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The Relationship Between Demographic Factors and Technological Pedagogical Content Knowledge TPACK at Higher Learning Institutions HLI: A Bibliometric Analysis

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Abstract

The current study is a bibliometric analysis of publications on the relationship between demographic factors and technological pedagogical content knowledge TPACK. The purpose of this study is to orient the respective researchers about the contemporary status of research on this topic. This study is based on more than 900 publications between 2013 - 2023 resulting from Scopus database under social sciences and computer sciences. The findings are reported in terms of number of publications across the timeframe, number of publications per journals and authors. Similarly, it reports the cite score of the most cited 10 publications. Finally, the prevailing themes that emerge from the keywords mapping has been reported to provide the current status of research on the topic.

INTRODUCTION

In recent years technology enabled learning has become an essential aspect of education at higher learning institutions across the globe. At the same time, this initiative has been facing a lot of challenges both for educators and students thus, guiding educationists towards frameworks of technology integration. As such, Technological Pedagogical Content Knowledge TPACK has been in the forefront of educators with the interest of technology integration since 2016. As a result, publications in connection to TPACK itself and TPACK with respective other variables have increased dramatically during the last decade (Imran & Mydin, 2023). Therefore, researchers working on this line will benefit from the contemporary trends emerge from the existing research on TPACK. Besides the vast number of publications on TPACK, bibliometric analyses exploring the relationship between demographic factors and TPACK at higher learning context are rare.

The TPACK framework under the umbrella of technology integration appears as one of the most cited and most influential theoretical foundations for technology integration across the literature (M. J. Koehler et al., 2014; M. Koehler & Mishra, 2009; Mishra & Koehler, 2006). More importantly, publications on this model have reached remarkable amounts in most common search engines such as Google, Google Scholar, and Scopus. A typical search on TPACK in Google during February 2024 results in more than 2 million results in less than a second consisting of all forms materials. Furthermore, the search in Google Scholar results in more than 21000 publications from 2006 - 2024 February. A similar search in Scopus results in more than 2000 publications for this time-period.

The TPACK framework represents some of the essential dimensions of knowledge towards technology integration (Mishra & Koehler, 2006). The core of TPACK framework is based on three domains of knowledge

including, Content Knowledge CK, Pedagogical Knowledge PK and Technological Knowledge TC. The combination of these primary knowledge dimensions produces three essential knowledge domains including Pedagogical Content Knowledge PCK, Technological Pedagogical Knowledge TPK and Technological Content Knowledge TCK. Ultimately, the combination of these secondary knowledge dimensions form the Technological Pedagogical Content Knowledge TPACK as illustrated in Figure 1 below.

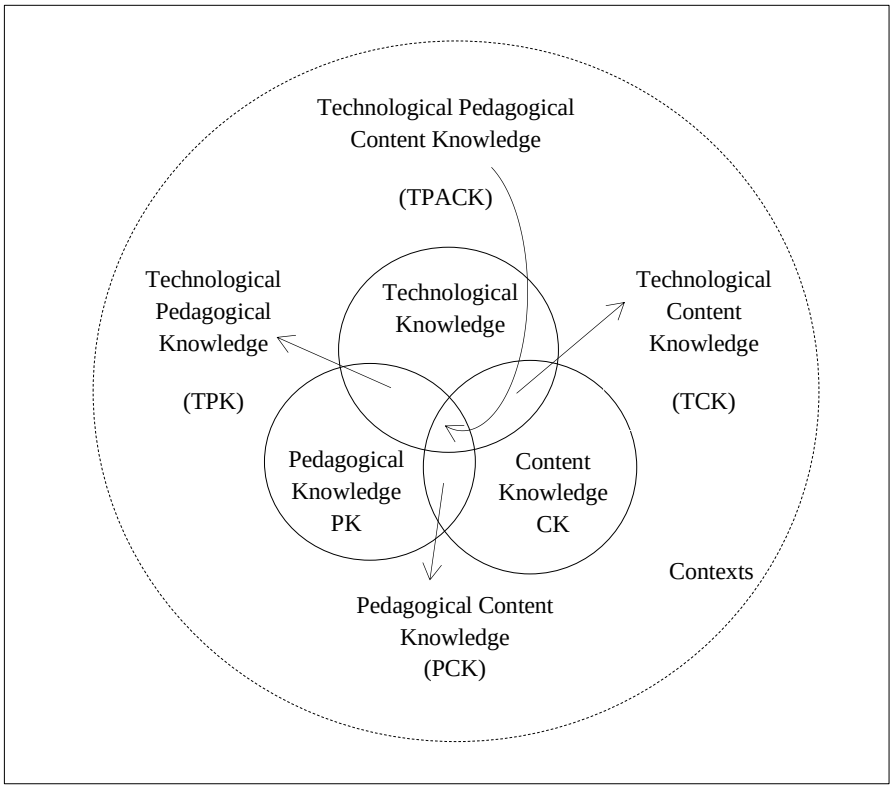


Fig. 1.
Model of TPACK. Adopted from Mishra & Koehler (2006).

