Humanities, Arts and Social Sciences Studies

Research Article

Humanities, Arts and Social Sciences Studies
https://so02.tci-thaijo.org/index.php/hasss
ISSN (Online): 2630-0079

A BIBLIOMETRIC STUDY OF TECHNOLOGICAL PROFICIENCY IN HIGHER EDUCATION

Shoeb Ahmad[1], Revenio Jalagat, Jr.[2], Abdulaziz Abdulmohsen Alfalih[3], and Adil Mirza[4]*

[1] College of Business and Management, Fahad Bin Sultan University, Kingdom of Saudi Arabia
[2] Al Zahra College for Women, Oman
[3] College of Business and Economics, Qassim University, Kingdom of Saudi Arabia
[4] Independent Researcher, India

ABSTRACT

The study of technological proficiency is a key concern within a nation's educational and social programs. Throughout their academic journey, ranging from primary through secondary education and afterwards in higher education, students cultivate and enhance a diverse range of abilities, including technology proficiency. Information technology has changed the way businesses and higher education institutions work and the strategies they use. Colleges and universities worldwide are spending a lot of money on IT resources for students and faculty. Hence, this study investigates the trend of studies conducted in the field from 2000–2023 using bibliometric analysis. The bibliometric data generated contains 831 documents and was analyzed using VOSViewer software. Highlights of the findings revealed that the highest number of documents was published in 2020–2023, they were mostly sourced from journals, and top institutions performing research were from the USA, Australia, Israel, England, and Mexico. Antonella Nuzzaci was the author with the most publications, and the journals with most articles in the field were the *Interdisciplinary Journal of e-Skills and Lifelong Learning Education*, and *Information Technologies*. The results of co-occurrences based on Total Link Strength revealed keywords such as universities, internet, online learning, technology, and curriculum. The most cited documents were published from 2000–2005, and the most cited journals are *Education and Information Technologies*, *Small Business Economics*, and *TechTrends*. The trend of research on technological proficiency in higher education from 2000–2023 serves as reliable data to consider for further studies related to the field and for references and literature. The findings add value to current studies or topics of interest.

Keywords: Technological proficiencies; higher education; information and communications technology; e-learning; technological skills; bibliometric

***Corresponding author:**
Revenio Jalagat, Jr.
revjalagatjr@gmail.com

***Received:** 28 August 2024*
***Revised:** 3 March 2025*
***Accepted:** 21 March 2025*
***Published:** 5 June 2025*

***Citation**:*
Ahmad, S., Jalagat, R., Jr., Alfalih, A. A., & Mirza, A. (2025). A bibliometric study of technological proficiency in higher education. Humanities, Arts and Social Sciences Studies, 25(2), 311–326. https://doi.org/10.69598/hasss.25.2.272262

1. INTRODUCTION

As people become educated, they gain autonomy. Education enables people to live a good life, and can also change their beliefs, attitudes, and interests. Information and communication technology (ICT) has changed the world and everyone's life, becoming an important part of today's school system. Along with age and income, problem-solving, communication, and technology skills (the most important skills for the 21st century) were

found to make people happier with their lives (Leelakulthanit, 2018). Thus, in addition to general skills, technological skills are necessary in today's knowledge society, and seem to be important to people's future happiness in life. At the organizational level, technologies help with managing time, spreading and promoting knowledge, and solving problems. They also make organizations more efficient by allowing for better communication and connectivity, managing data, working from home, and adapting to a world that is always changing.

When ICT is used in the classroom, it forces teachers and schools to rethink how they teach and how students learn. In a survey, Singh (2023) states that the issue of ICT use has been dealt with across the board in the education system, and similar worries have been raised about the lack of laws, facilities, and teacher and student skills that make it harder to provide a good education. Digital tools are common in higher education and they are part of formal learning environments where students are seen as active participants in the search for information (Damşal, 2019). Using ICT at educational institutions not only improves teaching and learning, but also makes e-learning possible. ICT changes the standard curriculum, and how teachers teach in this digital age. It eliminates the problem of teachers and students being physically apart during the teaching and learning process. Researchers have also found that ICT makes students more active learners, because it improves their ability to think creatively, critically, and reflectively. In addition, it grows the learning community by letting students work together (Nevado-Pena et al., 2019). When technology was first brought into educational institutions and classes, it was met with resistance, fear, and a lack of trust in teachers' ability to use it in the lessons. Abdullahi (2013) observed that currently, it is hard for teachers to learn and study without using technology. By using technology in the classroom, it is easier for teachers to switch to personalized teaching and focus on how to use technology appropriately for each age group and subject.

However, though there are lots of studies conducted on technology, digital technologies, and the use of technology as applied to companies, higher institutions and others, less attention is focused on technological skills in higher education, for example, measuring the performance of teachers and students in the utilization of ICT in learning (Haleem et al., 2022; Rodrigues et al., 2021). This study examines the trends in the demonstration of technological proficiencies in higher education for the period 2000–2023 to determine the research gaps and future direction of the research related to the topic.

Technology has created a new economic and social environment, putting pressure on universities to produce graduates who can succeed in this competitive global information-based economy. Higher education institutions (HEIs) around the world are rapidly integrating ICT into all aspects of teaching and learning to fulfill societal needs. Digital knowledge, innovative thinking, efficient communication, and high productivity are essential for success today, according to research. Few examples of constructive education using information technology exist (Kramer et al., 2007). The utilization of ICT is contingent upon educators' proficiency and expertise. The potential for information overload arises when a teacher lacks the necessary expertise to effectively filter the relevant information (Yunus et al., 2009).

Academic staff are often called "agents of change," and if they learn how to use modern technology, they will change a lot of people's minds about how to use computers and the internet (Yusuf et al., 2022). ICT must be used in schools, where teachers are under a lot of pressure to get their work done quickly in a world of knowledge-based technology and globalization.

