Bibliometric Analysis of Technological Pedagogical Content Knowledge Framework in English Language Teaching (TPACK-ELT)[1]

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Abstract

The Technological Pedagogical Content Knowledge Framework in English Language Teaching (TPACK-ELT) has gained significant attention in educational research. This theoretical model explores the intricate interplay between technology, pedagogy, and content knowledge in language education. As technology continues to play a crucial role in teaching and learning, understanding the progress and impact of TPACK-ELT research has become increasingly important. Therefore, this study presents a comprehensive bibliometric analysis of TPACK-ELT journal articles published between 2006 and 2021. The analysis aims to uncover annual publication trends, identify influential authors and institutions, examine the contributions of different countries, highlight prominent TPACK-ELT journal publishers, identify highly cited articles and prevalent keywords, and identify emerging topic trends in TPACK-ELT research. Applying a descriptive quantitative approach and data from the Scopus database, bibliometric analysis was conducted using *Biblioshiny* and *VOSviewer*. The findings indicate a consistent increase in TPACK-ELT article productivity over time. Asia emerges as a dominant region, excelling in various categories including author productivity, institutional contributions, and citation impact. However, disparities exist in terms of the most impactful authors and cited countries. Co-authorship mapping reveals potential influences on authors' productivity and impact. Furthermore, the selected articles demonstrate alignment between keywords and the targeted journal aims and scopes. Co-occurrence analysis of keywords provides insights into potential topic trends for future studies. Overall, this research emphasizes the need to enhance research productivity in the field of TPACK-ELT, thereby advancing the understanding and application of this framework in English language teaching.

Resumen

El Marco de Conocimiento del Contenido Pedagógico Tecnológico en la Enseñanza del Idioma Inglés (TPACK-ELT) ha ganado una atención significativa en la investigación educativa. Este modelo teórico explora la intrincada interacción entre la tecnología, la pedagogía y el conocimiento del contenido en la enseñanza de idiomas. A medida que la tecnología sigue desempeñando un papel crucial en la enseñanza y el aprendizaje, comprender el progreso y el impacto de la investigación TPACK-ELT se ha vuelto cada vez más importante. Por lo tanto, este estudio presenta un análisis bibliométrico integral de los artículos de revistas TPACK-ELT publicados entre 2006 y 2021. El análisis tiene como objetivo descubrir las tendencias de publicación anuales, identificar autores e instituciones influyentes, examinar las contribuciones de diferentes países, destacar a los editores destacados de revistas TPACK-ELT, identificar artículos altamente citados y palabras clave predominantes e identificar tendencias temáticas emergentes en la investigación TPACK-ELT. Aplicando un enfoque cuantitativo descriptivo y datos de la base de datos Scopus, se realizó un análisis bibliométrico utilizando *Biblioshiny* y *VOSviewer*. Los hallazgos indican un aumento constante en la productividad de los artículos TPACK-ELT a lo largo del tiempo. Asia emerge como una región dominante, sobresaliendo en varias categorías, incluyendo productividad de autores, contribuciones institucionales e impacto de citas. Sin embargo, existen disparidades en términos de los autores más impactantes y los países citados. El mapeo de coautoría revela influencias potenciales en la productividad y el impacto de los autores. Además, los artículos seleccionados demuestran la alineación entre las palabras clave y los objetivos y alcances de la revista objetivo. El análisis de co-ocurrencia de palabras clave proporciona información sobre posibles tendencias temáticas para estudios futuros. En general, esta investigación enfatiza la necesidad de mejorar la productividad de la investigación en el campo de TPACK-ELT, avanzando así en la comprensión y aplicación de este marco en la enseñanza del idioma inglés.

Introduction

The Technological Pedagogical Content Knowledge (TPACK) framework, firstly proposed by Mishra and Koehler (2006), an extension of the Pedagogical Content Knowledge (PCK) proposed by Shulman (1986), incorporates technology to address the growing need to equip students with 21st-century skills, including digital literacy. As information and communication technology continues to develop rapidly, there is an increasing demand to integrate technology into teaching practices. Voogt et al. (2009) emphasize that technology can play a pivotal role in facilitating effective teaching and learning by creating interactive and engaging educational experiences. Similarly, Koehler et al. (2013) define TPACK as a conceptual framework that requires teachers to have a comprehensive understanding of the content, pedagogy, and technology and integrate them synergistically to create effective instruction. Building upon these concepts, Willermark (2018) underscores the importance of fostering strong interactions among technology, pedagogy, and content knowledge to promote meaningful learning experiences in the digital era. By employing the TPACK

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framework, teachers can successfully integrate technology into their instructional practices and enhance the quality of education.

The TPACK framework consists three primary components: technology knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). According to Irwanto (2021), TK refers to technology used for effective teaching, PK is about teachers' ability to manage teaching and learning, including choosing suitable teaching methods, and CK is teachers' understanding of the subject matter. These three major components intersect and give rise to additional components of TPACK: technological content knowledge (TCK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), and technological pedagogical content knowledge (TPACK). TCK refers to how teachers use technology to represent learning content, for example, the teacher uses English movies to train students' skills to listen to English vocabulary (Metruk, 2019). PCK focuses on the effective delivery of subject matter through pedagogical reasoning. Teachers utilize various instructional strategies, such as concept mapping or case studies, to facilitate students' comprehension and critical thinking. TPK emphasizes the use of technology to communicate with students and foster active engagement during instruction. Teachers employ tools like interactive presentations or online collaborative platforms to promote interaction, provide feedback, and enhance students' participation. Finally, TPACK encompasses how teachers leverage technology to support student learning, making subjects more accessible and facilitating resource exploration and scientific investigations. It emphasizes the integration of technology, pedagogy, and content knowledge to create effective teaching and learning experiences in the digital age.

The TPACK framework has been extensively utilized in English language teaching across various educational levels for several years. In high school level, Prasetya et al. (2019) state that teachers in senior high schools in Buleleng Sub District exhibited positive perceptions of using the TPACK framework in teaching English, as reflected by a high mean score of 139.074. Aisyah et al. (2021) conducted a study demonstrating the implementation of TPACK in the EFL context through the use of *Telegram* in the teaching-learning process. An English teacher in a vocational high school transitioned from instant and commercial online learning platforms to a self-designed *Telegram* Bot application for English teaching purposes. Then, in university level, Ammade et al. (2020) reveal that the literacy levels of lecturers at Muhammadiyah University Pare-Pare, Indonesia, in terms of TPACK, are moderate, indicating the need for further improvement through additional practice or learning workshops. Drajati et al. (2021) explain that integrating the TPACK-21CL framework into the English subject lesson plans positively impacted English pre-service teachers in terms of solving problems and learning outcomes. The extensive research on TPACK in the ELT context has established it as an intriguing and important field of study.