Problem Statement

A number of bibliometric analyses concerning TPACK and TPACK in higher education have been conducted during the past couple of years. Google Scholar identifies more than 6000 articles with a basic search on "Bibliometric analysis of TPACK at higher education" as per February 2024. These analyses have accumulated publications exploring TPACK with other variables focusing on different subject areas, regions and focus groups. The few existing bibliometric analysis such as "Research Trend on TPACK through Bibliometric Analysis (2015-2019)" (Suprapto et al., 2021) and Research Trend on Technological Pedagogical Content Knowledge (TPACK) through Bibliometric Analysis (2015 - 2021) (Jinyao & Bhattacharyya, 2022) and Research on Technological Pedagogical and Content Knowledge: A Bibliometric Analysis From 2011 to 2020 (Lee et al., 2022) have partially identified demographic factors in relation to TPACK. According to (Lee et al., 2022) various studies have been conducted to reveal the relationship between TPACK and other demographic factors such as teaching experience, gender, and age. However, bibliometric analysis revealing the recent trends of research exploring the relationship between TPACK and demographic factors at higher educational context are rare.

Research Objectives

The current study is an effort to reveal the contemporary trends and overview of empirical studies on the relationship between demographic factors and TPACK in higher education context. The fundamental purpose is to orient the researchers regarding the significant authors, publications available, useful journals on this topic and most cited publications. At the same time, the scope includes analysing the publication derived from Scopus on this topic for a period of 10 years to determine the themes that emerge from the keywords. Specifically, this analysis concentrates on the publications limited to journal articles, conference papers and reviews under social sciences and computer sciences only. The specific objectives of this research includes:

1) Determine and analyse the overall trend of publications for the past 10 years.
2) Identifying the journals that have the most intense coverage of publications on the relationship between TPACK and demographic factors

3) Acknowledge the leading authors on the topic.
4) Acknowledge significant articles based on the cite score.
5) Discuss the major themes that emerge from analysis.

METHODS

In recent years, bibliometric analysis has garnered significant interest within the research community spanning diverse fields of study (Donthu et al., 2021). In various disciplines, the adoption of bibliometric analysis has experienced significant growth in recent years (Donthu et al., 2021). With the significantly increased numbers of research on diverse disciplines, scholars have deliberated upon and applied the concept of bibliometric analysis since 1950 (Wallin, 2005). According to Donthu et al. (2021), bibliometric analysis proves to be particularly suitable and useful in cases where the review scope is extensive and manual review is more burdensome and time consuming. This method proves useful in identifying prevailing contemporary trends within a particular research domain and facilitating the synthesis of existing research findings as overviews (Bjork et al., 2014; Kreps & Neuhauser, 2013; Rey-Martí et al., 2016). This established procedure is recognised for its capacity to derive significance and track trends from extensive datasets within a designated research area (Donthu et al., 2021; Rey-Martí et al., 2016).

A similar approach of conducting bibliometric analysis is observable across the literature. More importantly, a consistent process is notified in bibliometric publications across various fields, with minimal modifications and variations. The present study employs a methodology similar to several prior bibliometric studies, such as those conducted by (Bonilla et al., 2015; Donthu et al., 2021; Imran & Mydin, 2023; Rasidi et al., 2020). This study considers the process of conducting bibliometric analyses into five main steps, depicted sequentially as illustrated in Figure 2 below. It includes 1) defining the aims and objectives, 2) Choosing the technique, 3) Data collection, 4) administering the analysis, and finally 5) presenting the results and discussion.

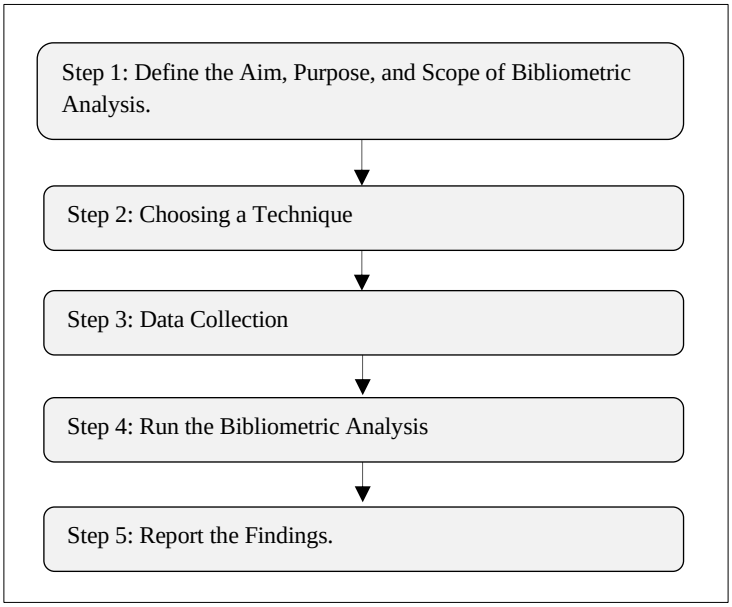


Fig. 2.