According to research, the integration of technology into teaching practices has been proposed as a potential solution to mitigate the stress experienced by instructors. There have been significant changes in the world because of ICTs, especially the internet, which have had an impact on how people interact with one another. In contemporary times, educational institutions are increasingly expressing apprehension regarding the utilization of ICTs to facilitate pedagogy and foster the development of valuable competencies among instructors.

In the present era, information is readily accessed and disseminated with remarkable efficiency. The internet has made it possible to access modern and advanced libraries, where one can receive high-quality, up-to-date data for research (Nwankwoala, 2015). The right use of ICT could also help scholars complete their research more quickly and easily, from finding literature, to collecting data and analyzing it, to writing research reports, sending letters, and publishing (Odigwe et al., 2020; Owan et al., 2020). Scholars who do not use ICTs properly might become out-of-date because they do not have the latest knowledge and skills they need in their field. Technologies help HEIs educate personnel more efficiently in the 21st century information economy, so they will operate more productively and efficiently in future workplaces. ICT application knowledge is essential in the modern world. To fully understand the importance of ICT in educational institutions, all members of a group need to be involved in its use.

The ability to use digital technology critically, creatively, and collaboratively is what it means to be digitally competent. By defining public policies and keeping track of citizens' technological proficiency, the Digital Competence Framework makes it possible to assess digital competence at the national level. The following, in order of importance, are the defined competence areas: information and data literacy,

communication and teamwork, digital content production, safety, and problem-solving. Four learning objectives, with two levels for each competency—foundation, intermediate, advanced, and highly specialized—have defined eight proficiency levels (Rodrigues et al., 2021). The creation of the EU-wide Digital Economy and Society Index, which measures human capital—a necessary resource for seizing the opportunities presented by a digital society—was made possible by the DigComp framework.

A key part of the long-term growth of countries, regions, and cities is quality of life. However, because this is hard to measure, there are no clear guidelines for which parts of the economy should be improved to make life better (Roztocki & Weistroffer, 2016). Just as literacy helped people grow and fit in with others in the past, using new tools and being able to complete tasks with them are important in helping people grow today. ICT changes people's daily lives, and it also changes the economy. This, in turn, further changes people's daily lives, by making facilities better and raising the standard of living.

It is possible that digitalizing teaching and learning will become a much bigger policy priority. This is because it can maintain quality and access while lowering the cost of instruction. Research has already been done on how technologies have been used in higher education, especially more recently. For example, changes to the curriculum (Volungevičienė et al., 2020), motivation (Mahande & Akram, 2021), teaching methods (Rouah et al., 2021; Alamri et al., 2020), how they were incorporated into the teaching process (Wieser, 2020), learning systems (Fearnley & Amora, 2020), and the supervision of HEIs (Maiorov, 2021). For HEIs, the findings are important at an organizational level as well. This is due to the possibility of influencing the financial sustainability of higher education, as well as the design of academic work, if digitalization is adopted in teaching and learning. It is crucial to realize that this encompasses more than just a change in how education is delivered, such as going from person-to-person instruction to online or hybrid learning. Instead, it has the power to drastically change higher education, including how academic work is organized and how students, teachers, and their respective institutions interact with one another (Sharma & Sharma, 2021).

The integration of various ICTs has facilitated the implementation of remote education, increasingly a fundamental component of the education system, particularly within the context of higher education. Based on data provided by the National Centre for Education Statistics, it was observed that more than 70% of educational institutions in the United States employ distant learning technologies (Hernandez, 2017). Roszak and Kolodziejczak (2017) mention that this way of teaching is used by many universities around the world because it saves money and is more fun for both students and teachers, because they can do it whenever and wherever they want. According to Kolodziejczak and Roszak (2017), universities must make sure that both teachers and students are proficient in ICT to use online education, especially e-learning. Hence, the incorporation of digital technology within HEIs is essential for fostering students' technological competencies and enhancing their prospects in the professional world. Consequently, this integration also contributes to an improved quality of life for students, teachers, and the institution in general.

The performance of the students in technological knowledge relies on the teachers' ability to deliver instruction with technological proficiency. However, academicians have begun to embrace the adoption of technological tools in teaching and learning during the COVID-19 pandemic (Cabero-Almenara, 2020; Casado-Aranda et al., 2021; Usher et al., 2021). Lagging behind proficiency, teachers still need to emerge with recent technologies which are becoming a trend in the post-pandemic era where increasing research problems and gaps have evolved. As the topic of technological proficiency and digital competence is growing and continuously evolving with an increasing number of published and scholarly works in higher education, the growing need for comprehensive review and analysis of the recent trends, multiple perspectives, and future directions are imperative, especially for teachers who have relatively new knowledge in the utilization of technologies which are critical for student development learning directions. Existing review studies have already been conducted related to the topic; they employed qualitative research methodologies which limit qualitative insights, subjective outcomes, possible biases, and the lack of quantitative perspectives (Yang et al., 2023; Masoumi & Noroozi, 2023; Molina-García et al., 2023; Su & Yang, 2024). Recently, few studies dealt with the application of technology in higher education that focused on teachers' digital competencies and technological skills and based on the researchers' knowledge there is still a need to explore the topic of technological proficiency in higher education. Most of published studies tackle on the use of technology rather than assessing the technological proficiency and skills. This study, therefore, examines the trends of publications on technological proficiency and higher education, citations from 2000–2023 and their contributions to teaching and learning in higher education, and top journals in the development of technological skills in higher education.

Conducting this study is expected to provide various benefits such identifying emerging trends and patterns that focused technological proficiency in higher education, mapping the knowledge gaps in this field, assessing the impact of citation patters, help in developing and shaping educational policies, improving technological integration, and supporting networking and collaborations.

This study aims to analyze the extent of application of technological proficiency in higher education using bibliometric analysis. Based on the problem statement, the following research objectives are formulated:

1. To assess the evolving trends of publications related to technological proficiency in higher education in terms of studies performed over the years, publication type, top performing institutions, researchers with highest number of publications, top fields of study, most active countries in the study field, and top journals by citation.

2. To determine the trend of publications that tackled on technological proficiency in higher education by investigating keywords and co-occurrences.

