Berkala Ilmu Perpustakaan dan Informasi, Vol. 18, No. 1, Juni 2022 Hal. 31-44
https://doi.org//10.22146/bip.v18i1.2715
ISSN 1693-7740 (Print), ISSN 2477-0361 (Online)
Tersedia online di https://journal.ugm.ac.id/v3/BIP

Discovering the technical terms on digital learning transformation in the COVID-19 era

Abdurrakhman Prasetyadi[1], D.W. Ari Nugroho[2], Aria Bisri[3], Fitria Laksmi Pratiwi[2], Jazuli[2], Penny S. Putri[2], Siti Kania Kushadiani[1]
[1]Research Center for Informatics - National Research and Innovation Agency
[2]Directorate of Repositories, Multimedia, and Scientific Publishing - National Research and Innovation Agency
[3]Center for Data and Information - National Research and Innovation Agency
[123]Jalan Sangkuriang No.10, Bandung, 40135
e-mail: abdurrakhmanpras@gmail.com

Naskah diterima: 4 Oktober 2021, direvisi: 24 Januari 2022, disetujui: 14 Februari 2022

ABSTRAK

Pendahuluan. Pandemi telah memicu beberapa publikasi untuk mengukur keberhasilan metode dan platform yang digunakan dalam pembelajaran digital. Penelitian ini bertujuan untuk menemukan istilah-istilah teknis yang lebih luas dalam studi transformasi pembelajaran digital di masa COVID-19.
Metode Penelitian. Menggunakan basisdata *Web of Science* (WoS) untuk mencari dan mengumpulkan data publikasi studi transformasi pembelajaran digital di masa COVID-19. Data publikasi yang terkumpul sebanyak 432 artikel dari November 2019 hingga Agustus 2021.
Data Analisis. Data dianalisis secara deskriptif menggunakan analisis bibliometrik dan analisis teks dengan menerapkan pengelompokan pada dataset artikel..
Hasil dan Pembahasan. Hasil penelitian ini telah berhasil membuat tiga klaster bidang teknis dari seluruh dataset artikel dan memperoleh istilah teknis yang digunakan dalam studi transformasi pembelajaran digital seperti *virtual clinical trials, emergency remote learning, image augmentation*, dan lainnya. Selain itu, penelitian ini juga mendeskripsikan jaringan kolaborasi penulis dan negara dalam studi transformasi digital di masa COVID-19.
Kesimpulan dan Saran. Berdasarkan temuan tersebut, banyak istilah baru yang diperoleh dalam studi transformasi pembelajaran digital di masa COVID-19 yang tidak hanya pembelajaran daring.

Kata kunci: analisis bibliometrik; analisis teks; COVID-19; transformasi pembelajaran digital; klastering

ABSTRACT

Introduction. *The pandemic has triggered researchers to measure the success of the methods and platforms used in digital learnings. This study aims to discover technical terms in the study of digital learning transformation in the COVID-19 era.*
Data Collection Methods. *Using the Web of Science (WoS) database to search and collect publication data on digital learning transformation in the COVID-19, this paper collected 432 articles from November 2019 to August 2021.*
Data Analysis. *The data were descriptively analyzed using bibliometric and text analysis by applying clustering to the paper dataset.*
Results and Discussion. *The results of this study show three technical field clustersand terms in digital learning transformation studies. These include virtual clinical trials, emergency remote learning, and image augmentation.. In addition, this paper show a collaborative network of authors and countries in the study of digital transformation in the COVID-19 era.*

Conclusion. *Many new terms have been obtained in the transformation of digital learning studies in the COVID-19 era, which is not only "online learning".*

Keywords: *bibliometric analysis; COVID-19; clustering; digital learning transformation; text analysis*

A. INTRODUCTION

Since March 2020, governments in various countries have issued policies on the distance and movement of people (Irhandayaningsih, 2020; Pokhrel & Chhetri, 2021). Social distancing policies and restrictive activities significantly disrupt traditional educational practices (Pokhrel & Chhetri, 2021). The phenomenon of social distance restriction has affected the implementation of learning in schools and universities in Indonesia. Circular of the Minister of Education and Culture of the Republic of Indonesia 3 of 2020 dated March 3, 2020, the prevention of COVID-19 in education units, changes learning activities based online. Online-learning is based on gaining knowledge of gadgets that don't take vicinity in a single room so that there may be no bodily interplay among instructors and learners, and face-to-face is performed virtually (Irhandayaningsih, 2020). Make online learning a solution to overcome the difficulties of face-to-face learning. This challenges all elements and levels of education to maintain regular classes even though schools are closed (Herliandry et al., 2020).

In online learning, we recognize the terms asynchronous learning and synchronous learning. According to Chaeruman (2017), in synchronous learning, students and teachers are in the same place at the same time. An example of synchronous learning is when teachers and students communicate and interact through web conferencing in the classroom. This activity is also known as virtual face-to-face or virtual teaching. At the same time, asynchronous learning is an independent approach that can be carried out even when students or teachers are not connected (Kurniasari et al., 2020). Everyday asynchronous learning is interacting with the Learning Management System (LMS), communicating using e-mail, discussing forums, and reading articles (Kurniasari et al., 2020). We take the example of asynchronous learning conducted at the Center for Coaching, Education and Training-Indonesian Institute of Sciences (Pusbindiklat-LIPI), namely through the Learning Management System (LMS) LIPI, with the address https://elearning.lipi.go.id. During the education and training activities at the Pusbindiklat LIPI, to support the asynchronous learning process, training participants can access all materials, broadcast materials, and assignments through the LMS LIPI.