Bibliometric Approach as Adapted from (Donthu et al., 2021; Rasidi et al., 2020)

The aim of this study is to provide researchers with bibliometric insights into existing publications regarding the relationship between demographic factors and TPACK. Accordingly, this study aims to address the following research questions.

RQ 1: What is the overarching publication trend over the past decade?
RQ 2: Which journals exhibit the highest concentration of publications concerning the relationship between demographic factors and TPACK?
RQ 3: Who are the predominant authors in this topic?

RQ 4: Which articles have garnered the highest number of citations?
RQ 5: What primary themes emerge from the analysis of keywords?

Bibliometric analysis has been executed using diverse methodologies, which can generally be categorised into two primary methods: i) performance analysis and ii) science mapping (Donthu et al., 2021a). The present study employs performance analysis, which is inherently descriptive in nature. It concentrates on various characteristics including authors, publication counts, affiliations, citations, geographical distribution, and keywords (Imran & Mydin, 2023). Additional aspects of this approach may involve examining metrics such as sole-authored publications, co-authored works, contributing authors, total citations, average citation rates, and citations per publication (Donthu et al., 2021).

Data collection in bibliometric analysis adheres to predefined parameters and inclusion and exclusion criteria established for the study (Wallin, 2005). These parameters steer the researcher toward an appropriate path for collecting data from the vast array of publications. Bibliometric analysis proves more appropriate when the dataset exceeds the capacity for manual review or analysis (Donthu et al., 2021). Hence, for this study, the search has been focused on a list of key parameters, namely timeframe, context, keywords, language, document type, subject area, and database. These indicators are among the typical metrics utilised by researchers, and they facilitate the researcher to achieve objectives of bibliometric analysis (Donthu et al., 2021; Imran & Mydin, 2023; Rasidi et al., 2020; Rey-Martí et al., 2016). More importantly, parameters in bibliometric analysis serve to refine and structure the analysis process, leading to more meaningful and actionable insights from bibliographic data.

Accordingly, several factors are held constant in order to reach the purpose and objectives of this study. As such the scope of this study is limited to specific attributes. Initially, the search has been limited to scientific materials and is strictly limited to documents published exclusively within the Scopus database. Scopus is acknowledged as one of the leading databases in recent times, containing an extensive collection of multidisciplinary scientific materials. Secondly, as a temporal parameter, documents published within a timeframe of 10 years (from 2013 to 2023) were included. Subsequently, the analysis exclusively targeted documents centered on institutions providing higher education, specifically colleges and universities. Lastly, several crucial keywords, namely “TPACK”, "technological knowledge," "pedagogical knowledge," and "content knowledge," "higher education," “demographic factors” have been incorporated. In summary, the following list of criteria is rigorously incorporated into the inclusion criteria.

1) Timeframe:
2) Language:
3) Context:
4) Documentation type:
5) Subject area:
6) Key words:

Incorporating the key words, the following search query has been administered to obtain the data set meeting the inclusion criteria effective for the study. It appears as ("technological AND pedagogical AND content AND knowledge" OR "TPACK" OR technology AND integration OR e-learning) AND (higher AND learning AND institutions OR higher AND education OR university OR college OR lecturers) AND (demography OR demographic OR age OR gender OR teaching experience OR qualification OR male OR female). Significant alterations in the search outcomes were noted throughout the search process as different filters were applied in alignment with the search criteria. As a final sample, nearly 900 articles have been accepted for the analysis. This search procedure was planned and executed in February 2024. The details of the findings are elaborated in the findings and discussion below.

FINDINGS AND DISCUSSIONS

The findings of the study will be presented in two major segments. Initially, presented below are the findings related to the number of publications relative to application of respective inclusive criteria. Several facts about the status of research on the topic have been revealed from the search results. One notable fact is the significant variations to the number of publications with the application of different search parameters such as timeframe, language, and document type. The variation in the search results at various steps are reported sequentially in figure 3 below.

The initial search resulted from keywords without any effective filters reached up to 1617 publications. Secondly, as an inclusion criterion the time frame 2013-2023 has been made effective, reducing the number of articles from 1617 to 1224. Thirdly, the acceptable document types have been limited to journal articles,

conference papers and reviews. The application of this criteria brought a huge difference in the total number of publications from 1224 - 1130 documents. Limiting the documents to English language does not bring much difference (1130 - 1087) in the search results. However, limiting the publications to subject areas “social science” and “computer sciences” brought a notable decline (1087 - 903) in the number of materials meeting the inclusion criteria. It is worth noting that none of the key words have been added to the exclusion criteria. Upon implementing all the mandatory criteria, the number of results is accepted as 903. An overview of the search process is provided in Figure 3 below.