3. To investigate which documents are most cited from 2000–2023 and their contributions.

4. To assess the contribution of top journals in the development of technological skills in higher education.

In this study, major terminologies used are defined as follows:

Digital Technology—encompasses devices, tools, systems, and resources that create, keep, or process data which includes technologies such as internet, computers, digital media, smartphones, and artificial intelligence (Brynjolfsson & McAfee, 2014).

Technological Skills—is defined as the required knowledge and abilities to effectively utilize digital devices, tools, and systems comprising hardware, software, and operating systems (Binkley et al., 2012).

Technological Expertise—refers to in-depth learning and experience in specialized technological area including system analysis, programming, network security, and hardware design.

E-learning—describes the utilization of digital media and information and communication technologies to present academic subject and accelerate learning processes through academic software use, online courses, and virtual classrooms (Clark & Mayer, 2016).

Information and Communications Technology (ICT)—is a general phrase for all of the different mediums used to convey information. For instance, in an educational setting, ICT can refer to computers, the internet, television broadcasts, and even handwritten or printed notes (Oxford, 2025).

2. METHODOLOGY

Many studies have been conducted examining the influence of technology and e-learning on higher education, but a limited number of articles examine the effect of technological skills in higher education learning (Haleem et al., 2022; Rodrigues et al., 2021). Most of the studies are based on systematic reviews, quantitative and qualitative research. There is a considerable increase in studies in 2020–2023, though investigations have been carried out since 2000, which indicates the trend in the utilization of technology and skills. This means that technology and technological skills in higher education learning are evolving and continuous topics for investigation.

In this paper, the main objective was to conduct a bibliometric analysis on the topics “Technological Skills” and “Higher Education” for the period from 2000 to 2023, using bibliometric data. The use of bibliometric analysis enables an objective review of publications and removes subjective bias and human error that may appear in other review methods (Donthu et al., 2021; Mukherjee, 2021). It primarily analyzed variables such as studies performed over time, publication type, top performing institutions, top researchers, top field of study, most active countries, and top journals in the field.

Secondly, it sought to address the following questions:

1. What is the trend of publications on “Technological Proficiency” and “Higher Education” through examining occurrences and keywords?

2. Which documents are most cited from 2000–2023, and what are their contributions?

3. What is the contribution of top journals in the development of technological skills in higher education?

2.1 Research design

This paper utilized a bibliometric study sourced from bibliometric data of scientific publications focusing on “Technological Skills” and “Higher Education”. Bibliometric analysis was performed to identify two important considerations: (1) a bibliometric map to investigate the trends in technological skills in higher education, and (2) analysis of keywords and citation by documents and source to determine co-occurrences and future research directions.

2.2 Obtaining the data set

To obtain the data, the bibliographic database from Lens was utilized, covering peer-reviewed articles and other sources. The study used the Lens database for various reasons. Firstly, Lens is open access that

provides data on publications, patents, and citations without spending high subscription fees for institutions wherein, the researchers' institutions have limited access to Scopus and Web of Science databases. Secondly, it has a global coverage that involves publications from a wide range of nations and fields including developing and conventional research topics that are suitable for bibliometric investigations that aim to map the worldwide research landscape. The scope of the search was from 2000 to 2023. Firstly, general keywords were used ("Digital Technology" and "Higher Education") and the results showed 5,828 publications. Using the keywords "Technological Skills" and "Higher Education", it was trimmed down into 439 sources. However, the search was expanded to consider other related keywords, and a total of 831 sources were collected (Figure 1).