Literature studies on the TPACK framework have gained attention in recent years. Willermark (2018) conducted a systematic literature review of 107 documents retrieved from the SSCI database, covering the period from 2011-2016. The study analyzed a variety of approaches and instruments to investigate teacher TPACK. Similarly, Rodríguez Moreno et al. (2019) conducted a systematic review of 37 papers retrieved from the Web of Science and Scopus databases between 2005 and 2013, focusing on publications related to TPACK. Their analysis encompassed aspects such as publication venues, topics, primary results, and methodological designs. Recently, Soler-Costa et al. (2021) conducted a bibliometric review of 471 articles retrieved from the Web of Science database, spanning the years 2006 to 2019. Their investigation aimed to explore the significance and evolution of the TPACK concept. Irwanto (2021) conducted a literature review of 106 research articles retrieved from the Springer database, covering the period from 2010 to 2021. This review provided insights into prior literature and identified potential directions for future TPACK research. Notably, the existing literature did not specifically focus on TPACK in the context of English Language Teaching (ELT), which is the specific focus of the present study.

Understanding research trends and potential directions in the field of TPACK-ELT is valuable for researchers and educators seeking to stay informed about the developments in this area and plan future investigations. However, to the best of our knowledge, no comprehensive bibliometric study has been conducted to comprehensively examine TPACK in the context of English Language Teaching (ELT) throughout its entire history, from its initial introduction until 2021. Therefore, the primary aim of this study is to analyze recent advancements and provide an extensive overview of TPACK-ELT research conducted between 2006 and 2021. To achieve this objective, we performed data mining from the Scopus database, a globally recognized indexer that houses a vast number of scientific journals from various disciplines, including ELT. By undertaking this study, we aim to offer a comprehensive view of TPACK-ELT, assisting researchers and

educators in conducting further research and publishing in this field. Accordingly, the research questions addressed in this study are as follows:

For the period from 2006-2021 related to TPACK-ELT articles…

1. what are the annual publications trends ?
2. who were the most prolific authors ?
3. who were the most cited authors?
4. who were the most impactful authors?
5. which were the most productive institutions?
6. which countries contributed the most?
7. which were the most cited countries?
8. which academic journals published papers more frequently?
9. which were the top-cited articles?
10. which were the top-used keywords?
11. what were the prevailing topic trends?

Methodology

Approach and type of research

The present study employed a descriptive quantitative analysis and employed the bibliometric method to analyze the journal articles discussing TPACK-ELT from 2006 (the year of TPACK's introduction) until 2021. The bibliometric method was chosen due to its reliability in analyzing citations, text, and data mining (White & McCain, 1998; Nerur et al., 2008).

Data collection

Two criteria elicited the data for the present research: the specified keywords and the time period. The keywords inserted into the Scopus (https://www.scopus.com) database search engine were related to TPACK and ELT. The period to limit the discussion was from 2006 until 2021. The process of data mining from the Scopus database followed the following instruction: TITLE-ABS-KEY=(("TPACK" OR "TPCK" OR "PCK" OR "TCK", "TPK" OR "technology pedagogy and content knowledge" OR "technological pedagogy and content knowledge" OR "technology pedagogy content knowledge" OR "Technological pedagogical content knowledge" OR "Pedagogical Content Knowledge" OR "Technological Content Knowledge" OR "Technological Pedagogical Knowledge") AND ("English as a foreign language" OR "English as a second language" OR "English as an additional language" OR "English as a lingua franca" OR "English as an international language" OR "English as a global language" OR "teaching English as a foreign language" OR "teaching English as a second language" OR "teaching of English to speakers of other languages" OR "English language teaching" OR "English teaching" OR "teaching English" OR "English language learning" OR "English learning" OR "English education" OR "English language education" OR "teaching English as" OR "learning English as" OR "English language instruction" OR "English instruction")). Subsequently, the researcher obtained a CSV as the raw data for the analysis process. The general information of the downloaded data from the database is presented in Table 1.

	Description	Results
Main Information About the Data	Timespan	2006:2021
	Documents	75
	Average years from publication	3.71
	Average citations per document	9.36
	Average citations per year per doc	1.668
	References	3509
Document Types	Article	75
Document Contents	Keywords Plus (ID)	64
	Author's Keywords (DE)	246
	Authors	
	Authors	157
	Author Appearances	170
	Authors of single-authored documents	22
	Authors of multi-authored documents	135
Authors Collaboration	Single-authored documents	23
	Documents per Author	0.478
	Authors per Document	2.09
	Co-Authors per Documents	2.27
	Collaboration Index	2.6

Table 1: Description of the collected data

Data analysis

For data analysis, the raw data were imported into two bibliometric software tools: *Biblioshiny* and *VOSviewer. Biblioshiny* was used to analyze data pertaining to TPACK-ELT. The following aspects were examined: the annual publication, the most prolific authors, the most cited authors, the most impacting authors, the most productive institutions, the most productive countries, the most cited countries, the journals that published related topic articles, and the top-used authors' keywords. On the other hand, *VOSviewer* was used to analyze data related to the top-cited article co-citation network, co-authorships, co-occurrence of the keywords, and topic trends.

Findings

The present research aimed to analyze the journal articles which discuss TPACK-ELT from 2006 (the year of TPACK's introduction) until 2021, the detailed objectives correspond to the mentioned research problems. Consequently, the present research findings are displayed according to the order of the research questions.

Annual publication trends

To address the first research question, which pertains to the annual publication trends, the raw data were imported into *Biblioshiny*. The data were processed, and the analysis result is presented in Figure 1.

Figure 1: The annual publication of TPACK-ELT articles in journals

Figure 1 shows a noticeable increasing trend. From the Figure, there were only two publications related to TPACK-ELT in 2006 and one in 2007, showing zero publications in the Scopus database from 2008 to 2010. An increasing number of publications appeared from 2010 to 2021. The highest number of TPACK-ELT journal articles was 14 in 2021 The second-highest was observed in 2019, totaling ten publications. The detailed distribution of journal article publication numbers is presented in Figure 1.

Most prolific authors

Addressing the second research question, the present study seeks the most prolific authors. The result of the journal articles analysis through *Biblioshiny* shows that the most prolific authors were Hashim, H. with three publications, followed by D. A. L. Bharati (2 articles), C.-W. Chien (2 articles), L. Hsu, (2 articles), W. M. Jones (2 articles), J. Konig (2 articles), S. Lammerding (2 articles), G. Nold (2 articles), A. Rohde (2 articles), S. Straub (2 articles), S. Tachtsoglou (2 articles), and Y.-T. Wu (2 articles) as shown in Figure 2.