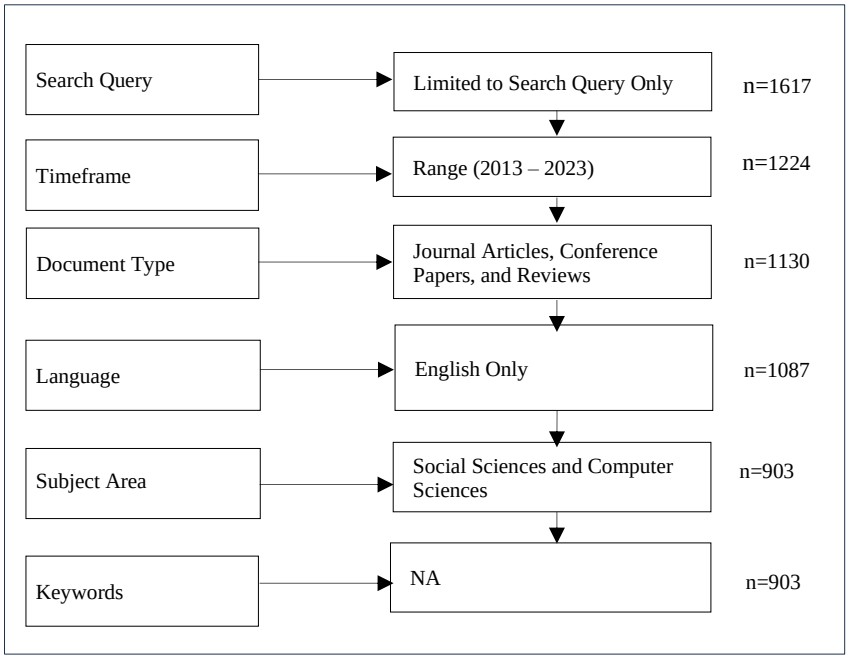


Fig. 3.
Summary of the Search Process

TABLE I
DETAILS OF THE INCLUSION AND EXCLUSION CRITERIA AT VARIOUS STAGES

Stage	Criteria	Details
1	The initial search	Search query only
2	Timeframe	Limited to 2013-2023
3	Document types	Limited to: Articles, Conference papers and Reviews
4	Language	Limited to English
5	Subject area	Limited to Social Sciences and Computer Sciences
6	Key Words	NA

The results of the analysis have been presented under the units of analysis including i) volume of publication, ii) journals, iii) publications per author iv) number of citations for articles, and v) thematic analysis. The following segment provides the details of the findings under each category separately.

1) Volume and trend of publications during 2013 - 2023
2) Journals
3) Number of publications per author and
4) Number of citations for publications
5) Thematic analysis (Keywords)

Volume and Trend of Publications during 2013 - 2023

The findings of the Scopus database regarding the publications on the relationship between demographic factors and TPACK (Technological Pedagogical Content Knowledge) revealed the availability of documents dating back to the early 1990s. Considering the publications all times, an insignificant number of publications has been tracked prior to 2005. The number of publications counted prior to 2005 was 27 and it has increased to 1550 from 2006 to 2023. The total number of publications meeting the inclusion criteria for the set time frame of this study counts to 903. The details of the volume of publications and the trend of publications across the time have been described in Table 2 and figure 4 below.

TABLE 2
TOTAL NUMBER OF PUBLICATIONS FROM 2013 – 2023

#	Year	Number of Publication
1	2023	140
2	2022	127
3	2021	140
4	2020	88
5	2019	83
6	2018	70
7	2017	57
8	2016	51
9	2015	53
10	2014	54
	2013	40
Total		903

As reported in the table 2, a gradual increase in the number of publications on the topic has been reported in the time frame. As outlined in table above, the quantity of publications on the subject has surged, starting from an initial count of 40 publications, which has tripled by the year 2023.Typically, there is an average of 82 publications per year. Significantly, the peak number of publications was documented in 2021 and 2023, reaching 140. This trend is illustrated in in Figure 4 below. A significant surge in the overall number of publications is noticeable between 2021 and 2023. In other words, the number of publications on TPACK has increased drastically in the past decade. In fact, several studies concerning TPACK in connection to demographic factors have been established during the selected timeframe. Some of these studies may include (Erdogan & Sahin, 2010; Hsu & Chen, 2018; Jang & Chang, 2016; Kartal & Afacan, 2017; Koh & Chai, 2011; Lin et al., 2013; Ozudogru & Ozudogru, 2019; Roussinos & Jimoyiannis, 2019).