The only available option is to organize virtual learning, where a face-to-face class is replaced by face-to-face via virtual and involves digital technology (Zimmerman, 2020). In a university environment, lecturers and students must hold virtual classes and meetings on one of the platforms or software (Irhandayaningsih, 2020). Several online platforms include unified communications and collaboration platforms such as Microsoft Teams, Google Classroom, Canvas, and Blackboard. The platform enables teachers to provide and create courses, training and skills development programs (Petrie, 2020). The platform includes workplace chat options, video conferencing, and file storage to keep lessons organized and easy to use. Moreover, it supports sharing various content such as Word, PDF, Excel files, audio, video, and more. It also enables student learning and assessment tracking by using quizzes and rubric-based assessments of submitted assignments (Pokhrel & Chhetri, 2021).

On the other hand, the COVID-19 pandemic has sparked the awareness of academics to research digital learning transformation studies. This research has been conducted several times by researchers such as Pokhrel & Chhetri (2021), who ran a literature study on the impact of COVID-19 on such teaching and learning. Pokhrel discussed changes in teaching techniques (pedagogy) during the COVID-19 era, the various platforms used by teachers, and the challenge. In another

study, Banerjee et al. (2021) suggest learning in the COVID-19 era that uses the latest technology such as augmented reality (AR) and virtual reality (VR). According to Banerjee, COVID-19 has ushered in a new normal era where people can work and earn from home.

In the following study, Ratnaningsih et al. (2021) discussed technological literacy regarding digital learning in mathematics during the COVID-19 era. His research concludes that integrating technology in education requires a skill called technological literacy. There are four components to technical competence: content, process, context, and ethics. Unlike others, Suyetno & Yoto (2021) conducted research and development of new learning media based on Computer numerically controlled (CNC) simulators that support CNC learning practices during COVID-19.

With previous research, this study seeks to improve our understanding of the digital learning transformation in the COVID-19 era but aims to address some of the shortcomings of prior research. First, some previous studies only conducted a literature review and discussed the platforms used in digital learning. Second, there are no explicitly identified technical terms on the digital learning transformation in the COVID-19 era.

Based on the description above, this study aims to discover the technical terms in the digital learning transformation in the COVID-19 era. This research focuses on (1) creating a technology cluster profile on the digital learning transformation, (2) conducting text analysis by applying clustering to extract technical terms, and (3) network analysis to figure out networks of collaboration authors and countries. The novelty of this research is to discover technical terms on the digital learning transformation in the COVID-19 era. We also performed text analysis by applying the clustering method to gain knowledge in emerging technologies related to the novelty of each published article title.

B. LITERATURE REVIEW

Digital Learning Transformation: The Era of New Normal

In response to the COVID 19 pandemic, lockdown and social distance measures were implemented, and schools, educational institutions and universities were closed in most countries. There was a paradigm shift in how educators provide a quality education through various online platforms. Despite the challenges faced by faculty and students, online, distance learning and continuing education have become this unprecedented pandemic panacea. The transition from traditional face-to-face education to online learning can be a completely different experience for students and teachers, and there is no other option. (Pokhrel & Chhetri, 2021).

Teachers can now take part withinside the study room thru virtual displays so that each scholar can get hold of the equal content. The aggregate of various creativity and cutting-edge patterns will increase college students' interest. Every scholar receives world-magnificence training that isn't always to be had in conventional courses. Today, because of high-tech networks and era, the training region has to turn out to be a hastily growing field. There are computer systems and virtual gadgets withinside the study room, and gaining knowledge is extra exciting for college students. The teacher`s intention needs to be to create surroundings wherein each scholar desires to learn. In addition, today`s younger college students are surrounded by computer systems and cell phones, bringing the equal era into the study room, making gaining knowledge smooth and enjoyable (Banerjee et al., 2021).

With digital learning transformation during the COVID-19 era, the number of survey studies on digital learning has increased in the last two years. Pokhrel and Chhetri (2021) use a literature review to analyze teaching techniques (pedagogy) during the COVID-19 era, the various platforms used by teachers, and the challenge. The lack of their research only discusses digital learning tools/platforms it uses during the pandemic. In Table 1, the other studies are discussed.

Bibliometric Analysis

Bibliometric analysis is a quantitative method for processing mappings of numerous publications and scientific literature, a powerful statistical tool, and is increasingly used in various research fields in recent years (Ranjbari et al., 2021). The bibliometric analysis allows researchers to quickly identify future research directions within a field of study by comprehensively visualizing relationships between articles, journals, headings, citations, and co-citation networks (Feng et al., 2017). Bibliometrix were used to conduct the bibliometric analysis (Aria & Cuccurullo, 2017). Different bibliometric parameters, including most global cited documents, clustering by coupling, word cloud, collaboration analysis for authors and countries, and co-occurrence network, were presented in this research.