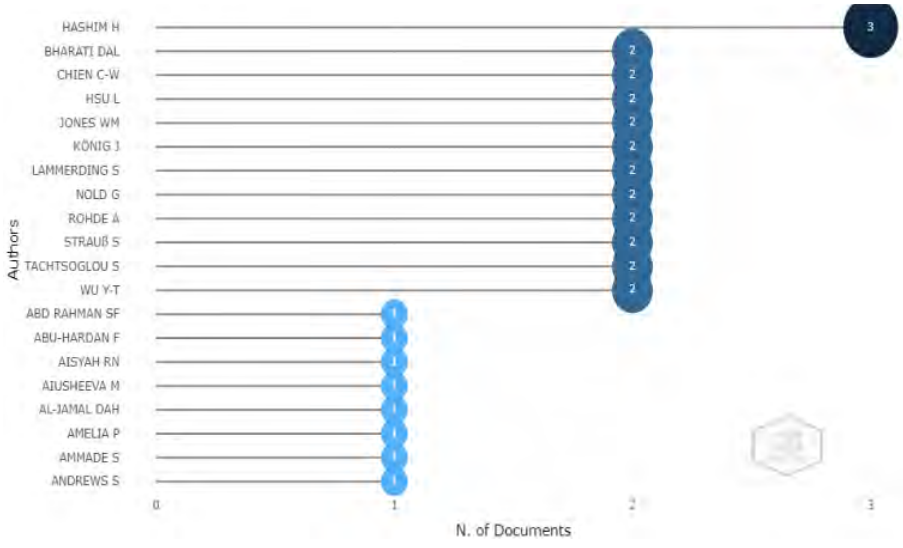

Figure 2: The most prolific authors of TPACK-ELT during 2006-2021

The rest of the authors published only one article in the TPACK-ELT area in Scopus. According to the data presented in Figure 2, the author's interest in producing a journal article on the same topic or research area could have been higher. Most authors in Figure 2 published only one or two articles during this long time span (2006-2021) and only H. Hashim produced more.

Most cited authors

Moving on to the third research questions, the analysis using *Biblioshiny* reveals that the most cited authors were H. Hisham and L. Wah with nine citations. D. L. Banegas had the second-highest number of citations. The complete data of the most cited authors are presented in Figure 3.

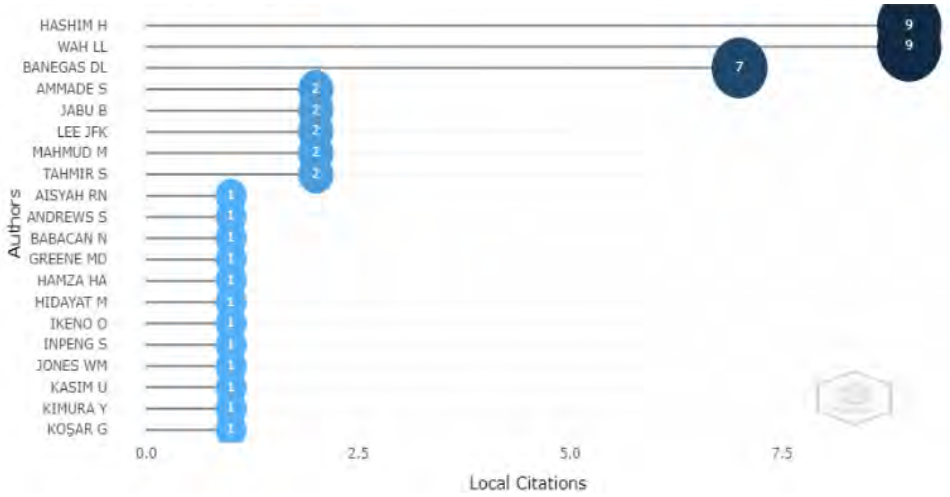

Figure 3: The most cited authors of TPACK-ELT during 2006-2021

Author with most impact

The fourth research problem focused on identifying the authors with most impact. The analysis of influential authors in the present study was based on the H-Index score. H-index is a standard scholarly metric in which the number of published articles and the number of times their author is cited is put into relation (Masic, 2016). Scopus considers H-Index score to measure the impact of the authors' publications among readers (Elsevier Author Services, 2021). The analysis was conducted using *Biblioshiny*, which calculated the H-index scores based on raw data imported from Scopus. This approach objectively quantified each author's impact in the field of TPACK-ELT research and provided insights into their scholarly influence. The results are presented in Figure 4.

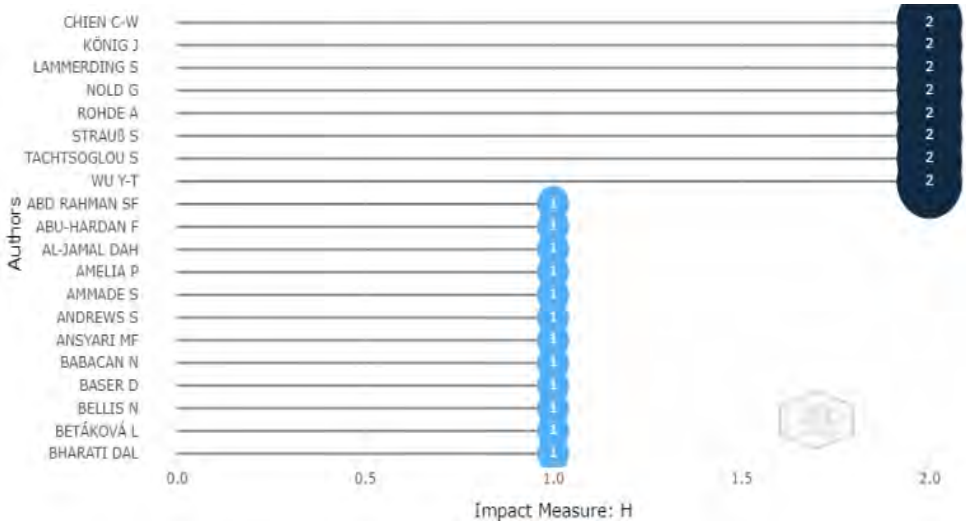

Figure 4: Authors with the most impact in TPACK-ELT publications.

According to Figure 4, the order of names is not similar to the list of the most prolific and most cited authors of TPACK-ELT publications during 2006-2021. H. Hashimis not the highest in author local impact by H-index figure. C.-W.Chien, J. Konig, S. Lammerding, G. Nold, S. Rohde, S. Straub, S. Tachtsoglou, and Y.-T. Wu. with 2 H-index become the authors with most impact. However, not all of them cooperated to produce articles, as shown in Figure 5.

Figure 5: The co-authorships in TPACK-ELT publications during 2006-2021

This figure highlights the co-authorship strings in TPACK-ELT publications. The string connections show that only six authors had collaborations as authors in similar TPACK-ELT research articles. H. Hashim, who was noted as the most prolific and cited author, published alone. Similarly, C.-W. Chien and Wu, Y.-T. did not have co-authorship strings.