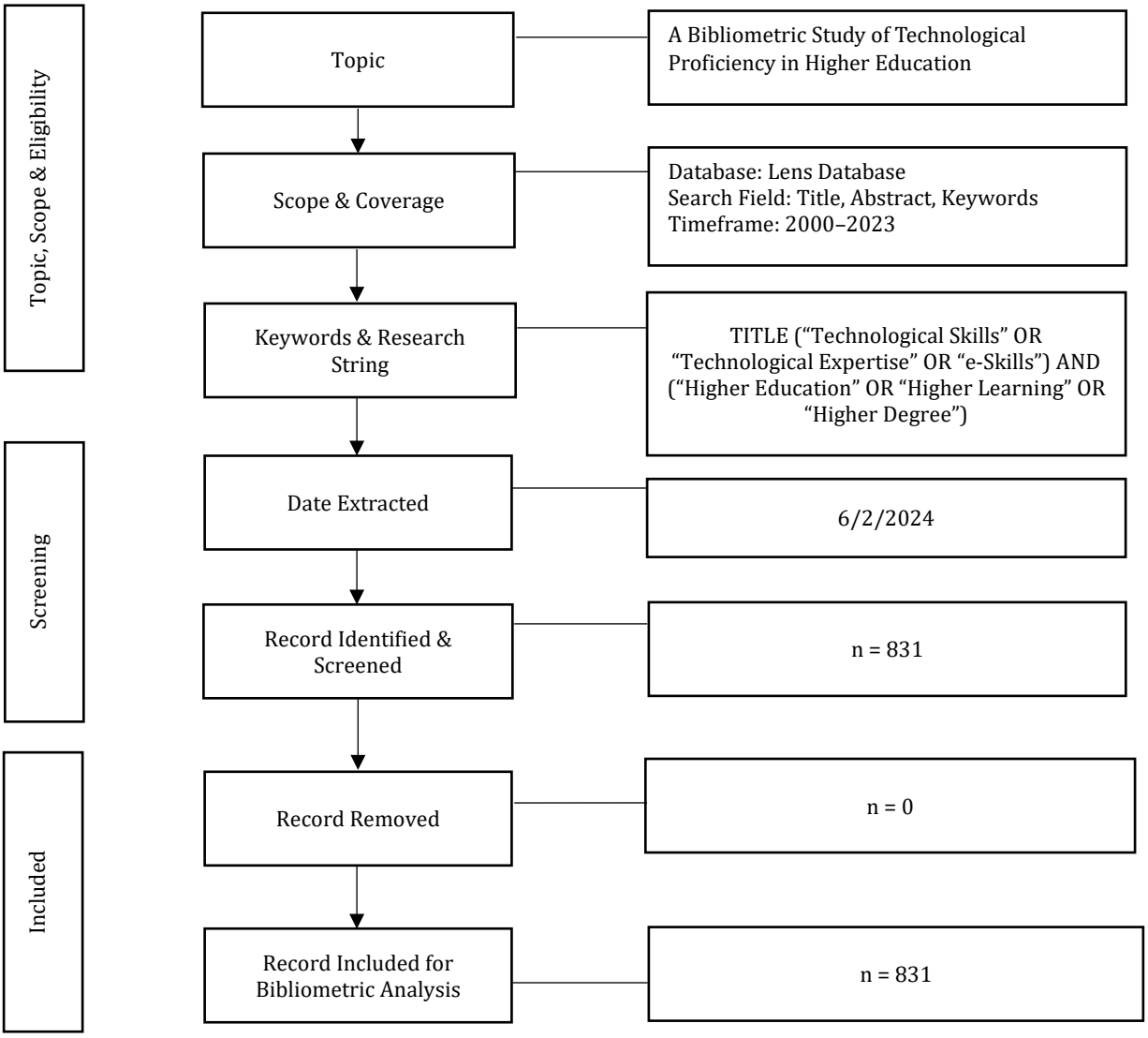

Figure 1: Flow diagram of the search strategy

2.3 Data analysis

This study utilized the ViosViewer to analyze the extracted publications from the Lens database. According to Zhao and Zhou (2024), the use of bibliometric analysis elucidates fields that are unexplored or evolving trends in technological proficiency that necessitate further study which leads to future investigation efforts and policy-making in higher institutions of learning. It is an effective instrument for tracing the growth and impact of technological proficiency in higher education as well as identifying research gaps, educational contributions, and collaboration associations that can direct academic policymakers, practitioners, and scholars in achieving up-to-date judgments about technological assimilation and proficiency in academic settings. Furthermore, the 831 papers were selected because it links to the research objectives and research questions of bibliometric investigation and emphasizes specific field of investigation which the researchers considered as representative view of the field.

3. RESULTS

The data analysis was divided into two parts. The first part consisted of analyzing profile performance, such as information on studies performed over time, publication type, top institutions, top researchers, top fields of study, most active countries, and top journals in the field. In the second part, VOSViewer software was used to analyze the bibliometric data on co-occurrences and keywords, citations per document, and citations per source. The use of co-occurrences of keywords shows the development of the field over time (Deng & Xia, 2020), while citation analysis aids authors to identify popular academic papers and topics that other researchers are working on (Lai, 2020).

Figure 2 shows that 2020–2023 accounted for the greatest number of publications, during the COVID-19 pandemic outbreak. From 2000–2023, 2021 has the highest number (n = 79, 10.87%) followed by 2022 (n = 75, 10.32%); 2023 (n = 71, 9.77%); 2020 (n = 47, 6.46%); 2019 (n = 47, 6.46%); 2015 (n = 39, 5.36%); 2016 (n = 37, 5.09%); 2018 (n = 30, 4.13%); 2014 (n = 30, 4.13%); and 2017 (n = 29, 3.99%). All top 10 years are between 2014–2023. Aside from the association of the increase in publications due to pandemic, technological advancement continues to rise with new digital platforms and resources that plays a significant role in higher education. The rise of publications in 2020–2023 is also driven by the growth in the integration of emerging technologies such as big data, virtual reality, and artificial intelligence in educational processes (Antonopoulou et al., 2023).

Figure 2: Studies performed over time

Figure 3 shows performance based on publication type. The findings show that the top 5 publication types are: Journal (85.44%); Unknown source (6.38%); Book Chapter (3.85%); Conference Proceedings Article (2.41%); and Dissertation (0.72%).

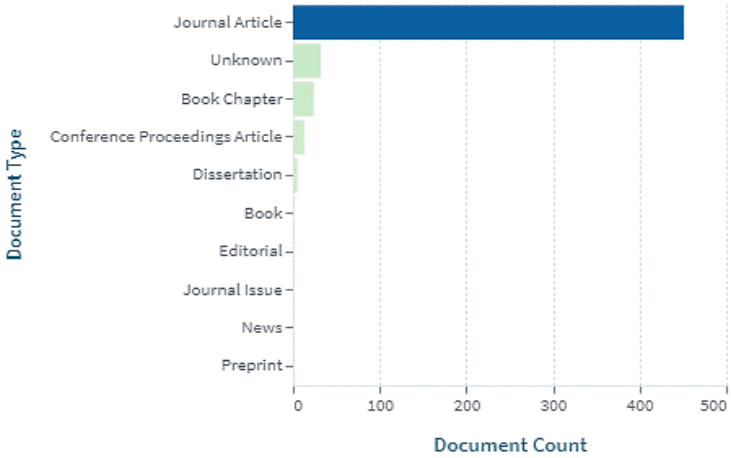

Figure 3: Publication type

Figure 4 shows the performance of the top 10 institutions conducting research in fields related to technological skills in higher education. First is the University of Maryland Eastern Shore (n = 7, 14%); followed by Curtin University (n = 5, 10%); Monterey Institute of Technology and Higher Education (n = 5, 10%); Tel Aviv University (n = 5, 10%); Bobson College (n = 4, 8%); Clemson University (n = 4, 8%); Hebrew University of Jerusalem (n = 4, 8%); Laval University (n = 4, 8%); Loughborough University (n = 4, 8%); and Macquarie University (n = 4, 8%).