Text Mining Analysis

We applied a text mining method (document clustering) to achieve the research aims in this research. The text mining technique is a tool for extracting information from a large collection of text documents and analyzing research topics and trends (Jung & Lee, 2020)and is widely used by researchers in various research fields. According to Kumar et al. (2021), text mining, also known as Text analysis, is an artificial intelligence technology that uses Natural language processing (NLP) to transform unstructured data into structured data to improve machine learning algorithm analysis.

Text mining is a widespread technique in computer science, information science, mathematics, and management for extracting intelligence from big data (Grover & Kar, 2017; Humphreys & Wang, 2018). Text mining becomes essential when the massive text corpus and manual content analysis is impossible (Kumar et al., 2021). In particular, text mining analysis can capture the semantic structures and phrase patterns that best characterize large amounts of text data. Text mining analysis based on term co-occurrence algorithm (Ranjbari et al., 2021).

Social Network Analysis

This technique allows the researcher to represent the logical structure in two dimensions visually. More importantly, by observing the visualization results of the graph, researchers can draw meaningful conclusions and provide insights for further work and research (Abdelsadek et al., 2018). The basic unit of analysis is the relationship or connection between nodes in the network. Using matrix algebra and graph theory, Social network analysis (SNA) enables researchers to discover interactions between individuals or the flow of knowledge within a network and visualize invisible networks (Saheb & Saheb, 2019).

C. RESEARCH METHODS

Data Source

This study identifies the main keywords related to the research problem. The search string is used based on the efficiency of Boolean search strings for information retrieval (Aliyu, 2017). Boolean search is a method of enabling keyword combinations or exclusions with operators to get more relevant results. Two criteria for generating search terms were considered: 1) the term should be associated with many articles and be relevant to the related field, and 2) experts must determine how well the requirements are covered. This study uses the Web of Science (WoS) database as a data source to collect scientific publications. Then use different search queries and search for title, abstract, and topic. Our final search terms are TS=('digital learning') AND TS=('COVID-19') AND AB=('technology'). We identified 432 research articles published from November 2019 to August 2021; the dataset was then imported into the Bibliometrix: R tool (Aria & Cuccurullo, 2017) and Rapid miner for analysis.

Data Analysis

This paper uses bibliometric analysis to describe document types, author productivity, and document citation. We also performed text analysis by applying clustering by coupling to the paper dataset. Clustering by coupling is an unsupervised learning method used to uncover the intrinsic coupling relationships between

base clusterings, between clusters, and between objects. To conduct clustering by coupling, we used Bibliometrix R-package.

In addition, this research also uses SNA to figure out networks of collaboration authors and countries. Researchers can use SNA to measure collaboration patterns across multiple scales, including countries, institutions, and authors. (Jordan et al., 2017). An indicator for measuring collaboration can be defined as the Degree of collaboration (DCO). The overall research process includes (see Figure 1):

1) Data collection: data collection performs on the WoS database using predefined search strategies and terms
2) Clustering: the clustering process is carried out on the Bibliometrix software at RStudio with clustering by coupling. Clustering by coupling measures the impact of local citations, titles and units of analysis is documents
3) Technical terms extraction: after the clustering results are obtained, then the cluster table data is imported into Rapid miner software with the Text vectorization function to extract the key terms from the document titles in each cluster
4) SNA analysis: the last process is mapping the author's social network and the country in the Bibliometrix software.

D. RESULT AND DISCUSSION

Result

Bibliometric Analysis

Studies related to the COVID-19 era digital learning transformation are traced to the emergence of the acute-coronavirus syndrome (SARS-CoV) at the end of 2019. Publications continue to increase until 2021 with 118 documents (100.85%) or three times from the previous year. Journal articles dominate the publication type of digital learning transformation in the COVID-19 era studies with more than 313 documents. It was followed by 43 document preprints, 30 document review articles, 22 document proceedings papers, 14 editorial materials, and 10 other documents. The most cited document globally, namely Budd (2020) from the Journal of Nature Medicine, with a total of 110 citations. Initially, this implies that the study of digital learning transformation in the field of medicine is of high interest.

The source with the highest citation impact was the Journal of Medical Internet Research (h-index: 4). Meanwhile, the source with the highest document growth is the Sustainability Journal, at 72.72% in 2021. The author's affiliation with the most relevant is the University of Colorado with 9 documents.

We also analyze the productivity of digital learning transformation writers in the COVID-19 era through Lotka's Law. Lotka's law is a method used to calculate the productivity of writers in a field or journal. In the table, it is known that the productivity level of the authors in this study is still low. Only one author wrote three documents with a proportion of authors 0,001. Then 30 authors (0.019) wrote two documents, and 1525 authors (0.98) wrote 1 document.

The following analysis process was document clustering. The aim is to find an existing technology cluster in the dataset. The WoS category was a variable of choice during the cluster validation process because it is an essential part of the document data for identifying the cluster's functionality. The results of the four clusters show a group of articles. There were 432 articles from 2019–2021 distributed in each cluster and calculated as a percentage, shown in Table 2.