Most productive institutions

The fifth research question investigated the most productive. Data arising from the analysis using *Biblioshiny* is displayed in Figure 6.

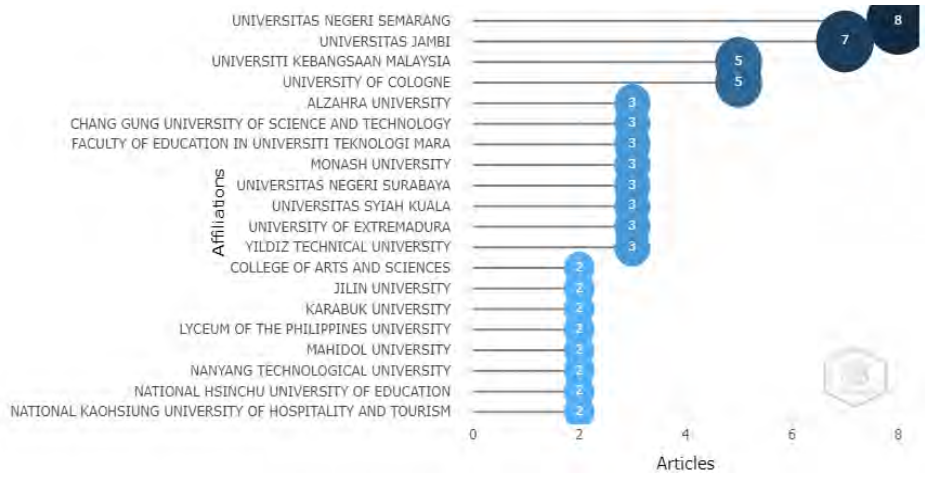

Figure 6: The most productive institutions of TPACK-ELT articles

The data presented above reveals the most productive institution was Universitas Negeri Semarang (UNNES) in Indonesia, with eight documented publications. The second most productive institution was Universitas Jambi, Indonesia, with seven published articles. The third most productive were Universiti Kebangsaan Malaysia, Malaysia, and the University of Cologne, Germany, each having published five articles in the field.

Most productive countries

Moving on to the next research question, the analysis focused on determining the most productive countries. The findings are displayed below based on data from the Scopus database is displayed on a world map (Figure 7) and Microsoft word chart (Figure 8).

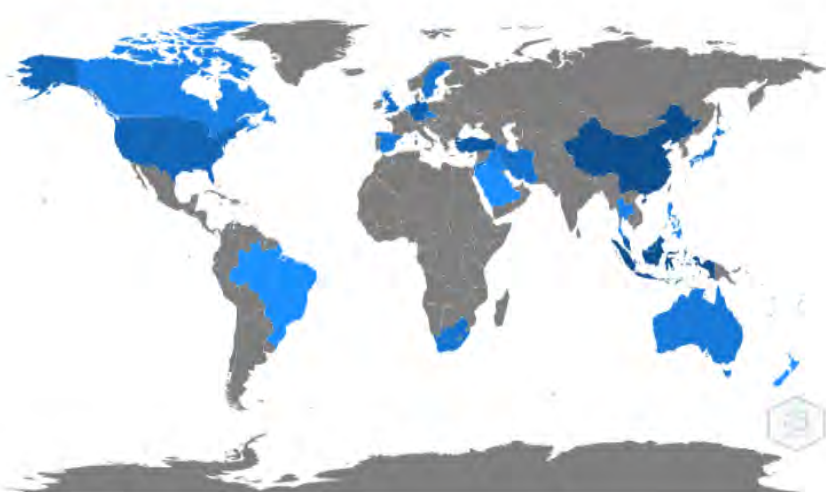

Figure 7: World map of the most productive countries of TPACK-ELT articles

Figure 7 displays countries' productivity based on colors (grey, dark blue, medium blue, and light blue). The grey color represents countries with no TPACK-ELT journal. Regarding the blue tones, the darker the blue, the more production of relevant journal articles. The world map shows the dark blue color on the Indonesia and China map area, making them the most productive countries. The details of productivity can be observed in Figure 8 below.

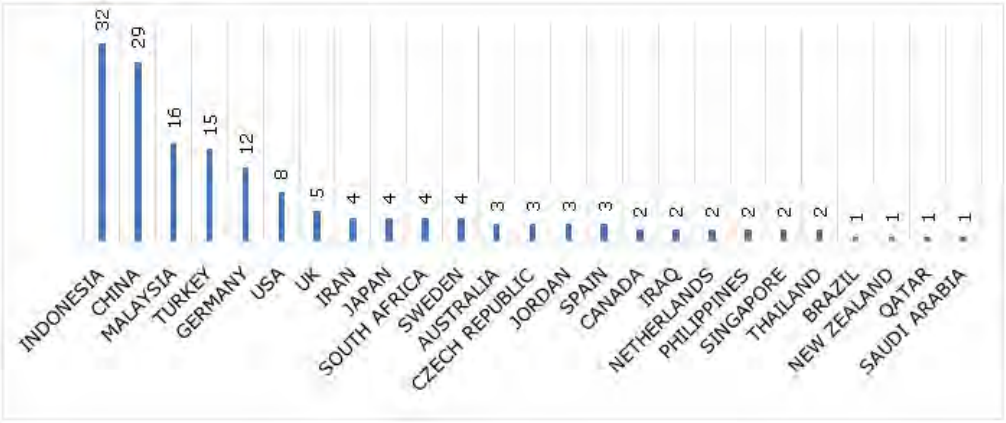

Figure 8: The most productive countries of TPACK-ELT articles

Based on Figure 8, Indonesia was the most productive country for publishing TPACK-ELT journal articles. This finding is related to the data related to the most productive institution. The second most productive country was China, with twenty-nine articles. Malaysia was in third place as the most productive country; like Indonesia, this was related to the finding of the most productive institution. According to data, the least productive countries to publish related field articles were Brazil, New Zealand, Qatar, and Saudi Arabia. Furthermore, Figure 8 reveals that there were only twenty-five countries from the 195 countries in the world in 202 where academics or scholars produced articles related to TPACK-ELT.

Most cited countries

The seventh research question was intended to name the most cited countries. After inputting the raw data gotten from the Scopus database, the result of the analysis is displayed in Figure 9.

