



Bibliometric Analysis of TPACK Publication Trends in Scopus Data Base from 2013 to 2022

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ABSTRACT

This study aims to find out the development of the publication of scientific articles about the TPACK (Technological Pedagogic Content Knowledge) Model. The research method used was a literature review using a bibliometric analysis approach that started by searching the TPACK model keywords in the Scopus journal database from 2013 to 2022. The study results revealed that within a period of 10 years, from 2013 to 2022, there were 528 publications of the TPACK model published in Scopus-indexed journals. Meanwhile, the United States is the country that contributes the most to the number of published articles. The Journal of Physics Conference is listed as the journal that has contributed the most to the dissemination of the Scopus-indexed TPACK model articles. To get more comprehensive results, further research is not only limited to Scopus-indexed journals but also includes the integration of the TPACK component in the learning to be studied.



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INTRODUCTION

Learning 21st century requires educators to have the ability to teach that is always creative and innovative (Purnawan & Hidayati, 2021). One of the learning innovations that is growing rapidly is technology-based learning (Firmadani, 2020; Zahwa & Shafi'i, 2022; Ummayah, 2018). This is based on the development of technology that is increasingly developing rapidly. Therefore, many fields are competing to continue to upgrade themselves so as not to be left behind, one of which is the field of education.

Learning that combines pedagogical and technological abilities is an alternative that can develop the world of education for the better. This innovation became known as TPACK (Technological Pedagogic Content Knowledge). The urgency of TPACK has attracted the attention of many researchers, for example (Ammade et al., 2020) in their research which says that educators' knowledge of TPACK is at a "good" level but needs to be improved to achieve better results by holding more exercises or learning workshops. Other researchers such as (Schmid et al., 2021; Saubern et al., 2020; Valtonen et al., 2020; Tanak, 2020) agreed on the importance of mastering technology in teacher education programs, they said technology in

learning is not only conceptually integrated but also requires activities that directly involve technology in it. Referring to the researcher's review, the researcher was interested in seeing further how this TPACK research trend uses bibliometric analysis.

Although some researchers have shown that the role of TPACK is very important, it is undeniable that some other researchers have suggested that the application of TPACK is not as easy as turning the palm of the hand. As stated by (Pertiwiet et al., 2021) who said that during offline learning teachers have not been able to maximize the use of TPACK aspects. Likewise, during online learning, teachers can only use kindergarten and TCK skills. Another obstacle according to (Nevrita et al., 2020) that the TPACK competency in the learning media of high school biology teachers in Tanjung Pinang city is only limited to utilizing technology-based learning media that is simple and easy to use and easy to develop and design. Meanwhile, according to (Janah, 2022) the correct application of TPACK is to apply the 7 components of TPACK, namely Technological Knowledge, Pedagogical Knowledge, Content Knowledge, Technological Pedagogical Knowledge, Technological Content Knowledge, Pedagogical Content Knowledge, and Technological Pedagogical Content Knowledge.

The development of learning technology requires educators to continue to innovate in improving the quality of their learning. One of the innovations is the application of TPACK in the learning process, for example (Pahlevi et al., 2021) in his research which states that TPACK training for teachers can help them integrate the use of technology, teaching and teaching materials in learning well. Almost the same thing was also stated by (Pahlevi et al., 2021; Wijayanto, 2017; Jannah & Rahman, 2021; Aditama & Pratiwi, 2021; Mutiani et al., 2021; Najibah et al., 2022; Munajib et al., 2021) where the researchers agreed that TPACK as a role model for learning that is oriented towards change and guidance for the 21st century in responding to the era of knowledge.

The use of TPACK in learning activities has been widely studied by researchers, however, researchers see that there is a gap that needs to be raised to the surface, namely the bibliometric trend of TPACK model articles. Researchers see that this bibliometric analysis is very important as a reference to see how a research trend is raised by researchers as revealed by (Sulardja, 2021) who said that bibliometric analysis is a method that can be used in order to analyze bibliographic data obtained from various literature, such as articles, journals, etc. In mendeley's search feature, bibliometric analysis has been widely performed by the researchers include (Barkah et al., 2022; Firmansyah et al., 2021; Sherliani, 2021; Wungo, 2021; Sulardja, 2021). Although research on bibliometric analysis has attracted quite a lot of attention from researchers, bibliometric studies on TPACK are still very few, even according to the search feature through Mendeley pages is still nil.