Clustering by coupling is measured by the unit of analysis, namely document and title, and measures impact by local citation score. The clustering results show a cluster map, network, data, and cluster, as shown in Figure 2. The cluster map displays the impact parameters and the point of centrality, where one of the clusters formed is in a deviation from this parameter, while the other two clusters are located on the bottom right and top left.

The clustering results by coupling in Bibliometrix form 3 clusters coded Cluster C1, C2, and C3. The clustering results show each WoS (technical fields) category in each cluster. In cluster C1, several technical areas include Medical informatics, Telecommunications, Radiology & nuclear medicine, Pathology, and

others. Then the C2 cluster includes Computer science, Pharmacology & Pharmacy, and Medicine general. Furthermore, in cluster C3, only the Green and sustainable science & technology field.

In addition to the technical field category, the clustering results also show a list of document titles in each cluster. In cluster C1 in the Medical Informatics field, for example, the titles of the documents included are 'Driving digital transformation during a pandemic: a case study of virtual collaboration in a German hospital' and 'Health information technology and digital innovation for national learning health and care systems. Then in C2 in the field of Computer science, for example, including the titles 'Game-based digital quiz as a tool for improving students' engagement and learning in online lectures' and 'iWorksafe: towards healthy workplaces during covid-19 with an intelligent health app for industrial settings'. Furthermore, C3 includes the document titles 'Sustainable educational robotics: contingency plan during the lockdown in primary school' and 'Creating a sustainable education environment with augmented reality technology'.

Clustering provided the most significant frequency and centrality. Each cluster contains data that reflects the relationship between the WoS category and technical terms extracted from the article title. Both can be used to describe the technology used to transform digital learning in the COVID 19 era. An analysis of technical fields and terms is provided in the next section.

Text Analysis of Technical Terms

The clustering in the previous section provides results from several WoS categories (technical fields) such as Medical informatics, Computer science, Telecommunications, Green and sustainable science & technology, etc. Next, we perform the primary process, namely Text vectorization in Rapid Miner software, to extract the technical terms from the document title. Examples of document titles and extracted key terms are shown in Table 3.

The extraction process begins by exporting each clustering document's data frame (table) title from the Bibliometrix software, and data is stored in Excel. Then the document titles in each cluster are regrouped into each technical field. So that the data frame consists of a clustered column, technical field, document title, and cluster frequency. Then the data frame is imported into Rapid miner software and processed using Text vectorization to produce word tokens with frequency. The token is then exported, and any non-technical terms are excluded. At this stage, sorting is done manually in Excel by creating general non-technical terms such as verbs and adjectives.

The technical terms that come from text analysis of each cluster are the words most often found in document titles—technical terms related to the novelty of each published article title (Ampornphan & Tongngam, 2020). In C1 cluster, several technical terms were extracted in the transformation of learning, for example, in the field of Medical informatics, including 'virtual' and 'remote' and another field Cardiac & cardiovascular systems including 'telemedicine' and 'telelearning'. Then in C2 in the field of Computer science, for example, including technical terms 'artificial', 'intelligence', 'games', and 'hybrid'. Furthermore, in C3 in the field of Green and sustainable science & technology, for example, including 'augmented' and 'robotics'.

The technical terms show a further technology of the platforms used in learning in each field, such as 'virtual' for clinical trials in Pharmacology and 'games' for digital quizzes in Computer science. Virtual is a technical term that often appears, followed by remote learning. More advanced technical terms that appear for digital learning include artificial intelligence, emergency-remote teaching (ERT), virtual-tumor board, and blended learning. Virtual-tumor board is a tumor treatment consultation between patients and oncologists and used for clinical trials. ERT explains the transition from formal classes to alternative online learning in crisis situations.

We also applied the word cloud to see what the pattern of keywords used by the authors looked like. It can be seen in Figure 3 that several terms such as artificial intelligence, telemedicine, remote learning, and emergency

remote teaching are used quite often as much as 9 to 13 times. However, the most widely used terms refer to digital learning, such as distance learning, online learning, e-learning, and distance education.

Social Network Analysis

The authors' collaborative network shows fewer relationships; namely, only Limone and Toto, who have a collaboration degree value of 0.75. As for the cooperation between countries that has the highest value of collaboration, namely the UK (187.41) and followed by the United States (122.9). The results of this study also show the author's keyword co-occurrence network, the term 'covid' being the most frequently occurring in terms of centrality in cluster 1 (page rank, 0.050). Then in the network cluster, 2 is the term 'social' that appears most often (page rank, 0.019).

Discussion

The COVID-19 pandemic has offered an opportunity to assess how well countries are prepared to leverage health information technology and apply the principles of digital-based learning systems in response to significant public health shocks. Sheikh et al. (2021) stated that with the experience gained during the pandemic, the UK must now re-evaluate its digital health and care learning strategies. The UK has implemented an AI-based Health Information Technology (HIT) system to improve usability and interoperability, develop the capacity to handle, process, and analyze data, address privacy and security issues, and promote digital inclusiveness.

