Jurnal Penelitian Pendidikan, Agustus, 22 (2), 2022, hal. 145-157
DOI: https://doi.org/10.17509/jpp.v22i2.48144

Technological Pedagogical And Content Knowledge Research In Indonesia: A Bibliometric Analysis

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Naskah diterima tanggal 06/03/2022, direvisi akhir tanggal 12/07/2023, disetujui tanggal 01/08/2022

Abstrak

Penelitian ini bertujuan untuk menganalisis tren publikasi TPACK terkait waktu, pengarang, jurnal, afiliasi, dan institusi; bidang penelitian yang menonjol dan berpengaruh terhadap TPACK; serta peluang dan keterbatasan bagi peneliti selanjutnya untuk eksplorasi penelitian TPACK. Desain penelitian yang digunakan adalah analisis bibliometrik. Sumber dokumen berasal dari Scopus sebanyak 109, selama periode 2015-2021. Kemudian dianalisis menggunakan biblioshiny melalui R-package. Hasil kajian menunjukkan publikasi tertinggi pada tahun 2020 dengan 34 dokumen; sumber yang paling relevan adalah Journal of Physics: Conference Series; penulis yang paling banyak dikutip adalah Drajati, dan afiliasi yang paling relevan adalah Universitas Pendidikan Indonesia. Hasil penelitian tersebut berimplikasi bahwa penelitian TPACK kedepannya akan fokus pada kajian pengetahuan konten pedagogik teknologi, pendidikan teknik, mahasiswa, dan sistem pembelajaran. Penelitian ini merupakan penelitian pertama yang membahas tentang TPACK di Indonesia menggunakan Bilioshiny melalui R-package.

Kata Kunci: TPACK, Bibliometrics analysis

Abstract

This study aims to analyze TPACK's publication trends regarding time, author, journal, affiliation, and institution; areas of research that are prominent and influential on TPACK; as well as opportunities and limitations for future researchers for TPACK research exploration. The research design used is Bibliometric analysis. Document sources come from Scopus as many as 109, during the 2015-2021 period. Then analyzed using biblioshiny through R-package. The results of the study show that the highest publications are in 2020 with 34 documents; the most relevant sources are the Journal of Physics: Conference Series; the most cited authors are Drajati, and the most relevant affiliation is Universitas Pendidikan Indonesia. The results of the study have implications that in the future TPACK research will focus on the study of technological pedagogical content knowledge, engineering education, students, and learning systems. This study is the first study that discusses TPACK in Indonesia using Bilioshiny through R-package.

Keywords: TPACK, Bibliometrics analysis

How to cite (APA Style) Machmud, A., Sidik R., IA Ramadhan (2022). Technological Pedagogical And Content Knowledge Research In Indonesia: A Bibliometric Analysis . *Jurnal Penelitian Pendidikan, 22* (2), 145-157. doi: https://doi.org/10.17509/jpp.v22i2.48144

INTRODUCTION

Today, education and technology are inseparable elements, and there is a need to integrate technology into education (Akturk & Ozturk, 2019). Technology integration plays an important role as a tool to improve student learning, better content understanding, and develop higher-order thinking skills (Habibi et al., 2021). In line with the 21st-century learning framework, which requires students to be equipped with skills, knowledge, and information related to media and technology skills, learning and innovation skills, as well as life and career skills (Zaragoza et al., 2021). Therefore, the teacher is the key for students to acquire these skills.

Teachers play a very important role in improving the quality, relevance, and efficiency of education. Therefore, learning in the 21st century requires technical education and content knowledge

e-ISSN: 2541-4135| p-ISSN: 1412-565 X

development (TPACK). Many studies to date have shown that TPACK for teachers is an important factor in creating effective learning and reinforcement to support the education sector. This idea is supported by Oladosu et al. (2020), Gozum et al. (2021), Prasojo et al. (2020), Sojanah et al. (2021).

Technological Pedagogical Content Knowledge was originally known as TPCK, but with changes, is now known as TPACK. The TPACK framework is based on the concept of Pedagogical Content Knowledge (PCK), which was proposed by Shulman in 1986. The development of the TPACK framework initiated by Mishra & Koehler (2006) shows that education is categorized as a fairly complex activity. Therefore, an effective learning process requires the integration of competent education, related content, and technical knowledge.