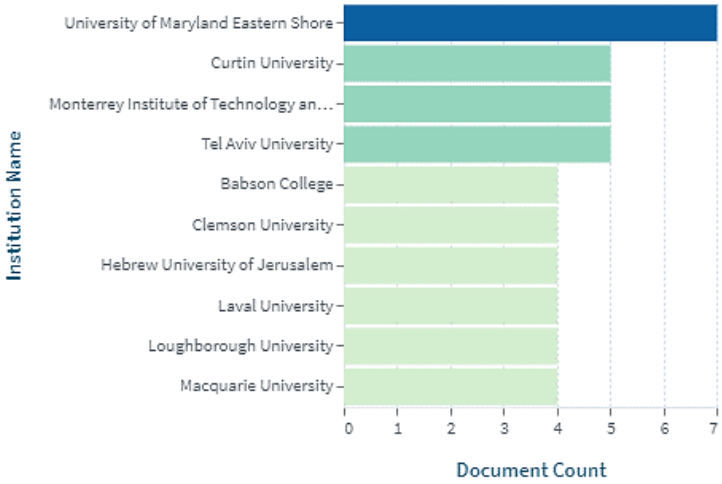

Figure 4: Top institutions

Figure 5 shows the researchers in the field with the highest number of publications: in sequential order, Antonella Nuzzaci, GJMSR Jayasinghe, KWSN Kumari, Agyei Fosu, Ali Khatibi, Allan Ellis, Ann Marie Delaney, Bruno Bertaccini, Cynthia Harper, and Davy Tsz Kit Ng. These authors had published 2–3 documents. This result signifies that the bulk of the publications were evident in 2020–2023 wherein examination to these documents revealed that most of these papers still to be cited, hence relatively new published documents.

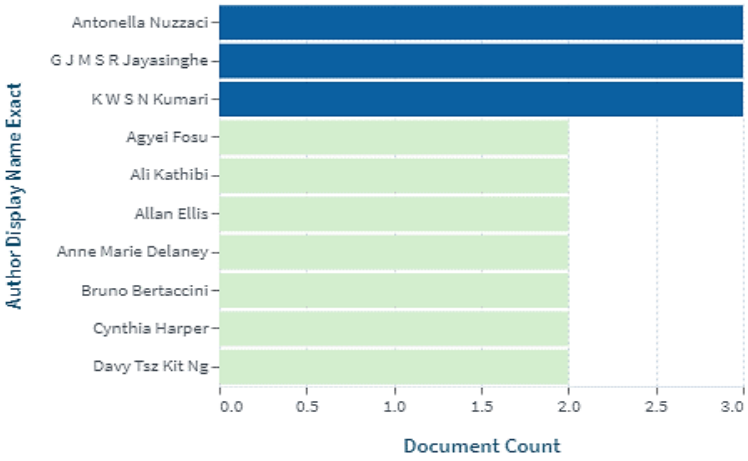

Figure 5: Researchers with highest number of publications in the field

Figure 6 depicts the top fields of study related to technological skills in higher education. The results revealed the top fields in order of number of documents: Psychology (226); Computer Science (141); Pedagogy (132); Sociology (128); Political Science (114); Medicine (79); Law (66); and Public Relations (59).

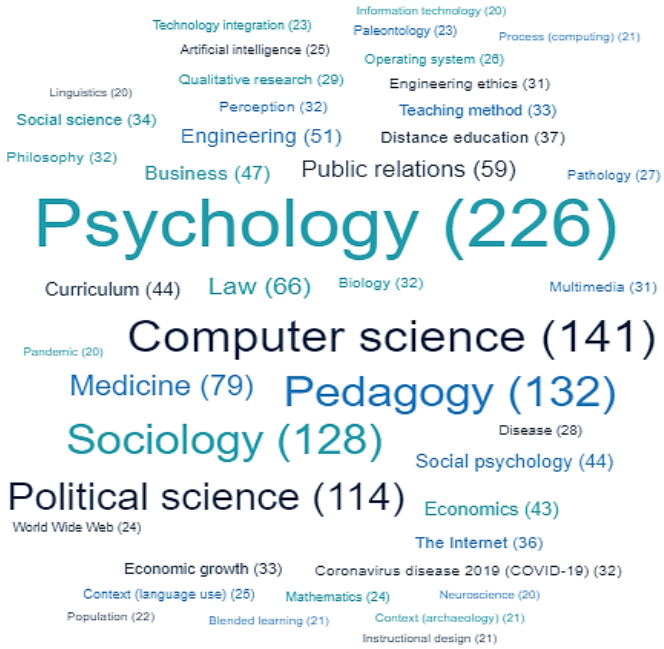

Figure 6: Top fields of study

Figure 7 displays the most active countries that perform studies in the field. Topping the list is the United Kingdom (37 documents); followed by Australia (23); Spain (21); China (15); Italy (14); Canada (11); Malaysia (11); South Africa (11), Turkey (9); Germany (8); and Mexico (8). The rest of the countries published fewer than eight documents. This finding can be interpreted that other countries may still require extensive exploration on integrating and assessing proficiency.

Figure 7: Most active countries

Figure 8 shows the top journals in the field of study. The findings revealed the top 10 journals by number of citations: the Interdisciplinary Journal of e-Skills and Lifelong Learning (47); Education and Information Technologies (42); TechTrends (26); International Journal of Technology and Design Education (14); Education and Information Technologies (13); Nature (13); Minerva (12); Technology, Knowledge and Learning (12); Higher Education Policy (11); and Journal of Computing in Higher Education (11).