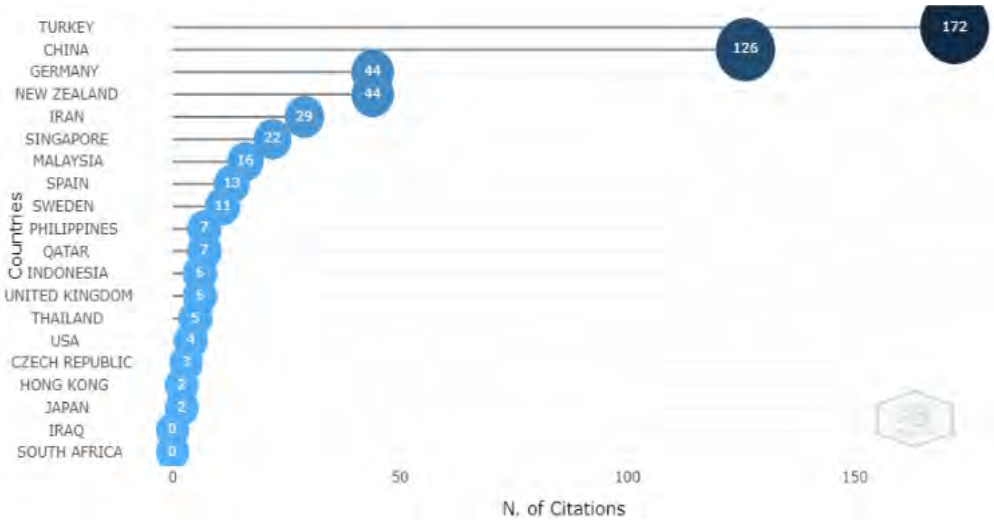

Figure 9: The most cited countries for their publication of TPACK-ELT articles during 2006-2021

Figure 9 illustrates that Turkey was the most cited country in TPACK-ELT articles, with 172 citations. China followed closely in second place with 126 citations. Meanwhile, Indonesia, which was identified as the most productive country, ranked twelfth in terms of citations. Additionally, Iraq and South Africa received zero citations, indicating a lower level of contribution in this research area.

Academic journals

The eighth research objective was to notice the academic journals that most frequently published papers related to TPACK-ELT. The findings based on the date analysis are displayed in Figure 10.

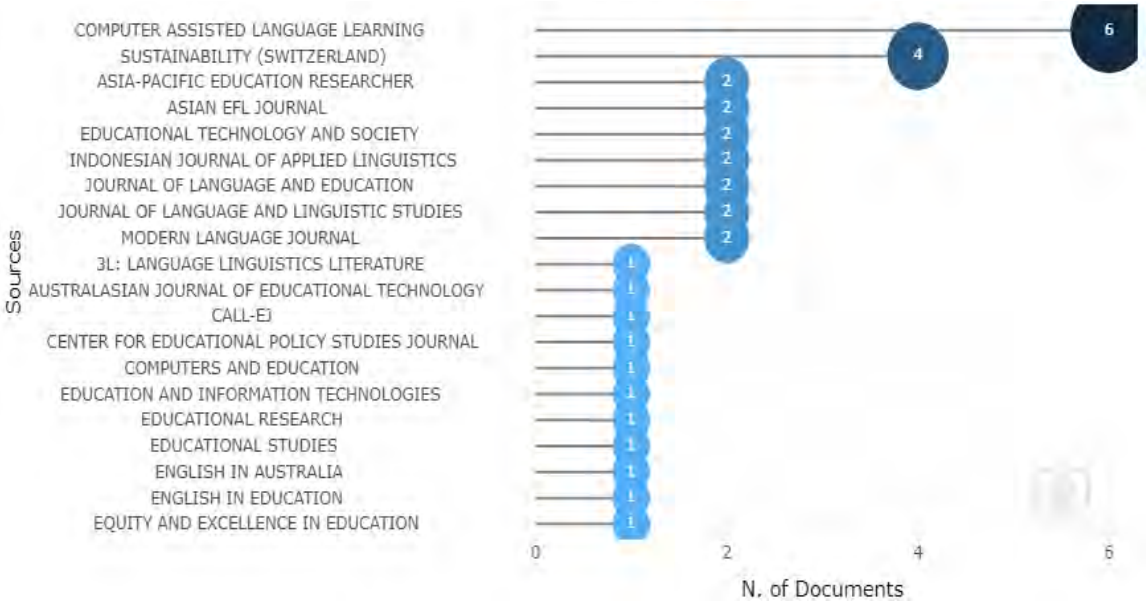

Figure 10: The academic journals which most frequently publish papers related to TPACK-ELT from 2006 to 2021

Figure 10 reveals that *Computer Assisted Language Learning (CALL)* had the highest frequency of publishing articles with six published articles. *Sustainability* (Switzerland) followed closely with four publications. Additionally, seven other journals, including the *International Journal of Applied Linguistics* (IJAL) in Indonesia, contributed two publications each in this research area.

Top ten cited articles

The next research objective was to illustrate the top ten cited articles. According to the analysis using *Biblioshin*y, the top-cited articles are presented in Table 2.

No	Paper	Total Citations	TC per Year
1	Sahin I, 2011, Turk Onl J Edu Tech	105	9.545
2	Mei B, 2018, J Educ Comput Res	44	11
3	König J, 2016, J Teach Educ	44	7.333
4	Baser D, 2016, Comput Assisted Lang Learn	41	6.833
5	Hsu L, 2016, Comput Assisted Lang Learn	38	6.333
6	Kavanoz S, 2015, Comput Educ	35	5
7	Liu M-H, 2015, Lang Learn Technol	34	4.857
8	Nami F, 2016, Comput Assisted Lang Learn	29	4.833
9	Öz H, 2015, Intern Educ Stud	22	3.143
10	Cheng K-H, 2017, Comput Assisted Lang Learn	20	4

Table 2: The top ten cited TPACK-ELT articles during 2006-2021

Table 2 shows that I. Sahin's article, which was published in 2011 received 105 citations, and the average citation score was 9.545 per year. In second place, B. Mei's article was cited 44 times since it was published in 2018. B. Mei had the same number of citations as J. Konig. However, B. Mei's article had a higher TC per-year score with a 3.777 margin. Figure 10 provides the visualization of the most cited articles in the present study.

Figure 11: Visualization of the top cited articles in TPACK-ELT articles during 2006-2021

Top keywords used

The tenth research question was about the top-used keywords. The keywords were gathered from 75 articles mined from the Scopus database. The keywords that appeared in the analysis are presented in Figure 12 and tabulated in Table 3.