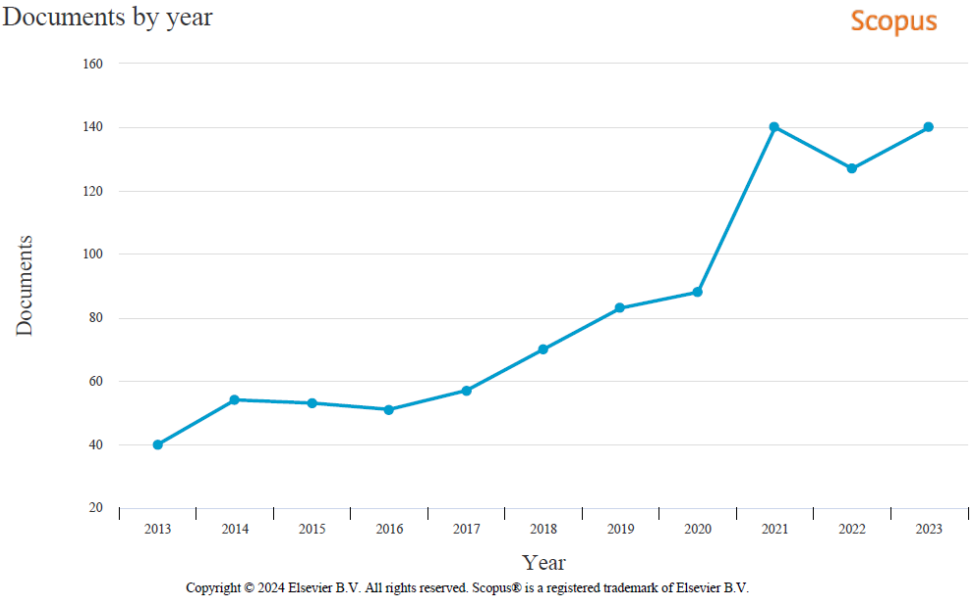


Fig. 4.
Overall Trend of Publications

Journals

The purpose of this study includes informing researchers working on this line of research regarding the most substantial journals with a significant number of articles on this topic. The search conducted in the Scopus database adheres to this criterion and was not restricted to journals. The findings indicated 77 journals encompassing diverse accepted formats of publications regarding the subject matter. For the purpose of reporting, the top 5 most contributing journals have been reported below in Figure 5 and the top 3 journals will be discussed.

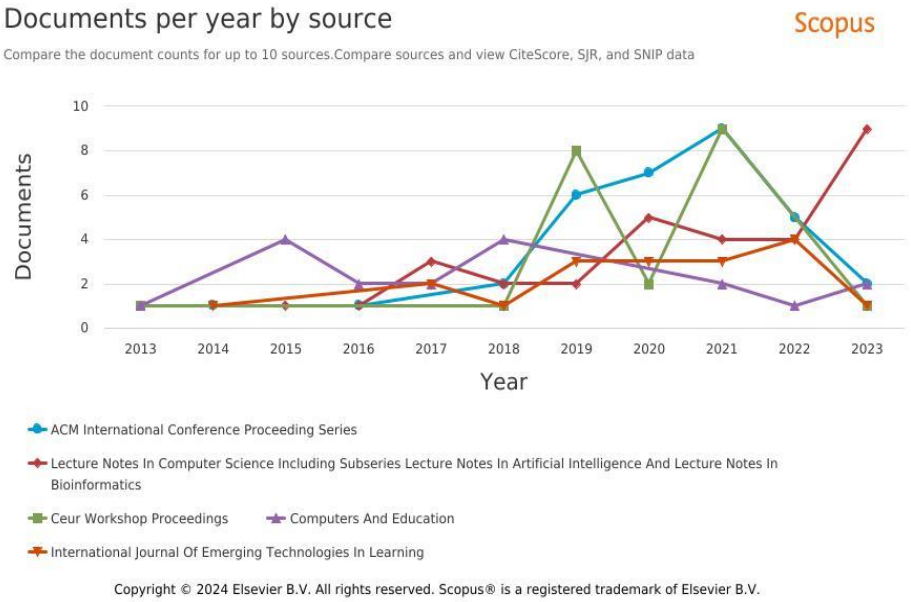


Fig. 5.
Trend of Publications by top 5 Journals

The findings indicate that ACM International Conference Proceeding Series has published the highest number of materials on the topic for the past 10 years. However, its publications have started declining drastically since 2021. The ACM International Conference Proceeding Series is a scholarly journal dedicated to publishing research in the field of Computer Science. It is published by the Association for Computing Machinery (ACM). Secondly, Lecture Notes in Computer Science appear with an equivalent number of publications. Its publications have reported a gradual increase since 2015. Finally, Ceur Workshop Proceedings has a record of 22 scientific manuscripts on the topic. CEUR Workshop Proceedings is hosted by Sun SITE Central Europe and administered by RWTH Aachen University.

Number of Publications by Author

One of the research questions of this study involves determining the leading authors on the topic. As previously noted, the aggregate quantity of publications reflects a researcher's productivity and impact within a particular research domain (Bonilla et al., 2015). One observation is that considering the 903 documents obtained, a total of 160 authors are recorded. Considering the number of manuscripts Wu, Weilong, Xiamen University of Technology, Xiamen (China) has reported as the most significant author. Secondly, Charbonneau-Gowdy, Paula A, Universidad Andrés Bello, Santiago (Chile) has published the second highest number of manuscripts on the topic after Wu, Weilong. The rest of the authors have manuscripts from 1-3. Figure 6 below illustrates the number of manuscripts as per the top 10 authors.