TPACK is defined as a framework for understanding and explaining the knowledge needed by teachers by emphasizing the relationship between subjects, technology, and pedagogy. The TPACK component is a cross between PCK (pedagogical content knowledge, TCK (technology content knowledge), TPK (technology pedagogical knowledge), and TPACK (Mishra & Koehler, 2006).

The study of TPACK in Indonesia is important because it is by Government Regulation of the Republic of Indonesia No. 32 Article 2 Paragraph 1 of 2013 concerning the standards of educators and education personnel that in terms of technical (professional) and educational (pedagogic) abilities, teachers must be able to utilize information and communication technology in improving the quality of learning. It is this efficiency and effectiveness that teachers need to prioritize when teaching by integrating technology. In addition, the use of information technology in learning must be able to attract and motivate students to make learning more fun and increase knowledge. This is to facilitate the transmission of information that can support learning, thus enabling students to actively participate in learning and make learning more efficient through the use of information technology (Wuryaningtyas & Setyaningsih, 2020).

Starting from the development of the TPACK study above, to contribute to future TPACK research, it is necessary to explore TPACK trends. To achieve this goal, the researcher used bibliometric analysis developed by previous researchers (Kulakli & Osmanaj, 2020). Bibliometrics is a systematic method used to analyze written and unwritten journals and other scientific publications (Harande, 2001). Bibliometrics is a study in library science and is the oldest study (Glanzel, 2003).

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Bibliometrics includes quantitative analysis of a particular publication or document, including author, subject, publication information, citing sources, and more. Bibliometric analysis can examine how scientific the communication process itself is (Güzeller & Celiker, 2017). Bibliometric studies make it possible to identify trends in a particular area (field of study) by measuring the literature in that area (Kasemodel et al., 2016).

Several bibliometric studies were conducted in various disciplines using more or less similar methods, such as agriculture (Santana et al., 2021), economics (León-Gómez et al., 2021), social (Liu et al., 2021), and education (Drajati et al., 2021). From this study, it is known that TPACK studies using bibliometric analysis are still relatively few, especially in Indonesia.

As part of this research, we reviewed all of the TPACK publications published in the Scopus database between 2015 and 2021 and attempted to analyze them in terms of co-authors/co-authors, affiliations/institutions, cited articles, and keywords about TPACK.

RESEARCH METHODOLOGY

This study uses five stages of the scientific method (shown in Figure 2) (Firdaus et al., 2019). In summary, Phase 1 includes research design, research questions, keywords, and database selection. Phase 2, data collection based on selection criteria. In Phase 3, after collecting data from the database, bibliometric analysis is performed using biblioshiny to help interpret the data (Jones and Gatrel, 2014). Stage 4, analyzing the results and their interpretation, accompanied by predictions for future research. Stage 5, this method is widely recognized for identifying research gaps and is the most recommended method for integrating existing research.