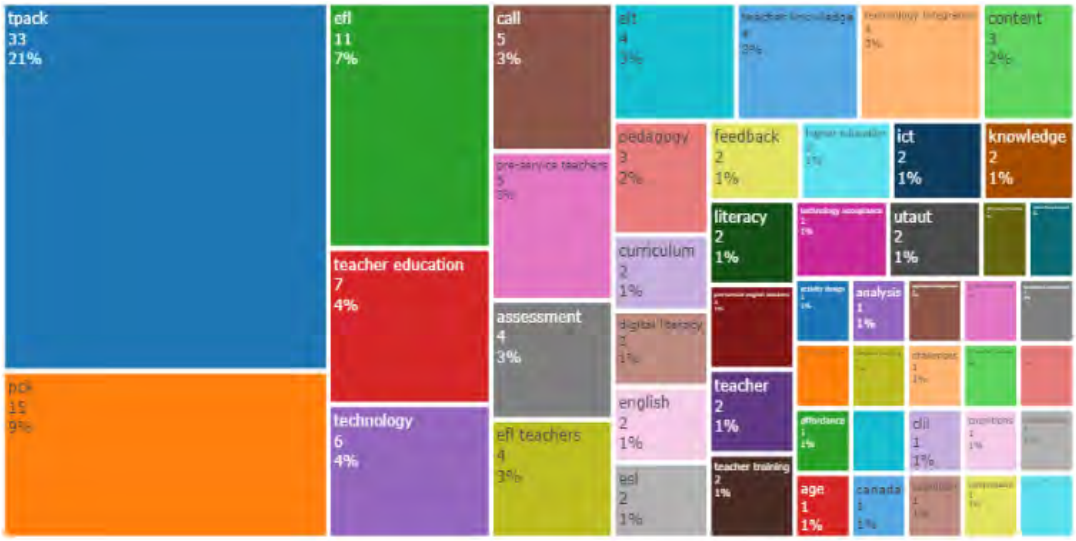

Figure 12: Treemap of the top-used keywords in TPACK-ELT articles during 2006-2021

This figure shows that the keyword “TPACK “ was the most used. The second most used keyword in the articles was PCK and followed by EFL, teacher education, and technology. The data on all key words are presented in Table 3.

Keyword	Freq.	Keyword	Freq.
TPACK	33	EFL teachers	4
PCK	15	ELT	4
EFL	11	Teacher knowledge	4
Teacher education	7	Technology integration	4
Technology	6	Content	3
Call	5	Pedagogy	3
Pre-service teachers	5	Curriculum	2
Assessment	4	Digital literacy	2

Table 3: The top used keywords in TPACK-ELT articles during 2006-2021

Table 3 shows that TPACK was the most frequently appeared keyword 1. PCK or Pedagogical Content Knowledge, as a part of the TPACK framework, stands in the second most frequently-appeared article keyword with 15 occurrences, and EFL or English as Foreign Language becomes the third. The first, second, and third most used keywords appear in Figure 12 with bigger sizes than the rest. Those keywords showed differences in usage in years, as shown in Figure 13 below.

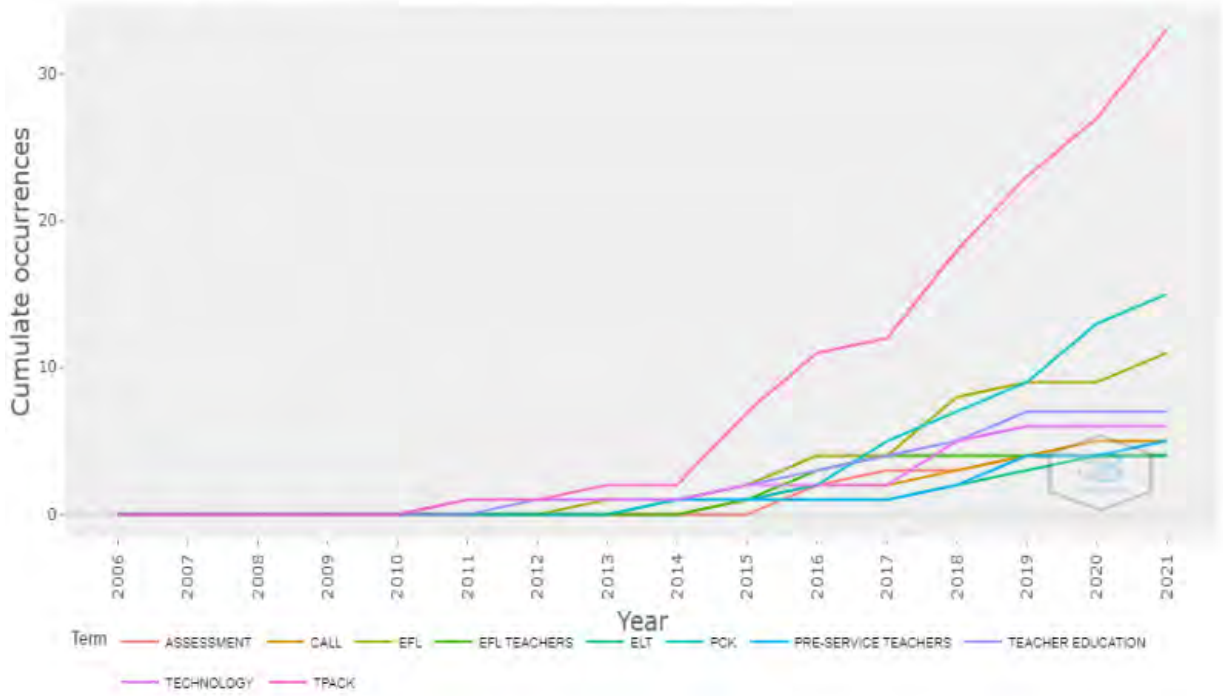

Figure 13: Visualization of top-used keywords usage growth in TPACK-ELT articles during 2006-2021

Figure 13 depicts keyword usage growth in TPACK-ELT articles every year from 2006 to 2021. The figure shows that the ‘TPACK’ keyword increased more steadily than other keywords across the years, especially between 2014 and 2021. Furthermore, in the present research context, the 'TPACK’ keyword lead from the beginning of the TPACK introduction. As the second most-used keyword, ‘PCK’ presented increases, especially during 2016-2021. Nevertheless, the ‘EFL’ keyword surpassed the 'PCK’ keyword’s domination during 2015-2017, and 2018-2019. ‘EFL’ keyword showed an unstable increase in usage frequency as it exhibited no improvement in 2016-2017 and 2019-2020. Furthermore, keywords such as ‘teacher education,' 'ELT,' and ‘technology’ showed regular occurrences during 2019-2021. To see the co-occurrence of the keywords (applying at a rule of least three occurrences in the system), *VOSviewer* was used to visualize all keywords that appeared, as presented in Figure 14.

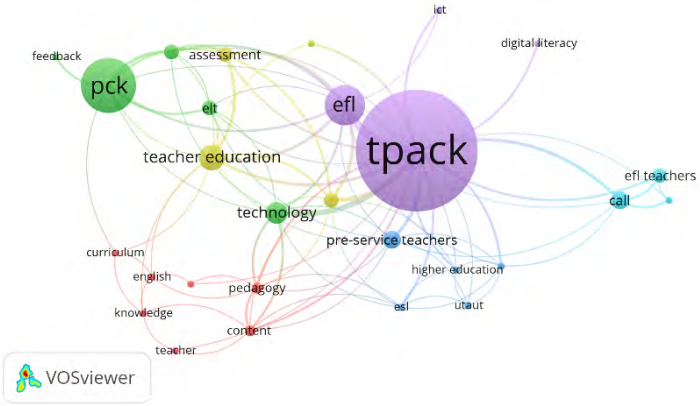

Figure 14: Co-occurrence of the top used keywords in TPACK-ELT articles during 2006-2021

Following the minimum occurrence rule of three in the VOSviewer visualization process, the finding revealed 16 thresholds in Figure 14. This figure displays co-occurrences of keywords in articles comprising six clusters of different colors (purple, green, yellow, dark blue, red, and light blue). The light blue cluster contains only three items (CALL, EFL teachers, and teacher training). Purple and yellow clusters each contains four items. More items appeared in green and dark blue clusters with five items. Then, the most frequently appearing numbers in the items were seen in the red cluster (7 items). The strongest co-occurrence link was between 'TPACK' and 'EFL', with 8 links. The link between 'TPACK' and 'Technology' was in second place with five links.