Through this article, the researcher will explain how the trend of this TPACK model article was reviewed by previous researchers. The first trend that will be reviewed through this article is the number of articles published each year through Scopus indexed journals. Furthermore, researchers will also conduct an analysis of Scopus indexed journals that contribute to the TPACK model. In addition, according to researchers, it is also necessary to look at how the publication trend of these TPACK model articles is based on Country. After that, to see how researchers are interested in studying TPACK, the researcher will conduct an analysis of the authors who have contributed the most to the development of TPACK. Finally, researchers will analyze the emergence of keywords related to TPACK publication trends in Scopus indexed journals.

Bibliometric studies according to (Anjani & Winoto, 2022) were first popularized by Pritchard in 1969. According to (Donthu et al., 2021) the main objectives of bibliometric analysis are to look at (1) research performance to evaluate the performance of research & individual and institutional publications and (2) science mapping which aims to reveal the structure & dynamism of a study topic. The two objectives according to (Ariwibowo, 2022) each have their own technicalities, for example to measure the performance of our research using certain metrics (quantitative calculations) such as total citations, *average citations*, *collaboration index*, etc. As for science mapping analysis, one of which we can use *co-word analysis*

to explore the relationships that exist between one topic and another in a particular field. Interestingly, bibliometric analysis is a currently trending method of analysis for exploring and analyzing large amounts of scientific data (Donthu et al., 2021). Thus, through the results of this bibliometric analysis, researchers can explore new nuances of a particular field, while examining the issues that arise in that field (Donthu et al., 2021).

Researchers use bibliometric measurements, one of which is as a consideration in choosing and sorting out study materials and journals that can be used as a reference in developing research materials (Donthu et al., 2021; Almasri et al., 2021; Agbo et al., 2021; Bellucci et al., 2021; Norris, 2019). Through bibliometric analysis, researchers will find it easier to map the number of articles published each year on a specific topic (Pambayun, 2021; Kusuma et al., 2021). Another advantage is the mapping of journals as a place for authors to publish the results of their thoughts and research (Aminy et al., 2021; Purnomo et al., 2020; Ratna & Nelisa, 2017). Thus, this bibliometric analysis has a very significant impact on the research development process carried out by researchers.

Bibliometric analysis is also very helpful in mapping the author's contribution to a research issue. One of the issues that has caught the attention of learning observers is the Technological Pedagogical Content Knowledge (TPACK) model. The TPACK model is considered one of the learning models that is quite relevant to technological developments, especially in education. TPACK is a significant provision to welcome the Era of the Industrial Revolution 4.0, education, especially 21st Century Education (Limbong, 2016; Hayati et al., 2019; Waluyo & Nuraini, 2021; Suyonto, 2019; Mutiani et al., 2021). Technological progress should not be an obstacle for educators but should be a big capital to give birth to a young generation who are technologically literate. In addition, technological advances must really be used as a qualified learning resource and able to increase the creativity of students.

The basic concept of TPACK according to (Mishra & Koehler, 2006) lies in three main components, namely content, pedagogy, and technology. This concept is then elaborated in more detail into 7 components which include Technological Knowledge, Pedagogical Knowledge, Content Knowledge, Technological Pedagogical Knowledge, Technological Content Knowledge, Pedagogical Content Knowledge, and Technological Pedagogical Content Knowledge (Mishra & Koehler, 2006). In many studies, the main challenge in applying TPACK in learning is that the mastery of educators of the 7 components is still very limited, in other words, the level of mastery of each component is not evenly distributed. Even in learning during the pandemic, the main component is the use of technology, the fact is that not all components in TPACK can be fulfilled. For example, in a study conducted by (Nevrita et al., 2020) which stated that TPACK competence in biology teacher learning media in Tanjung Pinang City is only limited to utilizing simple learning media based on technology that is easy to use, easy to develop and design. The same thing was also stated by (Pertiwi et al., 2021) who stated that during offline learning teachers have not been able to maximize the use of TPACK aspects. Meanwhile, during online learning, teachers can only use kindergarten and TCK skills.