On the telecommunications technology side, due to the limitations of Wi-Fi access in villages, Bangui University, Central African Republic, implements interconnection of villages and villages with Dynamic Spectrum Access technology on unused VHF and UHF analog TV bands called TV White Space (TVWS). Bangui University TVWS can accommodate students and lecturers for distance learning without internet connectivity and without spending money to pay for Internet credits from network operators (Ndassimba et al., 2021).

While Nuci et al. (2021) studied how to use Game-Based Digital Quiz for distance learning for students in the Faculty of Computer Science and Engineering, according to his research, having a systematic online quiz impacts student engagement and increases motivation. Overall, regarding the study dimensions of the LEAGUE framework (Learning, Environment, Affective, cognitive reactions, Game factors, Usability, UsEr), students claimed that they had more fun (affective, cognitive reactions) using the Kahoot! because of the gamified components it provides, such as competitions, music, and bonus points.

According to the findings of Karagozlu (2021), the use of AR technology in science education during a pandemic allows the visual presentation of topics, improves topic understanding, helps understand topics in a short time, and has a positive effect on student motivation. These findings suggest that AR components such as video and 3D images enable students to understand the content better. Bokolo & Noel (2021) presents online learning theory and challenges in adopting Emergency remote teaching (ERT) and Virtual learning (VL). The findings also present application platforms used for ERT and VL adoption such as in-house e-learning, Moodle, Blackboard, Lightboard Video Technology, Zoom, etc. Although some of the ERT and VL tools mentioned above were well used before the COVID-19 pandemic, the crisis has accelerated the adoption of these platforms.

E. CONCLUSION

This research was conducted to find new technical terms in the study of digital learning transformation in the COVID-19 era. The results of this study indicate that studies on digital learning transformation in the COVID-19 era continue to increase until 2021 by 100.85%. Then digital learning transformation studies in the field of medicine have the highest citation rate with 110 citations. Also, know that the productivity level of the authors in this study is still low. There is only one author who wrote three documents. The source with the highest

citation impact was the Journal of Medical Internet Research (h-index: 4). Initially, this implies that the study of digital learning transformation in the field of medicine is of high interest. This study also has succeeded in creating three clusters from the entire article dataset and coded by C1, C2, and C3 with the technical field in each cluster. This study also obtained technical terms in each cluster from digital learning transformation studies such as virtual clinical trials, ERT, image augmentation, and others. In addition, this research also describes a social network analysis such as the collaborative network of authors and countries in the study of digital transformation in the COVID-19 era.

Based on these findings, many specific technical terms have been obtained in digital learning transformation in the COVID-19 era, which are not only online learning. However, it is necessary to study more deeply the effectiveness of implementing the new technology platform in digital-based learning.

REFERENCES

Abdelsadek, Y., Chelghoum, K., Herrmann, F., Kacem, I., & Otjacques, B. (2018). Community extraction and visualization in social networks applied to Iwitter. *Information Sciences*, *424*, 204–223. https://doi.org/10.1016/j.ins.2017.09.022

Aliyu, M. B. (2017). Efficiency of boolean search strings for information retrieval. *American Journal of Engineering Research*, *6*(11), 216-222.

Ampornphan, P., & Tongngam, S. (2020). Exploring technology influencers from patent data using association rule mining and social network analysis. *Information*, *11*(6), 1-19. https://doi.org/10.3390/info11060333

Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An r-tool for comprehensive science mapping analysis. *Journal of Informetrics*, *11*(4), 959-979. https://doi.org/10.1016/j.joi.2017.08.007

Banerjee, D., Das, D., Pal, S., Paul, S. R., Debnath, A., & Reza, M. (2021). Effect of covid-19 on digital transformations in teaching learning methodology and its consequences in society: A review. *Journal of Physics: Conference Series*, *1797*(1), 1-8. https://doi.org/10.1088/1742-6596/1797/1/012066

Bokolo, A. J., & Noel, S. (2021). Examining the adoption of emergency remote teaching and virtual learning during and after covid-19 pandemic. *International Journal of Educational Management,* 1-18. https://doi.org/10.1108/IJEM-08-2020-0370

Chaeruman, U. A. (2017). *PEDATI Model Sistem Pembelajaran Blended, Panduan Merancang Mata Kuliah Daring, SPADA Indonesia.* Jakarta: Direktorat Pembelajaran KemristekDikti.

Darmalaksana, W., Hambali, R. Y. A., Masrur, A., & Muhlas. (2020). *Analisis pembelajaran online masa wfh pandemic COVID-19 sebagai tantangan pemimpin digital abad 21*. http://digilib.uinsgd.ac.id/30434/1/11042020%2015.30%20KTI.pdf

Devi Herliandry, L., Enjelina Suban, M., & Kuswanto, H. (2020). Pembelajaran pada masa pandemi COVID-19. *Jurnal Teknologi Pendidikan, 22*(1), 65-70. https://doi.org/10.21009/jtp.v22i1.15286

Feng, Y., Zhu, Q., & Lai, K.-H. (2017). Corporate social responsibility for supply chain management: A literature review and bibliometric analysis. *Journal of Cleaner Production*, *158*, 296–307. https://doi.org/10.1016/j.jclepro.2017.05.018

Grover, P., & Kar, A. K. (2017). Big data analytics: A review on theoretical contributions and tools used in literature. *Global Journal of Flexible Systems Management*, *18*(3), 203–229. https://doi.org/10.1007/s40171-017-0159-3

Humphreys, A., & Wang, R. J.-H. (2018). Automated text analysis for consumer research. *Journal of Consumer Research*, *44*(6), 1274–1306. https://doi.org/10.1093/jcr/ucx104

Irhandayaningsih, A. (2020). Pengukuran literasi digital pada peserta pembelajaran daring di masa pandemi COVID-19. *ANUVA*, *4*(2), 231–240. 10.14710/anuva.4.2.231-240.