Moreover, 'TPACK' sometimes also co-occurred with other keywords, which were the heads of word clusters such as 'PCK', 'pedagogy', 'teacher education,' 'pre-service teachers,' and 'EFL teachers'. All in all, as the top used keyword, 'TPACK' had 23 strings with other keywords from the total of all 93 strings in Figure 14. By understanding the top-used keywords and the co-occurrence of the keywords, the trend of topics in TPACK-ELT articles could be drawn, as shown in Figure 15.

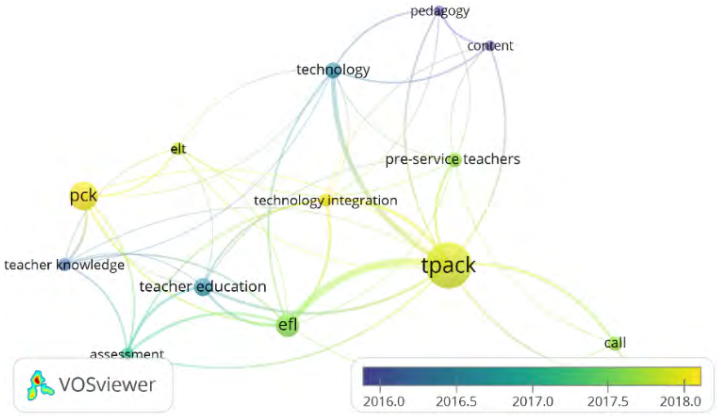

Figure 15: Topic trend in TPACK-ELT articles during 2006-2021

Figure 15 shows that currently, TPACK-ELT articles' trends were still about 'TPACK', 'PCK', and 'technology integration' as seen from the yellow color. Those three topics commonly co-occurred with 'pre-service teachers', 'CALL', 'EFL', and 'ELT' recently. However, there still needed to be a direct connection between 'TPACK' and 'ELT' and 'TPACK' and 'Teacher knowledge', which may open the possibility for future research.

Discussion

The present research mapped the scientific literature which discusses TPACK in the ELT context from 2006 (the year when TPACK was first introduced) until 2021. Henceforth, the research findings will be discussed according to the order of the research problems. The findings indicated the steady growth of article publications in the last sixteen years. Though no previous bibliometric study specifically discussed the TPACK-ELT topic with more extended period data, the present study findings were in line with the growth of TPACK framework studies trends (Irwanto, 2021; Rodríguez Moreno et al., 2019; Xue & He, 2021). For

example, Irwanto (2021) stated that in the past six years, the publication of TPACK articles had steadily increased, especially during 2016-2021. The increase in the mentioned years was about 61%. Rodríguez Moreno et al. (2019) also stated that the publication of scientific articles in both World of Science (WoS) and Scopus related to TPACK had increased steadily from 2014 to 2017. Similarly, Xue and He (2021) said that TPACK research showed a steadily rising trend in WOS in the past 12 years (2009-2020). These findings not only shed light on the increasing interest in TPACK but also reinforce the importance and relevance of studying its application in the ELT context. By examining the research landscape and trends, this study contributes to the existing body of knowledge and provides valuable insights for researchers and educators seeking to explore and advance TPACK-ELT research further.

Several factors have contributed to the growing popularity of TPACK-ELT research. Firstly, the TPACK framework, which encompasses technology knowledge, has influenced the beliefs of ELT teachers regarding the integration of technology in the teaching-learning process to enhance students' technological skills (Santos & Castro, 2021). Consequently, teachers and researchers have been motivated to seek scientific knowledge within the TPACK-ELT context. Secondly, the increasing use of technology as a medium for teaching and learning, particularly in the field of teaching EFL, has created a demand for understanding how technology can benefit ELT instruction (Inayati, 2015). However, it is important to note that these factors, despite triggering the growth of TPACK-ELT research, still require further support from additional scientific research.

The increasing publication of TPACK-ELT articles, as depicted in Figure 7, showed a scattered distribution across twenty-five countries. Among them, Indonesia emerged as the most productive country, followed by Malaysia in second place and China in third. This data indicated that Asian countries dominated the publication trend for TPACK-ELT articles. Relevant to the domination of TPACK-ELT publications based on countries, two universities in Indonesia were the most productive institutions according to the findings (Figure 6). Discussing the geographical situation and institutions of TPACK studies, Suprapto et al. (2021) stated that TPACK studies (during the period of 2015-2019) were dominated by the institutions in a Southeast Asian country (Singapore). Othman and Maat (2020) supported the idea that Asia played a dominating role in TPACK article publications.

The most prolific author of TPACK-ELT articles during 2006-2021 was H. Hisham, from the Kulliyyah of Education at the International Islamic University Malaysia (IIUM) in Selangor, Malaysia. His publications made him also the most cited author, with nine citations between 2006 and 2021. L. L. Wah, who was also affiliated to the Faculty of Education at Universiti Kebangsaan Malaysia in Bangi, Malaysia, shared this distinction with him. Irwanto (2021) stated that Asian countries dominated the top-five most cited authors in TPACK topics.

The analysis of influential authors in the present study was based on the H-Index score. The most influential authors were C.-W. Chien, J. Konig., S. Lammerding, G. Nold, A. Rohde, S. Straub, S. Tachtsoglou, and Y.-T. Wu with 2 H-index. According to the formula, those authors had published two TPACK-ELT articles, which were cited at least twice.

Co-authorship mapping indicated that some prominent authors who also belonged to the most influential authors group had collaborated to write TPACK-ELT articles. It might be said that there were links between co-authorship, scientific productivity, and authors' influence. This inference was supported by Mihaila (2018), who stated that by having co-authorship in an article, the citations would rise in numbers. Furthermore, this increasing citation numbers would influence the author's impact. Moreover, co-authorship might improve the academic productivity of the scholars (2020). On a similar stand, Ductor (2015) claimed that intellectual collaboration positively affected an individual's productivity performance. However, some prolific authors in this research tended to write the TPACK-ELT articles individually (refer to the data comparisons in Figures 2, 3, and 5). To discuss the numbers of authors in co-authorship from the perspective of productivity and impact, the data show that six authors in co-authorship strings possessed 50% of the twelve most productive authors and 75% of the eight most influential authors.