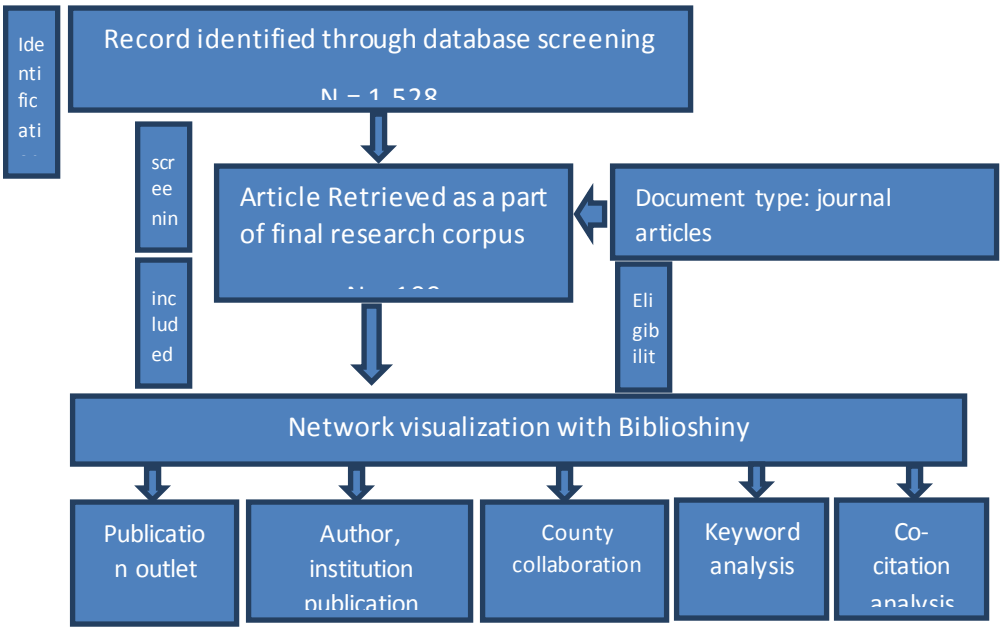

Figure 2. *Data filtering and visualization process*

Data was taken from the Scopus database in October 2021 to obtain relevant information in this study. Scopus is ideal for bibliometric analysis and includes publications from top journals (Korom, 2019). The data analyzed refers to the 2015-2021 period related to TPACK. Using the search terms "Technological Pedagogical and Content Knowledge" or "TPACK" to search for keywords, summaries, and titles, initial results were obtained for 1,528 documents (string TITLE-ABS-KEY ('technological AND pedagogical AND content AND knowledge'). This research is limited to TPACK research in Indonesia so that the data obtained are 109 documents (string TITLE-ABS-KEY ('technological AND pedagogical AND content AND knowledge') AND (LIMIT-TO (AFFILCOUNTRY, "Indonesia")). In the research, documents were selected based on the extraction of abstract results. The TPACK articles selected for the final analysis were relevant.

RESULTS AND DISCUSSION

Descriptions of bibliometric statistics in this study includes author analysis, citations, information, and country collaborations. Each category was carefully analyzed using methods such as (1) annual publication trends, (2) authors and institutions, (3) leading journals, (4) dendrograms, and (5) country cooperation maps. Further analysis is presented in the following sub-chapters.

Year-Wise Publication on TPACK

Table 1 and Figure 4 shows the dynamics of the number of published articles based on Scopus data for the 2015-2021 period. The number of articles published on TPACK in Indonesia increased from 2 articles in 2015 to 34 articles in 2020 and is expected to continue to increase in 2021.

TABLE 1

Annual publication trends from 2015-2021 obtained from Scopus

Publication Year	Recapitulation	% of 109
2021	28	25,69
2020	34	31,19
2019	27	24,77
2018	13	11,93
2017	5	4,59
2015	2	1,83

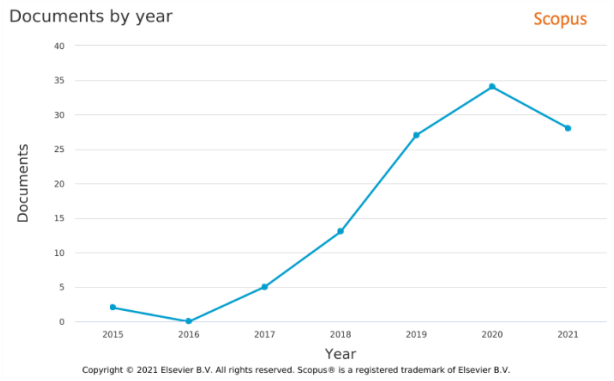

Figure 4. *Annual publication trends from 2015-2021 obtained from Scopus*

Some of the possibilities for an increase in the results of TPACK publications in Indonesia are that most researchers in Indonesia have realized that the scope of TPACK research is very broad and has a very large impact on teacher performance, especially in responding to the challenges of teacher competence as stated in Government Regulation of the Republic of Indonesia No. 32 of 2013 article 2 paragraph 1. Another reason is that many researchers from other countries have conducted research related to TPACK to improve teacher performance, thus attracting the attention of researchers in Indonesia.

Table 2. *Basic information about the characteristics of the issued document*

Data Information		Description	Freq.
1	Period	Total time period of the article	2015:2021
2	Sources (Journals, Books, and more)	Frequency distribution of all sources	38
3	Document	Total number of articles filtered from database	109

Data Information		Description	Freq.
	Average citation per document		2,064
	Average citation of documents per year		0,7345
4	Document type	Total number of document types	
5	Article		47
	Conference papers		61
	Data paper		1
6	Document Contents		
	Plus Keyword (ID)	Total number of unique keywords from all articles	335
	Author Keyword (DE)	Number of phrases that appear in all articles cited by the author	167
7	Writer		
	Writer	Total number of authors	315
	Author Appearance	Author's frequency distribution	388
	Author of single written documents	Total number of individual authors per article	8
	Author of multi-authored documents	Total number of authors by multi-authored documents	307

