that integrates technology, pedagogy, and student engagement to foster higher-order thinking skills essential for the 21st-century learner.

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What Are The Popular Keywords Related To The Study?

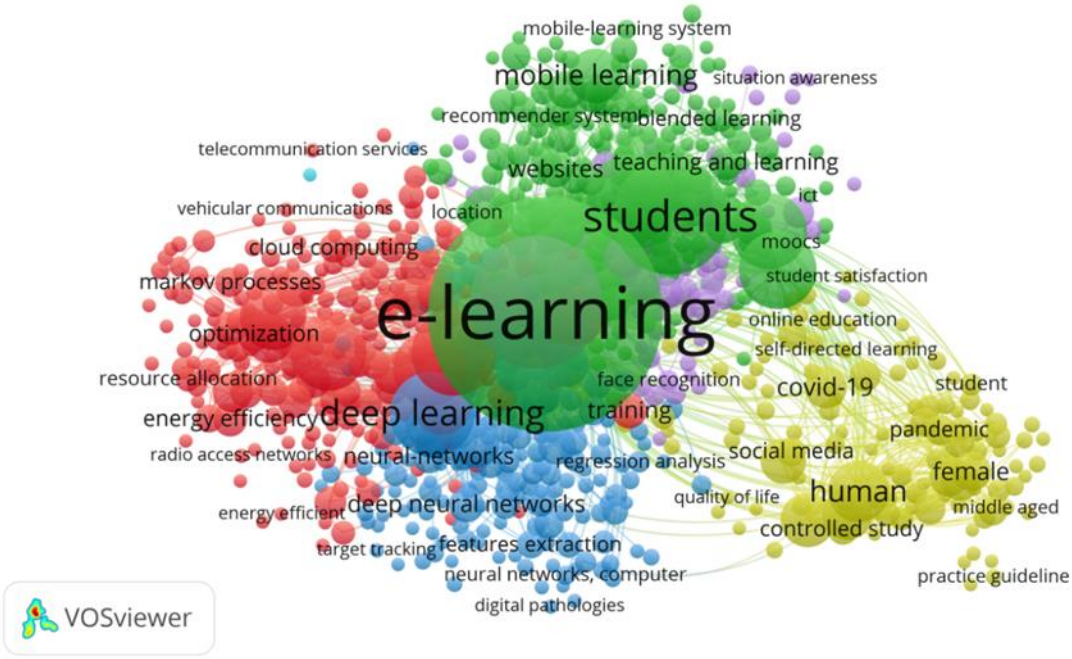

Figure 4: Work Visualization Map of Keywords' Co-occurrence

The map shows several clusters of keywords that represent the main themes and topics within the research literature. Here's a breakdown of some of the key clusters:

- E-learning, online learning, and distance learning: These are the core keywords of the analysis, as they represent the main focus of the research. They are central to the map, indicating their prominence in the literature.
- Higher education, universities, and students: These keywords highlight the specific context of e-learning during COVID-19, focusing on its application within higher education institutions.
- Perceived usefulness, acceptance, and satisfaction: These keywords suggest that researchers are interested in understanding how students and educators perceive and respond to e-learning during the pandemic.
- Challenges and barriers: This sub-cluster within the central theme indicates that researchers are also paying attention to the difficulties and limitations associated with e-learning implementation during COVID-19.

The overall density of the map suggests a high degree of interconnectedness between the keywords. This indicates that the research on e-learning during COVID-19 is complex and multifaceted, with various factors and themes being explored simultaneously. The size of the nodes corresponds to the frequency of the keywords. The prominence of "e-learning," "students," and "universities" further reinforces their central role in the research. The presence of smaller clusters around the periphery of the map suggests that there are also specific areas of inquiry that deserve further investigation.

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Overall, the network visualization map provides a valuable overview of the research landscape on e-learning during COVID-19. It highlights the key themes, areas of focus, and potential areas for further investigation. By analyzing the relationships between keywords, you can gain deeper insights into the trends and nuances within this field of research.