A similar pattern was observed when comparing the data for the most influential author and the most cited articles. An article published by I. Sahin (2011) received the highest number of citations (105, as shown in Table 2). This author was not the most prolific author but the most influential in the study of TPACK-ELT. His work provided insights into the use of the TPACK questionnaire in quantitative studies (Othman & Maat, 2020) and the integration of technology into curricula (Irwanto, 2021), which were very relevant to the contents of TPACK-ELT articles in the present research. Furthermore, when correlating the most cited articles

in the field of TPACK-ELT with their respective countries, it was revealed that Turkey had the highest number of citations and thus emerged as the most cited country. The superiority of Turkey in terms of citations did not place itself as the most productive country in TPACK-ELT publications since it was situated in the fourth position.

Mapping the journals where most articles on TPACK-ELT have been published, the findings showed a correlation between the journal names and TPACK-ELT. These journals had names related to various aspects of TPACK-ELT, such as computer, technology, EFL, language, linguistics, CALL, computers, and education. Only one journal, *Sustainability* (Switzerland), did not show any word related to the present study context. However, this journal opened submissions for articles related to the social sustainability of human beings (Rosen, 2021). *CALL* journal (see Figure 10) was the journal with the most significant number of TPACK-ELT article publications. This journal showed relevance in terms of journal name and scope. The scope of this journal encompasses computer-assisted language learning, teaching and testing for all four skills, and language courseware design and development (Colpaert, 2021). Therefore, prospective authors discussing the topic of TPACK-ELT should consider the journal's scope for publication (Research writing and journal publication guide, 2016).

Every journal that published articles required authors to state keywords related to the article's content (Springer, 2021). Findings of the present study unveiled that the keywords stated in TPACK-ELT articles were dominated by the word 'TPACK' (33 occurrences) and 'PCK' (15 occurrences). The 'TPACK' keyword appeared in some journals such as Asia-Pacific Education Researcher, Studies in English Language and Education, IJLE, IJLTER, Universal Journal of Educational Research, Texto Livre, CALL, English in Education, Nurse Education Today, Journal on Efficiency and Responsibility in Education and Science, Education and Information Technologies, IJIM, TESL-EJ, LEARN, International Journal of Information and Learning Technology, and Turkish Online Journal of Educational Technology.

Moreover, in analyzing the keyword data, it was observed that different ways of referring to TPACK were counted separately. For instance, terms such as 'TPACK,' 'Technological Pedagogical Content Knowledge,' and 'TPCK' were treated as distinct entries in the dataset. This variability reflects inconsistencies in how article authors refer to the same concept across publications. Consequently, the frequency of TPACK-related keywords may appear fragmented, potentially underestimating the prominence of this framework in the literature. The results indicate that 'TPACK' was still the most frequently used keyword in the articles. However, it was not consistently the top keyword in TPACK-ELT publications, as its frequency of usage declined during 2016-2017. During the same period, the usage of 'Technological Pedagogical Content Knowledge' increased in 2016, while 'Pedagogical Content Knowledge' rose in early 2017 (see Figure 12). These trends reveal a shift in keyword usage in TPACK-ELT articles during this timeframe. Recognizing these variations is essential for interpreting the results accurately and highlights the need for standardizing terminology to facilitate future bibliometric analyses. Addressing these inconsistencies provides a clearer understanding of the trends and emphasis in TPACK-ELT research.

Bornmann et al. (2018) said that keywords in research articles often appear together to provide context for the research. For example, the 'TPACK' keyword appeared together with 'teaching readiness', 'pre-service English teachers', and 'ed-tech apps for teaching-learning in Lisa et al.'s (2021) study. According to Figure 14, a main keyword often co-occurred with another keyword or the head of word clusters. For example, 'TPACK' co-occurred with 'PCK', 'pedagogy', 'teacher education', 'pre-service teachers', and 'EFL teachers.' This finding showed that keywords appearing in the present research data consistently matched with the content of the articles, the scope of journals where they were published, and with the intended objective of this research. The link strength indicated the frequency of co-occurrence between keywords and also notified the trend of published articles about both keywords (Guo et al., 2019). Moreover, connecting the strengths and the years of occurrences indicates that 'TPACK'-'EFL' has been rising within the topic trend from 2017 till now, and 'TPACK'-'Technology' shows a longer trend in the topic (2016 until now). Both trends were affected by the increased demand for technology use caused by the shift from offline to online learning triggered by the COVID-19 pandemic (Mishra et al., 2020). Also, language teaching in the EFL context has employed the TPACK framework more and more in recent years (Cheung & Jang, 2020). This implies that TPACK-ELT is currently relevant and warrants investigation from various perspectives. However, Figure 15 indicates that there was no direct link between 'TPACK' and 'ELT' or 'TPACK' and 'Teacher knowledge,' which suggests the need for further research in these areas.

Conclusions

In this research, seventy-five published articles on TPACK-ELT from the Scopus core collection database between 2006 to 2021 were used as the research data. *Biblioshiny* and *VOSviewer* were used to analyze the data. Several conclusions could be drawn from the findings and discussion. First, the publication of TPACK-ELT articles showed a steady increase over time. This growth might be influenced by ELT teachers' belief in improving technology literacy and integrating technology into learning. However, compared to the steadily increasing numbers of TPACK studies (Irwanto, 2021; Rodríguez Moreno et al., 2019; Xue & He, 2021), the number of publications in the TPACK-ELT field was more limited. There were years (2008, 2009, and 2010) when no authors published TPACK-ELT articles. Second, Asia dominated the other regions in some categories: the most productive country, the most productive institution, the most prolific author, and the most cited author. Several authors can be considered to be the most impactful, as they had a similar H-index. However, the most cited article was from Turkey, and the highest number of citations received by an article was published in a Turkish journal. Third, co-authorship mapping could affect authors' productivity and impact. Fourth, the articles used as data in this research show a consistent match between keywords and the targeted journals' aims and scopes for publication. Fifth, the co-occurrence analysis of keywords revealed a possible topic trend for future studies. Finally, the present research indicated the need to improve research productivity in the TPACK-ELT area.

However, there are limitations to these conclusions. The raw data were solely obtained from the Scopus database, while it is possible to gather more TPACK-ELT articles from other databases such as WoS, Google Scholar, Microsoft Academic, among others to gain more comprehensive understanding. This research design still offers ample room for improvement and optimization. It is necessary to explore the interconnections of the variables in the present research questions to enhance predictive capabilities in the future. It is recommended that researchers stay updated with the latest trends and conduct further investigations on TPACK-ELT research. The researchers hope that future studies can address these shortcomings and limitations.

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