Table 3. *Leading journal publisher on TPACK*

Sumber	Artikel	Zona
Journal of Physics: Conference Series	47	1
AIP Conference Proceedings	8	2
Indonesian Journal of Applied Linguistics	4	2
International Journal of Instruction	4	2
Cakrawala Pendidikan	3	2
International Journal of Emerging Technologies in Learning	3	2
Jurnal Pendidikan Ipa Indonesia	3	2
International Journal of Learning, Teaching and Educational Research	2	2
International Journal of Recent Technology and Engineering	2	3
IOP Conference Series: Earth and Environmental Science	2	3

As the results of the descriptive analysis (see Table 2), the average number of citations per document is 2,064, and the total number of individual authors is 8. Based on Table 3, it is known that there are 10 top journals with a contribution of 34.86% of the total articles. Journal of Physics: Conference Series is the most prominent journal publisher with a frequency of 47 articles, followed by Aip conference proceedings and the Indonesian Journal of Applied Linguistics. TPACK is a teacher performance study that is widely discussed and reviewed in the scope of these journals. These TPACK studies can be found mainly in the most reputable journals. Based on the results of the analysis, we can see that most of the results of the TPACK study articles were published in conference proceedings compared to journals.

Authors and Their Affiliated Institutions

Table 4 summarizes the top institutions related to authors who published articles or papers on the TPACK study: with the top three positions, namely Universitas Pendidikan Indonesia (27 articles), Universitas Sebelas Maret (18 articles), and Yogyakarta State University (14 articles). This shows that research in the field of TPACK mainly focuses on universities engaged in education. This shows that

most of the TPACK research has been carried out in these three institutions and there are opportunities for further studies at other institutions. Institutions with home-based education recognize the importance of TPACK studies as future assets for teachers.

Table 4. *Top 10 institutions that publish TPACK studies*

Institusi teratas	Artikel
Universitas Pendidikan Indonesia	27
Universitas Sebelas Maret	18
Yogyakarta State University	14
Sebelas Maret University	13
Universitas Negeri Malang	11
Universitas Negeri Yogyakarta	11
Universitas Syiah Kuala	10
Universitas Sarjanawiyata Tamansiswa	7
National University of Malaysia	6
Universitas Negeri Surabaya	6

Country Collaboration Map

Figure 5 shows global collaboration. The blue color on the map shows research collaboration between different countries. The pink color on the map indicates the degree of collaboration between authors in different parts of the world. Interestingly, Indonesia is actively involved in writing TPACK articles with many countries. Indonesia cooperates with Australia (3), China (2), Hong Kong (2), Hungary (1), South Korea (3), Malaysia (8), Oman (1), Singapore (2), and Thailand (1). This bilateral cooperation is very useful in various policy areas and explores all the boundaries of research activities.

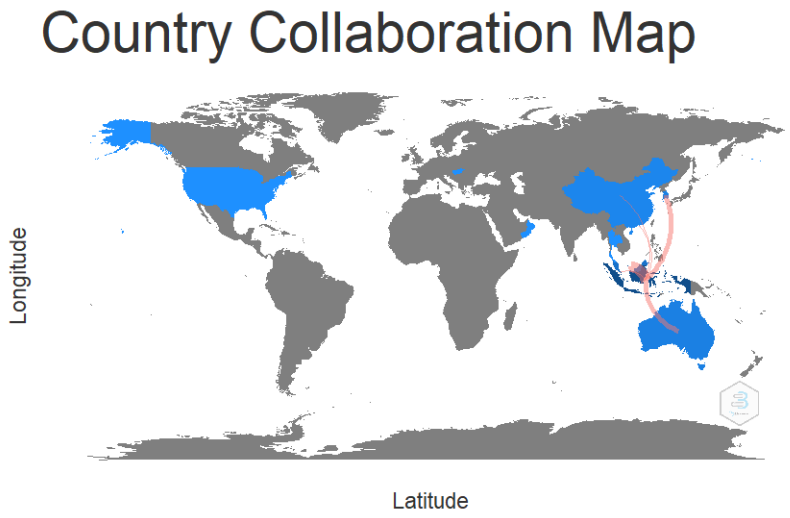

Figure 5. *Map of country collaboration*

Citation Analysis

The number of citations determines the index value received by the researcher. Frequently cited articles are considered more productive than infrequently cited articles. The best way to assess the

value of a research article is to use citation analysis. Articles with many local citations are considered productive within the scope of the TPACK review. Observable gaps in local and global citations indicate that TPACK is in great demand for a comprehensive review.