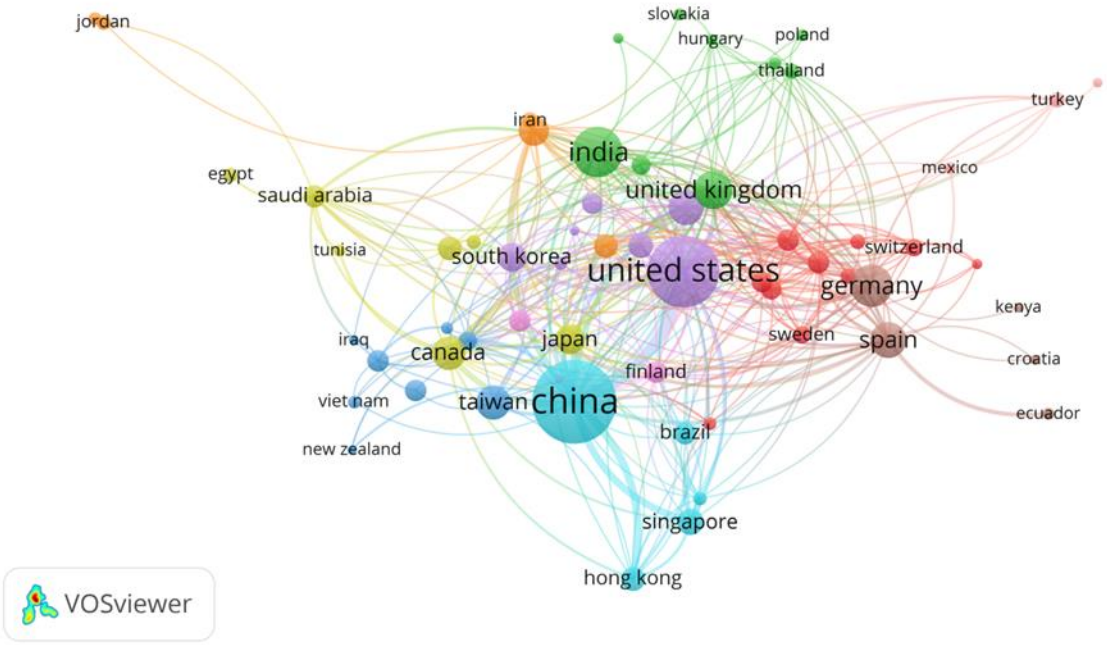

Figure 5: Shows the Countries whose Authors Collaborate on Higher Order Thinking of e-Learning

Co-authorship countries' collaboration refers to the partnerships and joint efforts between researchers or authors from different countries when working on a specific topic, such as higher-order thinking in e-learning. In academic research, co-authorship is a common indicator of international collaboration, as it demonstrates how researchers from various regions contribute their expertise and perspectives to advance knowledge in a particular area.

For example, in Figure 10 (as referenced), the diagram might illustrate connections between countries based on co-authored publications. These collaborations could be visualized through networks, where nodes represent countries and links between them represent co-authored works. Larger or more frequent collaborations would likely be depicted with stronger or more prominent links, showcasing the global partnerships in researching higher-order thinking skills in e-learning.
If you have access to Figure 10, it would be useful to examine the specific countries involved, as this could highlight key players or trends in global e-learning research.

Discussion and Conclusion

The analysis of research trends in e-learning implementation and awareness reveals a notable increase in scholarly interest from 2014 to 2024. Initially, the period from 2014 to 2018 exhibited a stable but limited number of publications, indicating a gradual recognition of the topic. However, a significant surge in research activity began in 2019, likely influenced by

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technological advancements and the urgent need for digital transformation in education. The COVID-19 pandemic further accelerated this trend, as educational institutions rapidly transitioned to remote learning. The peak in publications in 2023, reaching approximately 250 documents, reflects a heightened focus on e-learning, although a slight decline in 2024 suggests a potential stabilization of interest as the initial urgency surrounding remote learning diminishes. Overall, the data indicates that e-learning has emerged as a vital area of research, with ongoing developments expected as educational needs evolve.

The examination of the most cited authors in the field highlights key contributors and their affiliations. Leading authors, identified as prolific contributors, have produced a significant number of publications, indicating their influential roles in advancing e-learning research. The presence of these authors at institutions that prioritize educational technology research suggests a collaborative and interdisciplinary approach to the subject. The distribution of contributions among the top authors illustrates a network of researchers dedicated to enhancing e-learning awareness and implementation. While some authors dominate in terms of publication volume, the collective efforts of all contributors are essential in shaping best practices and guiding future research directions in this important field.

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