Jordan, J., Wachsmann, M., Hoisington, S., Gonzalez, V., Valle, R., Lambert, J., Aleisa, M., Wilcox, R., Benge, C. L., & Onwuegbuzie, A. J. (2017). Collaboration patterns as a function of article genre among mixed researchers: A mixed methods bibliometric study. *Journal of Educational Issues*, *3*(1), 83-108. https://doi.org/10.5296/jei.v3i1.10699

Jung, H., & Lee, B. G. (2020). Research trends in text mining: Semantic network and main path analysis of selected journals. *Expert Systems with Applications*, *162*, 113851. https://doi.org/10.1016/j.eswa.2020.113851

Karagozlu, D. (2021). Creating a sustainable education environment with augmented reality technology. *Sustainability, 13*(11), 1-15. https://doi.org/10.3390/su13115851

Kumar, S., Kar, A. K., & Ilavarasan, P. V. (2021). Applications of text mining in services management: A systematic literature review. *International Journal of Information Management Data Insights*, *1*(1), 1-14. https://doi.org/10.1016/j.jjimei.2021.100008

Kurniasari, A., Pribowo, F. S. P., & Putra, D. A. (2020). Analisis efektivitas pelaksanaan belajar dari rumah (bdr) selama pandemi COVID-19. *Jurnal Review Pendidikan Dasar: Jurnal Kajian Pendidikan dan Hasil Penelitian*, *6*(3), 246-253. https://doi.org/10.26740/jrpd.v6n3

Lubis, F., & Yudhi, A. (2021). Study development of digital teaching materials support online learning during COVID-19. *Journal of Physics: Conference Series, 1811, 012029.* https://doi.org/10.1088/1742-6596/1811/1/012029

Ndassimba, E., Ndassimba, N. G., Kossingu, G. M., & Ouya, S. (2021). Feasibility of interconnecting the University of Bangui and peripheral areas via the TVWS for e-learning in the context of COVID-19. *23rd International Conference on Advanced Communication Technology, ICACT 2021*, 7-13. https://doi: 10.23919/ICACT51234.2021.9370920

Nuci, K. P., Tahir, R., Wang, A. I., & Imran, A. S. (2021). Game-based digital quiz as a tool for improving students' engagement and learning in online lectures. *IEEE Access, 9*, 91220-91234. https://doi: 10.1109/ACCESS.2021.3088583.

Petrie. (2020). *Spotlight: Quality education for all during covid-19 crisis (hundredresearch report #01)*. https://hundred.org/en/collections/quality-education-for-all-during-coronavirus

Pokhrel, S., & Chhetri, R. (2021). A literature review on impact of covid-19 pandemic on teaching and learning. *Higher Education for the Future*, *8*(1), 133–141. https://doi.org/10.1177/2347631120983481

Ranjbari, M., Saidani, M., Shams Esfandabadi, Z., Peng, W., Lam, S. S., Aghbashlo, M., Quatraro, F., & Tabatabaei, M. (2021). Two decades of research on waste management in the circular economy: Insights from bibliometric, text mining, and content analyses. *Journal of Cleaner Production*, *314*, 128009. https://doi.org/10.1016/j.jclepro.2021.128009

Ratnaningsih, N., Ni'Mah, K., & Hidayat, E. (2021). COVID-19 the earliest for digital learning in mathematics: An overview from technology literacy. *Journal of Physics: Conference Series*, *1819*(1), 1-6. https://doi.org/10.1088/1742-6596/1819/1/012027

Saheb, T., & Saheb, M. (2019). Analyzing and visualizing knowledge structures of health informatics from 1974 to 2018: A bibliometric and social network analysis. *Healthcare Informatics Research*, *25*(2), 61-72. https://doi.org/10.4258/hir.2019.25.2.61

Sheikh, A., Anderson, M., Albala, S., Casadei, B., Bryony, D. F., Richards, M., Taylor, D., Tibble, H., & Mossialos, E. (2021). Health information technology and digital innovation for national learning health and care systems. *Health Policy, 3*(6), E383-E396. https://doi.org/10.1016/S2589-7500(21)00005-4

Suyetno, A., & Yoto. (2021). Learning media development based on CNC simulator as the digital tool to support the CNC practice learning during COVID-19 new normal. *Journal of Physics: Conference Series*, *1833*(1), 1-6. https://doi.org/10.1088/1742-6596/1833/1/012009

Zimmerman, J. (2020). *Coronavirus and the great online-learning experiment*. https://www.chronicle.com/article/coronavirus-and-the-great-online-learning-experiment/.