Table 5 shows a list of the most frequently cited TPACK authors at local and global levels from 2015 to 2020. Global citations indicate the frequency of reports, including research areas, and are cited throughout the database. The frequency of articles cited in other publications is indicated in the scope of local citations.

Drajati topped the list of authors with 13 citations in 2018, followed by Mahdum with 10 citations in 2015. Drajati (2018) has the most influential articles with research gaps related to research in the area of TPACK. This provides theoretical and empirical evidence about the effect of TPACK on improving teacher performance.

One of Drajati's articles that are quite widely cited is the article entitled "Investigating English Language Teachers in Developing TPACK and Multimodal Literacy". TPACK's three literacy points are related to Pedagogical Content Knowledge for Multimodal Literacy, Technological Pedagogical Knowledge (21st-century learning), and Knowledge about digital media tools. The implication of this research is to provide direction and alternative application of the TPACK model for teaching English. In the future, this process will help improve the quality of professional development of English teachers.

Keyword Analysis

The thematic map shows a fairly clear graph and the research topic is evaluated by quadrant analysis. Thematic maps explain how to evaluate and visualize specific topics in your field of study (Cobo et al. 2011). The X-axis of the thematic map shows centrality and the Y-axis shows density. Density measures the progress of the chosen topic, and centrality measures the importance of the central topic. Thematic maps have four quadrants. According to the map, a lot of research is being done on the TPACK study.

Table 5. *Top cites by a number of local and global cites*

Author cites	Local cites	Global cites
Drajati Na, 2018, Indonesian Journal Appl Linguistic	7	13
Mahdum, 2015, Mediterranean Journal Social Science	6	10
Juanda A, 2021, Journal Pendidikan IPA Indonesia	1	1
Sintawati M, 2020, Journal Physic Conference Series	1	1
Wulansari D, 2020, Journal Physic Conference Series	1	1
Ilmi Am, 2020, Journal Physic Conference Series	1	5
Thohir Ma, 2020, Journal Res Technology Education	1	2
Khoirul Antony M, 2019, Journal Physic Conference Series	1	1
Muhaimin M, 2019, Journal Technology Science Education	1	6
Rochintaniawati D, 2019, Journal Pendidikan IPA Indonesia	1	2

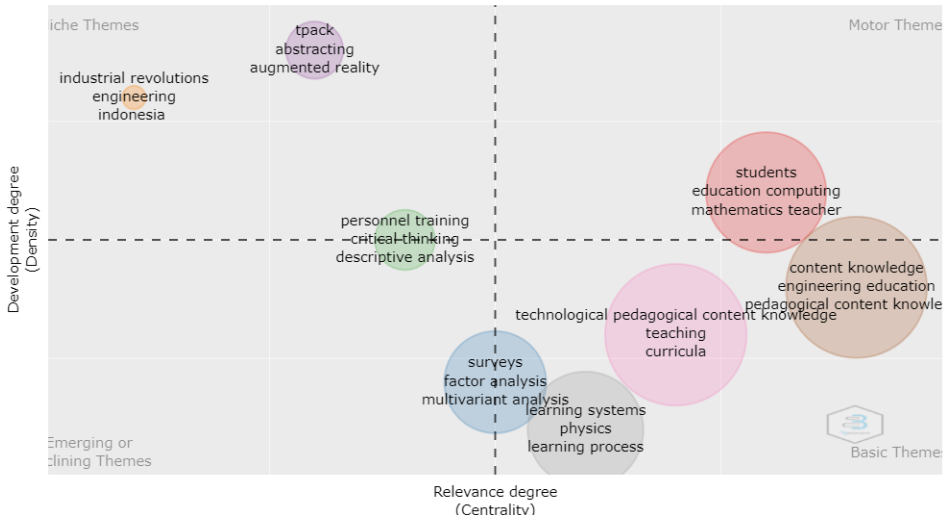

Figure 6. *Thematic map of TPACK*

Based on Figure 6, it is known that in quadrant 4 there are studies conducted on learning systems, physics, learning processes, technological pedagogical content knowledge, teaching, curricula, content knowledge, engineering education, and pedagogical content knowledge, classified as the basic scheme in this study. Studies related to the analytical methods taken, namely surveys, factor analysis, and multivariant analysis, show that many studies have been carried out and show a decline so that it is included in the scope of quadrant 3. In quadrant 2 there is an arrangement of research variables on TPACK, abstracting, augmented reality, industrial revolution, and engineering, this shows that research can still be developed (research is rarely done). Studies on students, mathematics teachers, and education computing are included in quadrant 1, meaning that the study can still be developed.