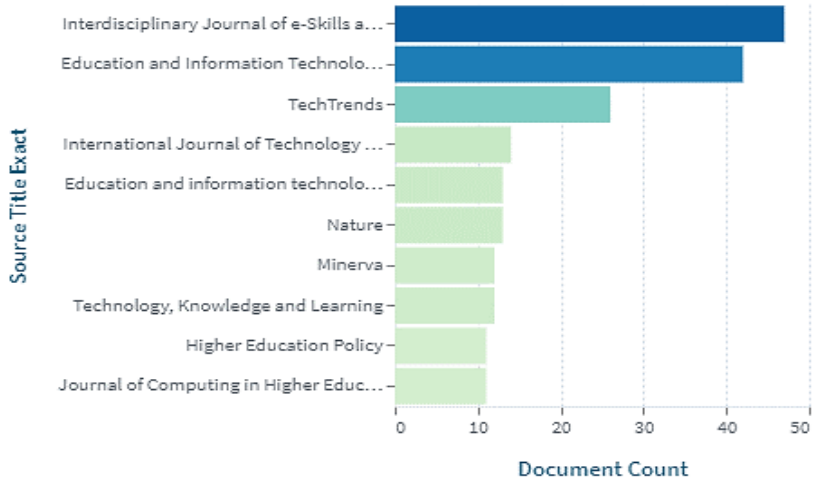

Figure 8: Top journals by number of citations

To determine the co-occurrences of keywords, a total of 831 documents were analyzed using ViosViewer to determine all keywords and their occurrences. The system ran with a minimum number of occurrences of 3, of which 32 keywords met the threshold. 17 of those 32 keywords were removed, especially those that related to the COVID-19 pandemic, to showcase the most relevant keywords to the topic, which resulted in 15 items, 4 clusters, 29 total link strength (TLS) (Table 1, Figure 9).

Table 1: Most used keywords ranked by total link strength

Rank	Keywords/Occurrences	Documents	TLS
1	Universities	6	30
2	Internet	5	21
3	Online Learning	6	17
4	Students, Medical	3	16
5	Technology	7	16
6	e-Learning	5	14
7	Curriculum	4	12
8	Telemedicine	3	12
9	Students	4	11
10	Higher Education	9	8
11	Online Education	3	7
12	Educational Technology	4	4
13	Online Teaching	3	4
14	Digital Technologies	4	3
15	Education	3	1

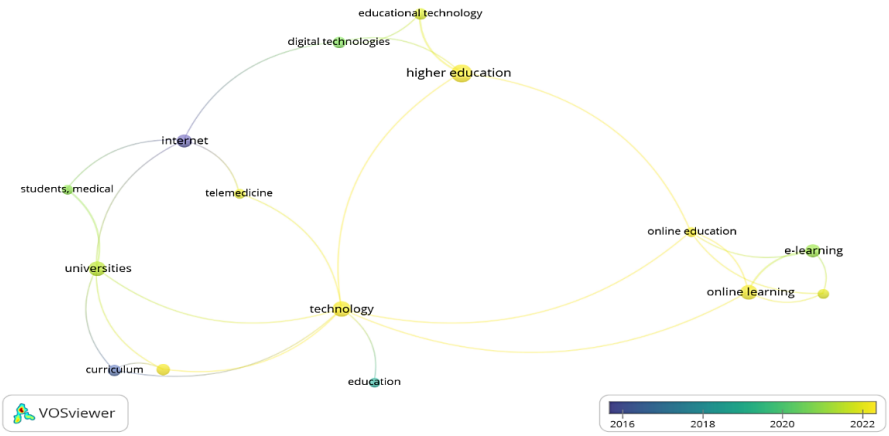

Figure 9: Bibliometric map of keywords and co-occurrences (minimum 3)

Table 2 shows the most cited documents by author (citation and documents). VOSViewer was used to determine the most cited documents, by analyzing 831 documents with a minimum citation number of 1, resulting in 575 documents (Figure 10). The top 10 cited documents are: Klaus E. Meyer (2001) (733 cites); Magnus Klofsten (2000) (529); David H. Jonassem (2000) (436 cites); Vicki J. Rosser (2004) (340 cites); Jessica J. Summers (2005) (326 cites); Doris Schartinger (2001) (295 cites); Liisa Ilomäki (2014) (272 cites); Sumit K. Kundu (2003) (221 cites); Robert I. Dehaan (2005) (214 cites); and Guadalupe Anaya (2000) (198 cites). When comparing this result to Figure 5, it is evident that most of the cited documents do not correspond with Table 2. This discrepancy arises because the significant increase in the number of publications occurred between 2020 and 2023, during which many of these publications had not yet been cited. In contrast, the most referenced papers were primarily from the periods between 2000 and 2014.

Table 2: Most cited documents by author ranked by citations

Rank	Documents by Author	Citations	TLS
1	Klaus E. Meyer (2001)	733	0
2	Magnus Klofsten (2000)	529	0
3	David H. Jonassem (2000)	436	0
4	Vicki J. Rosser (2004)	340	0
5	Jessica J. Summers (2005)	326	0
6	Doris Schartinger (2001)	295	0
7	Liisa Ilomäki (2014)	272	0
8	Sumit K. Kundu (2003)	221	0
9	Robert I. Dehaan (2005)	214	0
10	Guadalupe Anaya (2000)	198	0
11	Mark Freel (2005)	184	0
12	Sarah Witham Bednarz (2004)	180	0
13	Marwa M. Zalat (2021)	177	1
14	Keld Laursen (2001)	172	0
15	Raafat George Saade (2007)	171	2