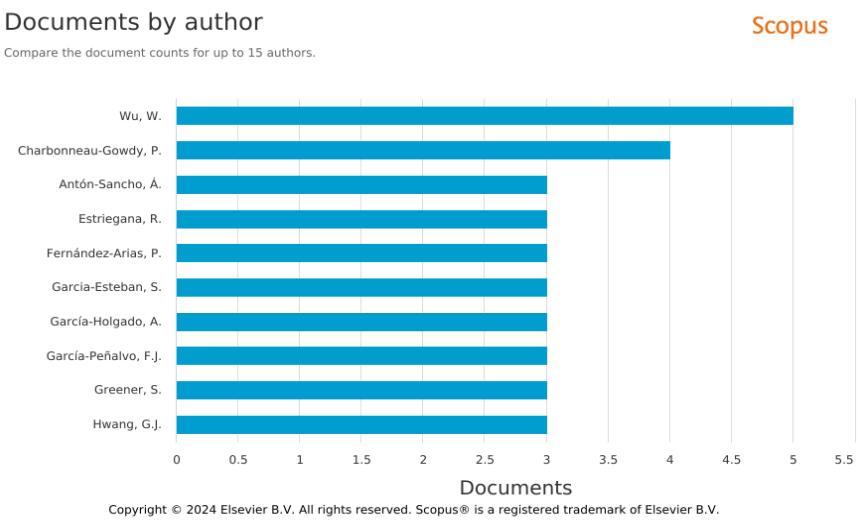


Fig. 6.
Publication Trend by Top 10 Authors

Number of Citations

An essential measure of the value and influence of academic research is the accumulation of citations over a period of time. The quantity of citations illustrates the impact of researchers within the academic realm (Bonilla et al., 2015). In order to guide researchers on this aspect of the research topic, one of the research questions of this study aimed to analyse the citation scores of obtained by the articles. The key observations of the cite score analysis are described below. Initially, the number of citations of the publications on the topic has increased drastically from 2013 - 2023 as illustrated in figure 7 below. As illustrated below the highest number of citations are recorded in 2023.

Considering the citations obtained for individual articles a notable finding is observed. For the 903 publications meeting the inclusion criteria a total of 10882 citations were recorded. On average this is 12 citations per article. In order to report the findings, the list of articles is sorted as per citation count (descending) and the top 10 articles with the highest number of citations are reported in table 3 below. The article with the highest number of citations for this period is titled “Investigating attitudes towards the use of mobile learning in higher education” with 371 citations by Al-Emran, Mostafa, Elsherif, Hatem M., Elsherif H.M.. Shaalan, Khaled (2016). This article has got 371 Citations in Scopus during the past 07 years. The article receives notably high citation counts in other databases as well. As such, in Google Scholar this article is cited 866 times as of March 2024. The cite score for the remaining articles are included in Table 3 below.

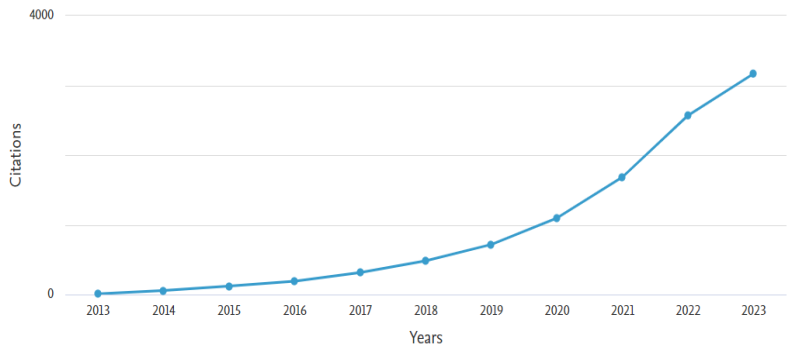


Fig. 7.
Total Number of Citations across the Publications

TABLE 3
NUMBER OF CITATIONS FOR TOP 15 ARTICLES

#	Title	Authors	Year	Cite Score
1	Investigating attitudes towards the use of mobile learning in higher education	Al-Emran M., Elsherif H.M., Shaalan K.	2016	371
2	Distance learning in clinical medical education amid COVID-19 pandemic in Jordan: Current situation, challenges, and perspectives	Al-Balas M., Al-Balas H.I., Jaber H.M., Obeidat K., Al-Balas H., Aborajooh E.A., Al-Taher R., Al-Balas B.	2020	343
3	Personalising learning: Exploring student and teacher perceptions about flexible learning and assessment in a flipped university course	Wanner T., Palmer E.	2015	282
4	From MOOCs to SPOCs	Fox A.	2013	270
5	Comparative analysis of Student's live online learning readiness during the coronavirus (COVID-19) pandemic in the higher education sector	Tang Y.M., Chen P.C., Law K.M.Y., Wu C.H., Lau Y.-Y., Guan J., He D., Ho G.T.S.	2021	241
6	Profiling teachers' readiness for online teaching and learning in higher education: Who's ready?	Scherer R., Howard S.K., Tondeur J., Siddiq F.	2021	228
7	Mobile instant messaging support for teaching and learning in higher education	So S.	2016	192
8	Measuring the moderating effect of gender and age on E-learning acceptance in England: A structural equation modeling approach for an extended Technology Acceptance Model	Tarhini A., Hone K., Liu X.	2014	184
9	Virtual and augmented reality effects on K-12, higher and tertiary education students' twenty-first century skills	Papanastasiou G., Drigas A., Skianis C., Lytras M., Papanastasiou E.	2019	159
10	A multilevel analysis of what matters in the training of pre-service teacher's ICT competencies	Tondeur J., Aesaert K., Prestridge S., Consuegra E.	2018	156
Total				10882

Thematic Analysis of Keywords

Examining the significant keywords and determining their connections can assist in identifying the overarching trends in research over a given period. Examining the keywords' trends within a research topic can offer valuable guidance for subsequent research endeavors (WeiYou & Xiang, 2020). Furthermore, bibliometric keyword mapping can provide insight into the scientific research landscape within a specific research area. Similarly, keywords play a pivotal role for researchers in bibliometrics by revealing emerging themes and networks (Donthu et al., 2021). Crucially, amidst the extensive body of literature, the visualisation of broader themes emerging can be understood through the implementation of keyword mapping approaches.