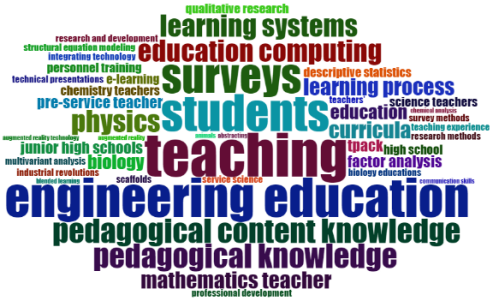

Figure 7. *Word cloud of TPACK*

Figure 7 shows the word cloud selected based on the plus keyword. The term Engineering education is most often used in the TPACK review literature. This shows that TPACK research is still focused on the unit of analysis of engineering education and there is still much to be researched in other fields of education. In the context of TPACK's research, these keywords (pedagogical content knowledge, mathematics teacher, professional development, students, learning process) are still frequently searched keywords. Over time, TPACK studies continue to develop in terms of the learning process, content, research methods, analysis units (teachers or prospective teachers), and subjects.

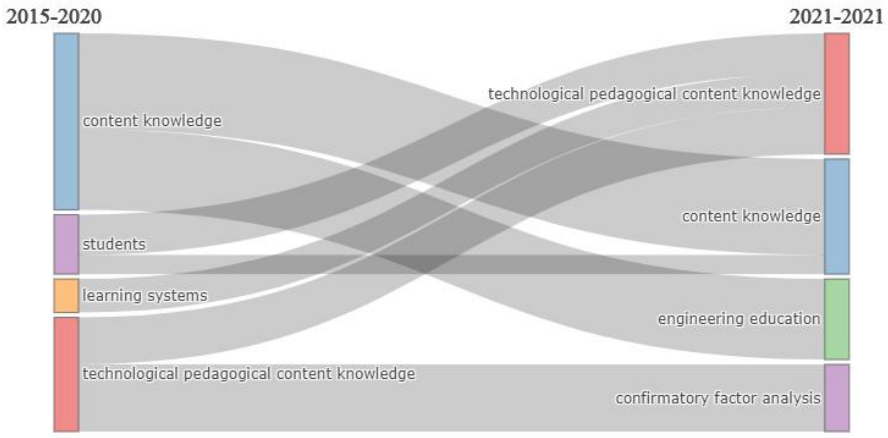

Figure 8. *Keyword analysis from the TPACK literature*

Similar results can also be seen from the keyword analysis (Fig. 8). The mapping results show that the highest search frequency is occupied by technological pedagogical content knowledge, which is the main study of this article. Learning process is a keyword that is mostly used in TPACK studies.

From 2015 to 2020, several studies have been conducted in the following areas, including technological pedagogical content knowledge, learning process, students, and content knowledge. In 2021, several studies will examine the relationship between technological pedagogical content knowledge, content knowledge, engineering education, and confirmatory factor analysis.

Figure 9 shows the growth of words since 2015 when information technology advances rapidly. Currently, TPACK is a source of research in the field of education, especially to improve teacher performance. The word treemap emphasizes the possible combinations of keywords that represent the relationship between keywords. The largest rectangle indicates the dominant keyword, which also indicates the researcher's preference for conducting research relevant to technological pedagogical and content knowledge (11%) and content knowledge (8%).