TABLE LIST

Table 1. Previous research

Source	Methodology	Research Results	Lack of Research
(Pokhrel & Chhetri, 2021)	Literature review	The results show teaching techniques (pedagogy) during the COVID-19 era, the various platforms used by teachers, and the challenge	Only discussing digital learning tools during the pandemic
(Banerjee et al., 2021)	Literature review	The results show suggest learning in the COVID-19 era that uses the latest technology such as Augmented reality (AR), Virtual reality (VR), and Artificial intelligence (AI)	Not doing an in-depth analysis of previous research
(Herliandry et al., 2020)	Descriptive content analysis	Online learning is an effective solution to keep the classroom active even when the school is closed due to the danger of time and place during this pandemic.	Does not discuss in detail the source of the article being studied, how to obtain it, and its analysis
(Darmalaksana et al., 2020)	Partisipatory approach	Showing the effectiveness of online learning with significant achievements in line with the demands of realizing digital leaders of 21st century higher education, even though it was carried out during the WFH period due to the outbreak of the COVID-19 pandemic	Not doing an in-depth analysis of previous research
(Lubis & Yudhi, 2021)	Quantitative research	The results showed that 81.6% were in the very positive category regarding college student response to the implementation of online learning	Only counts student responses regarding online learning
(Ratnaningsih et al., 2021)	Qualitative research	The results show that students need to improve their technology skills by using technologies that are in line with the global trends and realities they encounter in school learning	Only discussing online learning tools during the pandemic
(Kurniasari et al., 2020)	Quantitative research	The results of the learning from home (BDR) implementation survey, which showed low effectiveness on a 48% basis, were in the evaluation process. Home learning (BDR) recommends that teachers must be able to make their learning activities simpler, more creative and more effective, from planning to evaluation	Not doing a depth analysis of the correlation between the effectiveness of the material and mentoring from the teacher

Source: Prepared by the author

Table 2. Results of Clustering

Cluster	Frequency	Centrality
C1	97	0,42
C2	54	0,45
C3	99	0,35

Table 3. Summary of Extracted Technical Terms from Document Titles

Cluster	Example Technical Field	Example Extracted Technical Terms
Cluster 1	Medical informatics	virtual; remote; clinic; trials
	Telecommunications	interconnection; TVWS; e-learning
	Radiology, nuclear medicine & medical imaging	cloud-based; distance; workstation
	Pathology	remote; virtual; tumor; board
	Geriatrics & gerontology	virtual; information; communication; technologies
	Engineering (multidisciplinary)	hybrid
	Cardiac & cardiovascular systems	telemedicine; telelearning
	Oncology	remote; telemedicine
	Mathematical & computational biology	deep-learning
Cluster 2	Computer science	artificial; intelligence; games; hybrid; app; robotics; blockchain; blended
	Pharmacology & pharmacy	artificial; intelligence; virtual; remote; clinical; trials
	Medicine, general & internal	telemedicine; distance; image; augmentation; deep; social-machine
	Information science	Mobile; digital
Cluster 3	Green and Sustainable Science & Technology	augmented; virtual; TED; emergency-remote; robotics; remote; navigating; b-learning