As part of this study, it aims to ascertain the general research trend regarding the topic by analysing keywords. To grasp the co-occurrence rate of keywords, their connections, and, importantly, to discern the overall trend, various maps are constructed using bibliographic data. As such the results are described using three sources of data including keywords' clusters, co-occurrence, and prevailing networks or links. In order to report the findings three types of illustrations have been generated, encompassing network visualisation, overlay visualisation, and density visualisation.

In keyword mapping, VOSviewer identifies clusters based on keywords by considering factors such as the number of co-occurrences, total links, and link strength as well. As per the keyword analysis, a number of themes and their networks are observed. As such most evident themes include i) higher education, ii) e-learning, iii) online learning, iv) blended learning, v) covid 19 and finally, vi) educational technology. To provide a better picture the most dominant 5 themes are highlighted here. Table below 4 and Figure 8 provides the details of main clusters,

co-occurrence of key words and link strength score as well. It is worth noting that each of these themes have strong connections with each other as illustrated in figure 9.

TABLE 4
MAIN CLUSTERS AND CO-OCCURRENCE RATE

#	Keywords	Occurrences	Links	Link Strength
1	Higher Education	205	94	37
2	E-Learning	156	79	252
3	Online Learning	62	52	117
4	Blended Learning	60	51	108
5	Covid 19	63	48	150
6	Educational Technology	35	38	69

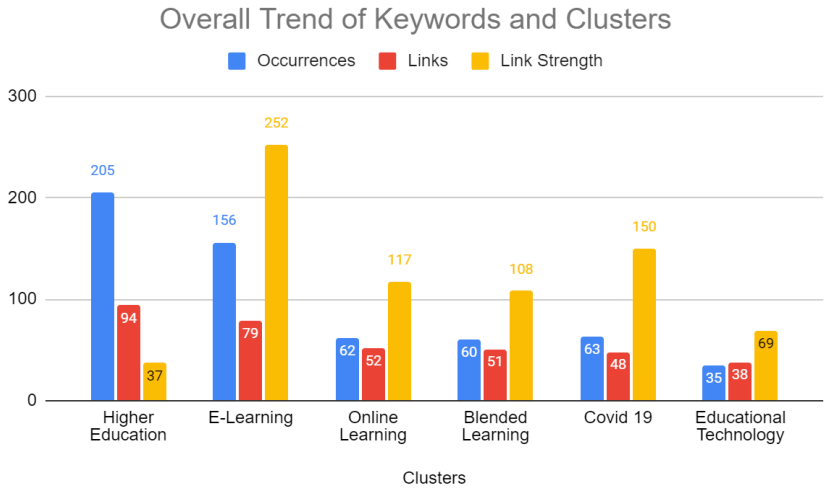


Fig. 8.
Overall Trend and Major Themes

The first and leading theme is “higher education” and is also the most frequently occurring author keyword as well. It has recorded 205 co-occurrences, 94 links to other keywords of this study and a link strength of 37. It has strong connections with other key variables such as e-learning, online learning, educational technology, and blended learning as well as illustrated in figure 9 below. The second most obvious theme is e-learning with 156 co-occurrences and 79 links to other clusters. It is worth noting that this culster’s link strength is much higher (252) compared to the first cluster. Finally, “online learning” is recorded as the third prominent cluster. The density visualisation and overlay visualisation is illustrated in figure 9 - 11 below.

Next, online learning, blended learning, covid 19 have been observed as the next three themes. These three themes have obtained an equivalent sum of co-occurrences 60-63 and an equivalent number of links (48-52). However, the link strength is much higher for covid 19 compared to the other two clusters as illustrated in Figure 8. One of the reasons is that most teaching and learning activities at higher learning institutions during covid 19 were executed with the help of technology and the same trend has been in practice even after the pandemic. Several research have been conducted on the nature of teaching and learning at higher education during covid 19 and these studies have been cited by other researchers at a remarkable rate as well. For instance, Imran and Mydin, (2023) conducted a bibliometric analysis on the influence of professional learning community (PLC) on TPACK at higher learning institutions HLI. This study found that the article titled as Online University Teaching During and After the Covid-19 Crisis: Refocusing Teacher Presence and Learning Activity as the most cited among the 1201 articles.