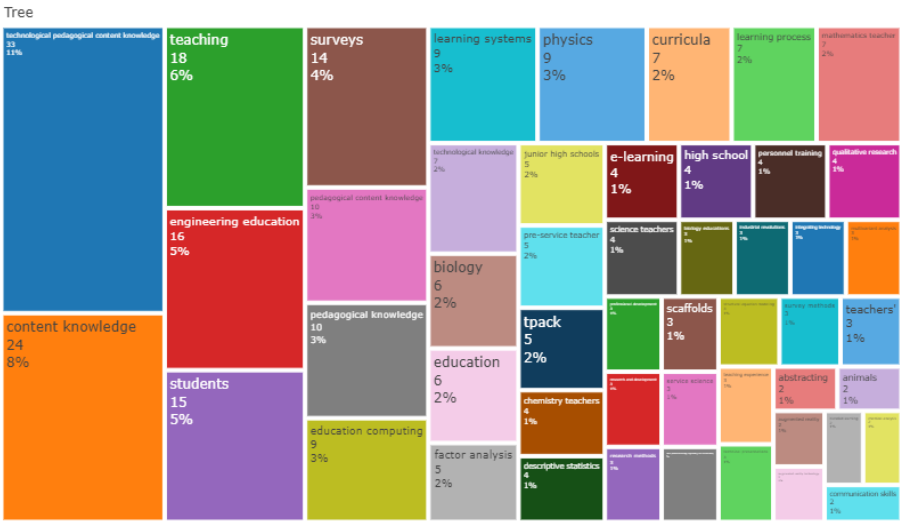

Figure 9. *Word tree map of TPACK*

Trend Topics Over the Years

In 2017, the TPACK study was related to education and teaching. The trend of topics mentioned in the TPACK study again occurred in 2018 related to technological knowledge, pedagogical knowledge, education computing, curricula, and content knowledge. The five topics are predicted to continue to exist in research until 2019-2020. Then, in 2019-2020 the topics that are widely studied are technological pedagogical content knowledge, engineering education, students, and learning systems. These topics are predicted to be topics that will be widely associated with the development of TPACK globally.

Figure 10. *Trend topics of TPACK*

Co-citation Analysis

Co-citation analysis describes two documents that were co-edited by at least one published document. In other words, if 2 documents are edited together by at least one document, it is said that the two documents are called co-citations. This technique is used to find key sources in bibliometric analysis and to understand the intellectual structure of scientific publications.

Thematic Categorization: Clustering

The study is divided into different groups in the diagram. This study is grouped into the same cluster and has the same problems and is different from the items in other clusters. Cluster formation helps evaluate the analysis of co-citation network topics. Figure 11 shows that the studies discussed have a significant impact on the TPACK concept, such as engineering education having an impact of 75% and content knowledge 66.7%. From this, it can be understood that the constructs built-in TPACK can be internal or external.

Figure 12 shows the most existing (influential) co-citation networks are Shulman and Mishra. Shulman first introduced the concept of TPACK through his theory of Pedagogical Content Knowledge (PCK) in 1986 through the article "Those Who Understand: Knowledge Growth in Teaching. Educational Research". From 2005 to 2006, Mishra and Koehler developed a conceptual framework for TPACK which Shulman described covering three domains namely TPK, PCK, and TCK in their article "Technological Pedagogical Content Knowledge: A Framework for Integrating Technology in Teacher Knowledge"