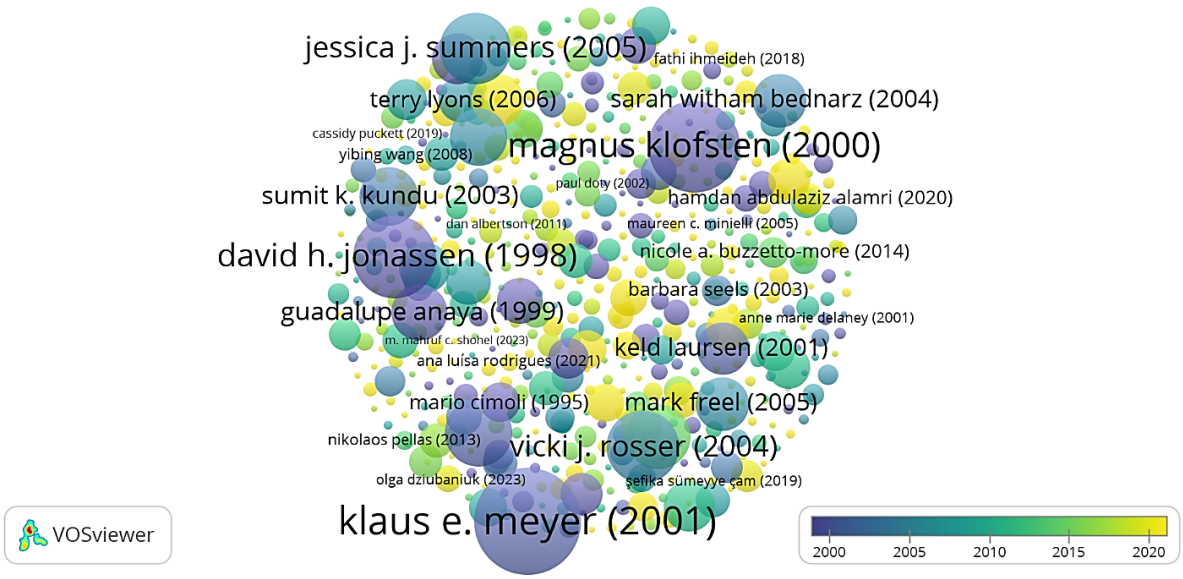

Figure 10: Bibliometric map of citation and documents (minimum 1)

To determine the number of cited sources (Table 3, Figure 11), out of 831 documents, 418 documents were collected with minimum number of documents and citations both set at 1, resulting in the threshold (297). Further processing provided an outcome of 297 items, 276 clusters, and 32 total link strengths. The findings show that the top 10 sources by number of citations are: *Education and Information Technologies* (1059); *Small Business Economics* (973); *Techtrends* (934); *Journal of International Business Studies* (733); R*esearch in Higher Education* (550); *Innovative Higher Education* (377); *Journal of Technology Transfer* (363); *Higher Education* (325); *International Journal of Technology* (325); and *Journal of Leadership Studies* (12).

Table 3: Most cited sources ranked by citations (Top 10)

Rank	Source	Citations	Documents
1	Education and Information Technologies	1059	55
2	Small Business Economics	973	4
3	Techtrends	934	26
4	Journal of International Business Studies	733	1
5	Research in Higher Education	550	4
6	Innovative Higher Education	377	4
7	The Journal of Technology Transfer	363	5
8	Higher Education	325	13
9	International Journal of Technology	325	14
10	Journal of Leadership Studies	12	1

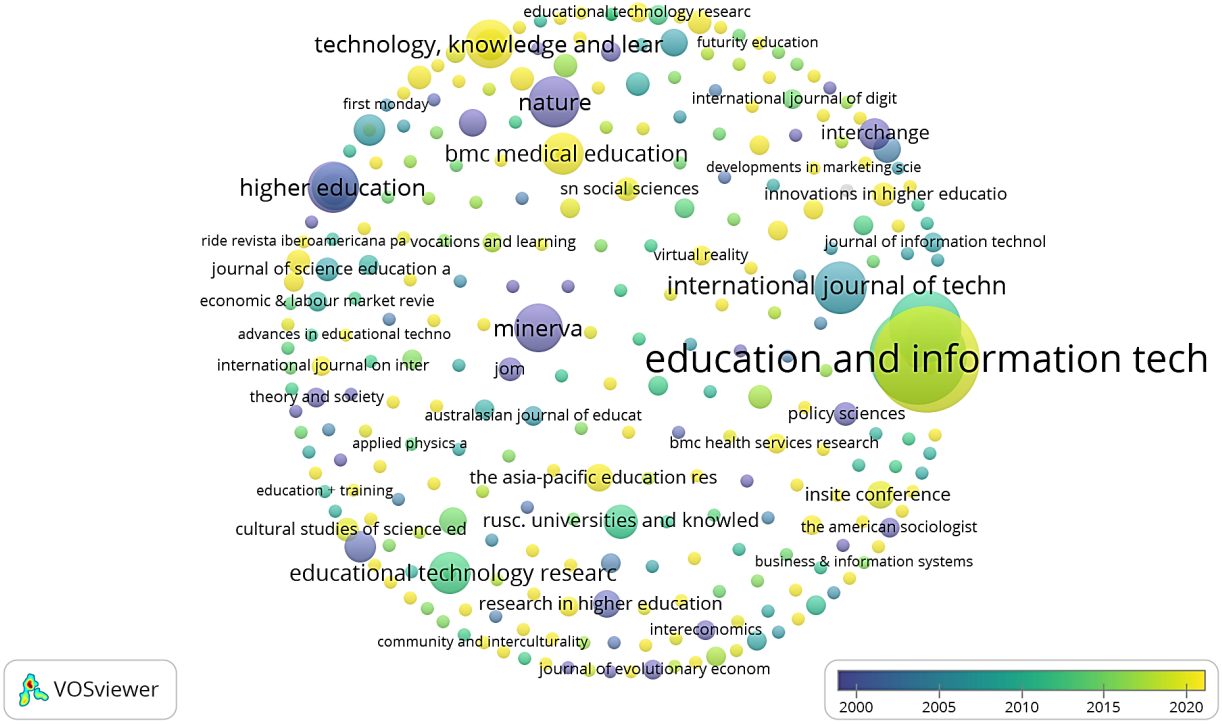

Figure 11: Bibliometric map of citation and sources

4. DISCUSSION AND CONCLUSION

Bibliometric analysis of data was undertaken on 831 publications on technological skills in higher education between 2000–2023, representing 14.25% of the 5,828 total publications focusing on digital technology and higher education. The first part of the analysis was quantitative, to find the results on studies performed over time, publication type, top performing institutions, top researchers, top field of study, most active countries, and top journals in the field. In studies related to the topic performed over the years, 2020–2023 are considered the most productive years of publication, amid the COVID-19 pandemic, which may be linked with the highest use of digital technologies by different entities including HEIs (Figure 2). The main source of publications is from journals, accounting for 85.44% of total publications generated from 2000–2023 (Figure 3), which means that the data collected are reliable and valid. In terms of top institutions' research performance, the highest numbers of publications are shared by institutions in the USA, Australia, Israel, England, and Mexico. These institutions are not in the top 100 in the world ranking but have been proved to excel in the field of digital technologies (Figure 4).