Fig. 9.
Overall Trend and Major Themes

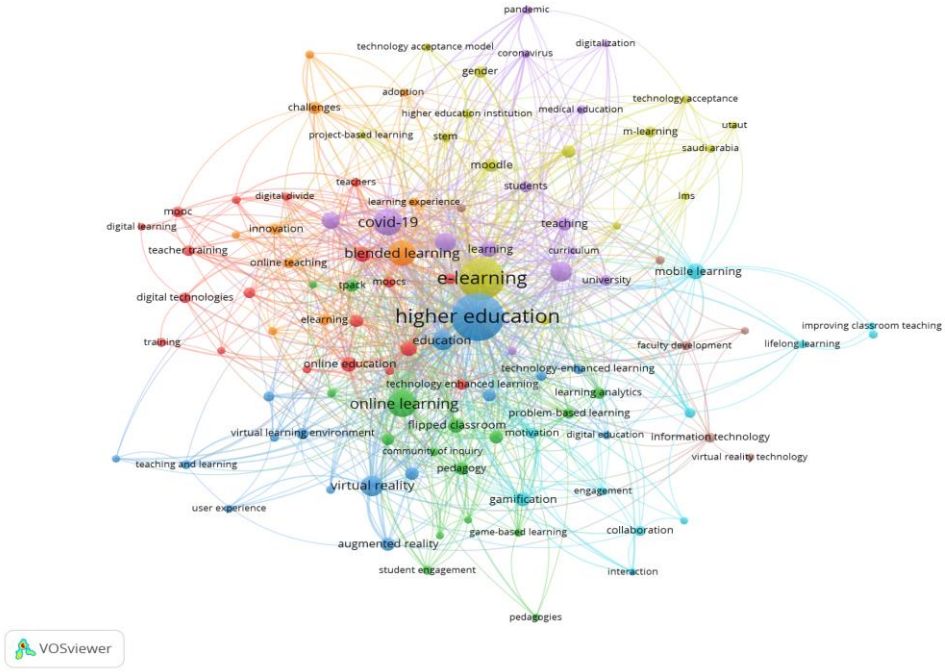


Fig. 10.
Density Visualisation

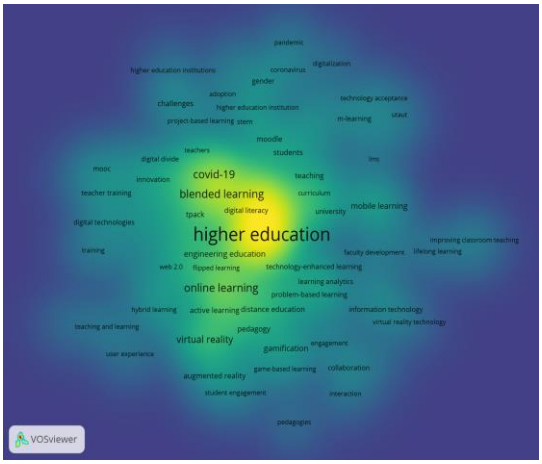
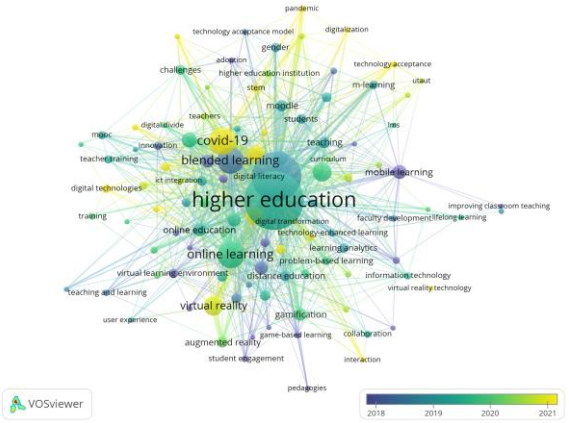


Fig. 11.
Overlay Visualisation



SUMMARY

Using bibliometric data, this study has endeavored to identify the overarching trend and prominent themes arising from research on the relationship between demographic factors and TPACK at higher learning institutions. To achieve this goal, it has examined over 903 documents retrieved from the Scopus database during February 2024, consisting solely of journal articles, conference papers, and reviews. It focused exclusively on documents published between 2013 and 2023. A general observation indicates that the amount of research on the topic has shown a general upward trend over the past decade. A few notable facts are worth noting here. Initially, when considering journals that publish scientific articles on this topic, ACM International Conference Proceeding Series stands out as the most significant journal chosen for further study on the topic. Regarding the authors' contributions to the topic, Wu, Weilong and Charbonneau-Gowdy, Paula A have been recognized as the central authors in this area. Furthermore, among the available documents, "Investigating attitudes towards the use of mobile learning in

higher education" from the journal Computers in Human Behavior by Al-Emran M and Elsherif H.M Shaalan K published in 2016 has emerged as the most frequently cited article throughout the specified timeframe. Finally, through keyword mapping, several themes have been identified from the clusters of keywords that emerge. The primary and the predominant theme is "higher education," which also happens to be the most commonly appearing keyword as well. Other dominant clusters include e-learning, blended learning, and online learning as well. In conclusion, this article has brought into surface the summary of most prominent authors, journals, articles, citations scores and the themes that emerge from the list of selected publications.

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