Source: Prepared with text vectorization algorithm

FIGURE LIST

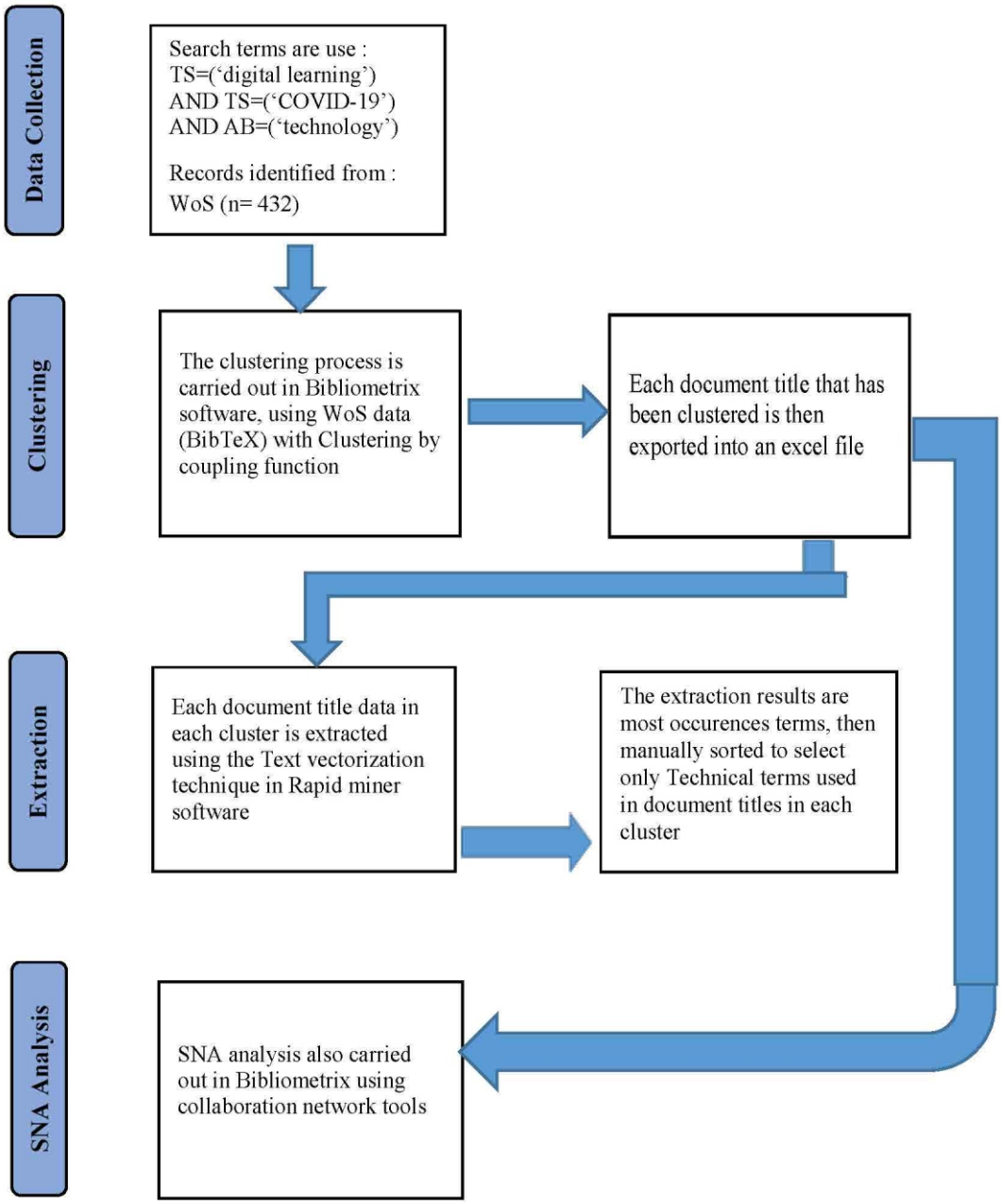

Figure 1. Overall Research Process

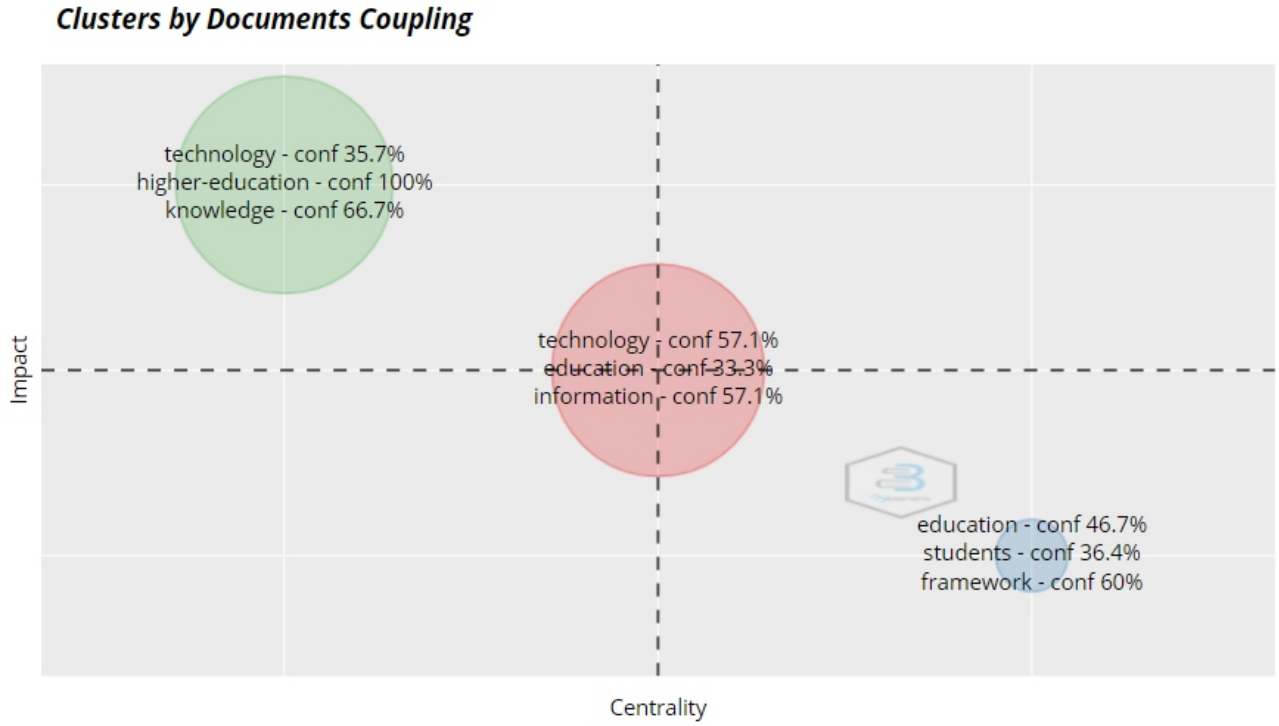

Figure 2. Clustering Results in Bibliometrix

Figure 3. Word Cloud of Author Keywords