The researchers in the field with the highest number of published documents (2–3) are Antonella Nuzzaci, GJMSR Jayasinghe, KWSN Kumari, Agyei Fosu, Ali Khatibi, Allan Ellis, Ann Marie Delaney, Bruno Bertaccini, Cynthia Harper, and Davy Tsz Kit Ng (Figure 5). Even though these authors held the top rank in terms of the number of published documents, almost none of them are the authors of the most cited publications, which could mean that the published documents have had less influence in the scientific field of study. Additionally, most of these publications were released between 2020 and 2023, while the most cited publications were published from 2000 to 2014. Regarding the top fields of study, it is surprising that most related studies are in the field of psychology, then computer science, pedagogy, sociology, political science, etc. These figures indicate that most articles in the field are published through interdisciplinary categories, rather than specializing in technology and education journals (Figure 6). It can also be seen that countries with a growth of technology and utilization are developed countries such as United Kingdom, Australia, Spain, and China. Figure 7 clearly shows that the ability to demonstrate technological skills is more likely to be found in countries with availability of technologies, compared to countries where the use of technologies is limited.

About the top journals in the field, most studies are published in the technological and education fields, which suggests that education is a field where research is beginning to unfold, especially recently.

Further analysis was performed to determine co-occurrences and keywords, citations per document, and citations per source. It can be inferred from the results of co-occurrences based on TLS that prevailing keywords occurred such as universities, internet, online learning, technology, curriculum, and others. This means that attention towards enhancing the use of technology in higher education became an urgent from the start of the COVID-19 pandemic. It also became a test of technological skills or ways of honing individual skills in the use of technologies. It coincides with the top journals in the field where the focus is technologies and higher education. However, this does not mean that HEIs completely rely on technology and technological skills, considering that on-site teaching is still carried out. Analyzing citation by document, it is noticeable that the top 10 most cited documents were published from 2000–2005, except for one published in 2014. This indicates that high-quality studies were carried out on technology, on its development and use, though the amount of publications is relatively small compared to 2020–2023 (Table 2, Figure 10). However, studies that focused on demonstration and assessment of technological skills in general, and specifically in higher education, are relatively low. This correlates with a recent study (Rodrigues et al., 2021) about the need to use digital technology critically, creatively, and collaboratively to be digitally competent.

Regarding citations and sources, it can be seen that not all the top journals received high citations because of a high quantity of published documents in the field. For example, the *Journal of International Business Studies* garnered fourth rank with 733 citations, despite having only one published article. Hence, regardless of how many papers are published, what is most important is a journal's impact through citations, which holds true with other top journals with 4–5 published documents (Table 3, Figure 11).

In conclusion, the study shows the trend of research on technical proficiency in higher education conducted since 2000, which revealed a small quantity of publications until the time of the COVID-19 pandemic. The conducted studies focus on the use and development of technology, but rarely cover how individuals acquire skills in the use of those technologies. The research gap identified is that very limited studies assess or evaluate the technological skills of users, including in the education sector, while a vast number of studies tackle its use. The utilization of technologies is evident in developed countries and less in third world countries.

4.1 Contribution to policies and practice

For higher institutions of learning, this study provides significant perspectives, trends, patterns, and impact of technological integration in academia by evaluating publications such as articles, books and book chapters, conference publications, and other valuable pieces of work that can add value and information to the higher educations' policies and practices. Firstly, it investigates evolving trends in the use of technologies in the educational context wherein educators and policymakers can identify which technologies fit the demand in academic settings by analyzing the volume of productions and citation patterns. Secondly, the study outcome provides an analysis of identifying which technological tools aligned with learning outcomes can help refine policies on technological use in application to education curriculum and educational practices. Thirdly, the higher institution of learning whether public or private along with government agencies begins to rely on bibliometric data to arrive at well-informed decisions about ensuring whether resources are invested in technologies effectively. Policies can focus on digital literacy, technological infrastructure, and curriculum development. It can provide valuable insights for institutional measures aimed at promoting a more technologically adept academic environment. Thus, this study encourages collaborations with other disciplines in the aspect of educational technology research including but not limited to education, engineering, business education, psychology, and others emphasizing technological proficiency in higher education.

Finally, the contribution of this study is that the results can encourage scholars, academicians, and professionals to focus their attention on studies that assess individual skills in using technology, especially recent technologies such as blockchain and artificial intelligence (AI). The trend of research from 2000–2023 serves as reliable data to consider for further studies related to the field and for references and literature. The findings add value to current studies or topics of interest.

4.2 Limitations and future research directions

This study has its limitations. First, the data was collected from Lens, wherein data is mixed from Scopus, Web of Science, and other sources, which can be a challenge in assuring its reliability. Second, the scope is limited to technological skills, which is just one of many skills that can be assessed in relation to higher education performance. Other valuable skills were not explored such as critical and problem-solving skills, leadership skills, communication skills, and cultural and organizational skills to mention a few. Moreover, in terms of the utilization of bibliometric analysis over other statistical tools, one of the biases using bibliometric analysis as applied in the study is that it is susceptible to self-citation biases as researchers or institutions can repeatedly cite their own publications which can create a mirage of influential bias on research performance.

Bibliometric analysis also emphasized capturing databases for English peer-reviewed papers as primary sources of data which may deprive the utilization of non-English quality papers for analysis inclusion. Sole reliance on bibliometric analysis may not provide a holistic approach to solving research problems, hence there is a need to complement it with qualitative analysis for a more balanced view.

For future research, the results of the study could be expanded to emphasize the integration of AI and blockchain, as prime technological skills to keep abreast of the latest technological development. By focusing on the assessment of an individual's or company's demonstration of technological skills, knowledge acquisition will go together with the development of technology, enabling users to more easily obtain knowledge whenever there is an introduction of a new technology.

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