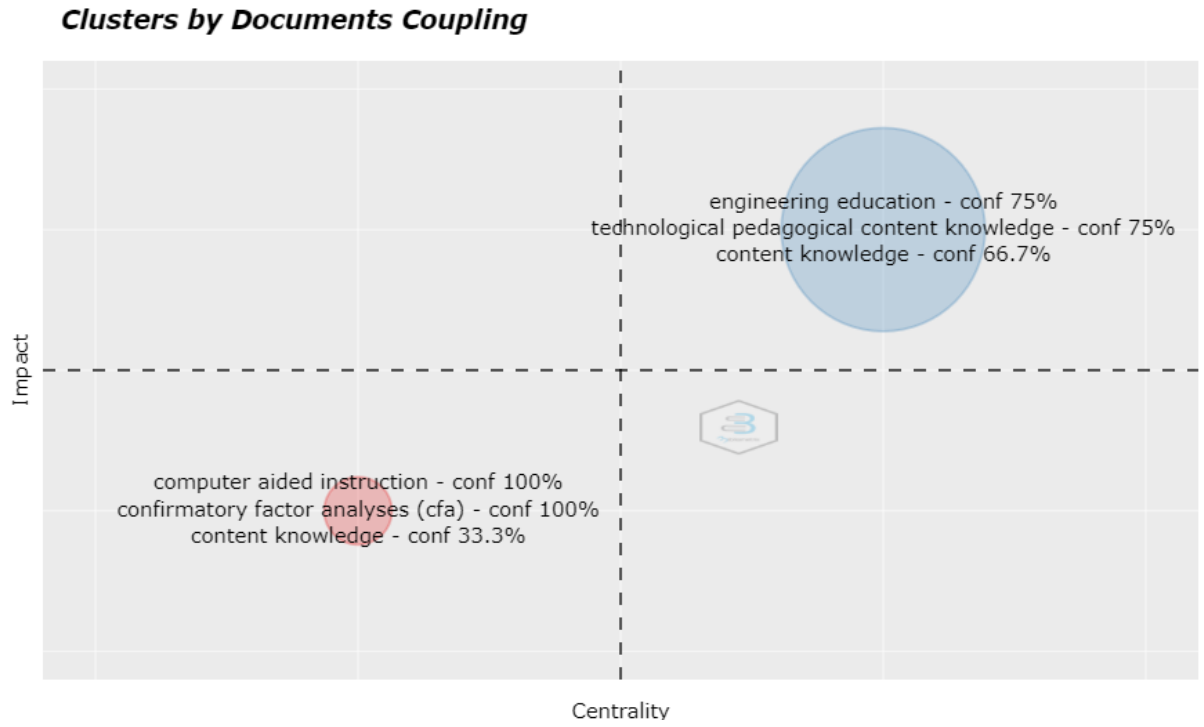

Figure 11. *Clustering by coupling*

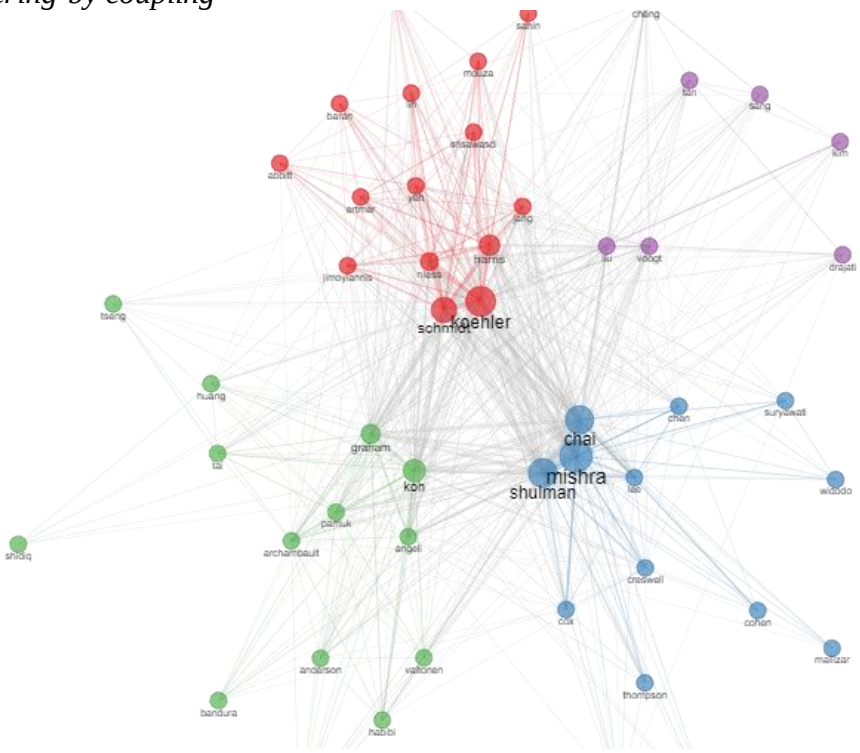

Figure 12. *Co-citation network*

CONCLUSION

This research framework aims to explore and identify the results of studies in the field of TPACK research. Therefore, based on the results of the database, research questions were created to understand and find the output of the TPACK publication pattern.

According to the results of the study, it is known that the Journal of Physics: Conference Series is the most reputable journal source that publishes 47 articles. Furthermore, the most relevant affiliate related to the publication of TPACK is UPI with a total of 27 manuscripts. Drajati is the author who occupies the top and most cited position with 5 scientific publications published related to TPACK.

Information was also obtained that Indonesia has collaborated the most in writing TPACK articles with Malaysia, which is 8 times. The research that can still be developed (and research is rarely done) is TPACK, abstracting, augmented reality, industrial revolution, and engineering. In addition, the trending topics that are widely studied are technological pedagogical content knowledge, engineering education, students, and learning systems. Furthermore, the most existing (influential) co-citation networks are Shulman and Mishra & Koehler.

This study has several limitations. First, the period of the study was limited from 2015-2021, this resulted in the previous research being annulled. Second, because this study was limited to one country, this study did not examine the impact of other countries. Third, this research was limited to keywords, resulting in some irrelevant articles not being included in the study, even though the sources were selected from the Scopus database.

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