However, not a few researchers about TPACK state that the mastery of TPACK by educators is quite good. For example (Munajib et al., 2021) which states that the understanding of mathematics teachers at Jambi City High School towards the TPACK framework in online mathematics learning during the COVID-19 pandemic is quite good, as well as (Munajib et al., 2021) which states that the understanding of mathematics teachers at Jambi City High School towards the TPACK framework in online mathematics learning during the COVID-19 pandemic is sufficient good. Other findings regarding the TPACK model in learning state that the implementation of learning based on the TPACK framework has been carried out properly (Maharani et al., 2021; Fajero et al., 2021). However, there are some researchers who also suggest that the use of TPACK in learning still needs to be developed either through workshops, training or other scientific forums so that knowledge and mastery of TPACK components in learning are more comprehensive (Saubern et al., 2020; Valtonen et al., 2020; Tanak, 2020; Ammade et al., 2020). The purpose of this research is to determine the development of scientific publications, journals that contribute to the TPACK model, and find

the latest topics in the development of research on TPACK in Scopus indexed journals with a review of bibliometric literature.

RESEARCH METHOD

This research uses a bibliometric approach with quantitative descriptive methods. The population in this study is a scientific article about the TPACK model published in a Scopus indexed journal in the period from 2013 to 2022 as many as 528 article documents. This study was conducted by searching for articles through *the Scopus* database. This study uses data from research/publication of scientific papers obtained from the *Scopus* database of the TPACK model field in brackets of 10 years (2013-2022). The stage in this study is to collect data based on years from 2013 to 2022. Furthermore, explore the Scopus database to see the development of publications/scientific papers related to the TPACK Model. Meanwhile, to describe the development of scientific articles about the TPACK Model, *VOS viewer* software is used. The way to create a map is by exporting search results from the Scopus database to CSV format, then entering it into VOS viewer software. The stages carried out in the study can be seen in the figure 1.

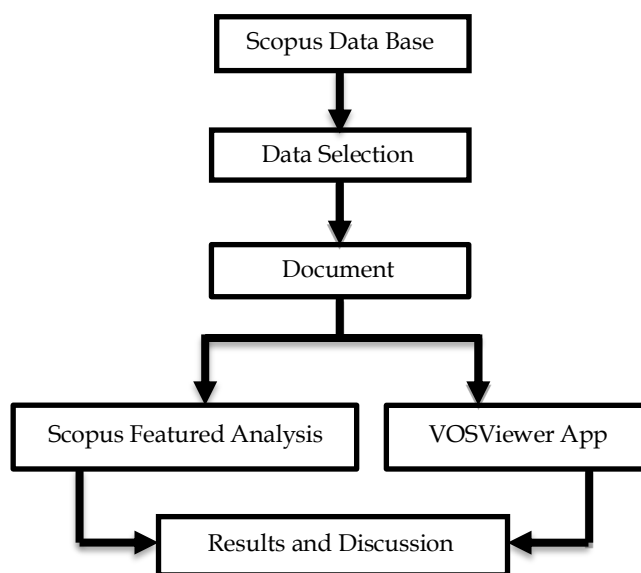


Figure 1. Flow of research

The research flow above describes the stages of research using a bibliometric approach. The initial process begins with searching for data in Scopus journal publications by determining keywords for data selection in Scopus journals. The results of data findings using search keywords, namely the TPACK model as a research document. The data is then processed through one of the *MS Office* devices, *Ms. Excel*. In addition, the data is also processed in detail by utilizing the *VOSviewer* application. So that the results and discussions can be described accurately and in detail.

RESULTS AND DISCUSSION

Result

a. Development of Scientific Publications

Search results on the Scopus data base using the keyword "TPACK and Models" have found data of 562 documents related to TPACK models. However, after the author limited the publication year in time brackets from 2013 to 2022, 528 articles were found. In 2013 there were 33 publications (6%), in 2014 there were 28 publications (5%), in 2015 there were 30 publications (6%), in 2016 there were 29 publications (5%), in 2017 there were 37 publications (7%), in 2018 there were 55 publications (10%), in 2019 there were 75 publications (14%), in 2020 there were 69 publications (13%), in 2021 there were 89 publications (17%) and in 2022 there were 83 publications (16%). In 2022 the data documents used until October. Although growth has

fluctuated, this research proves that it still has a trend as a research topic. Related to this can be seen in the figure 2.

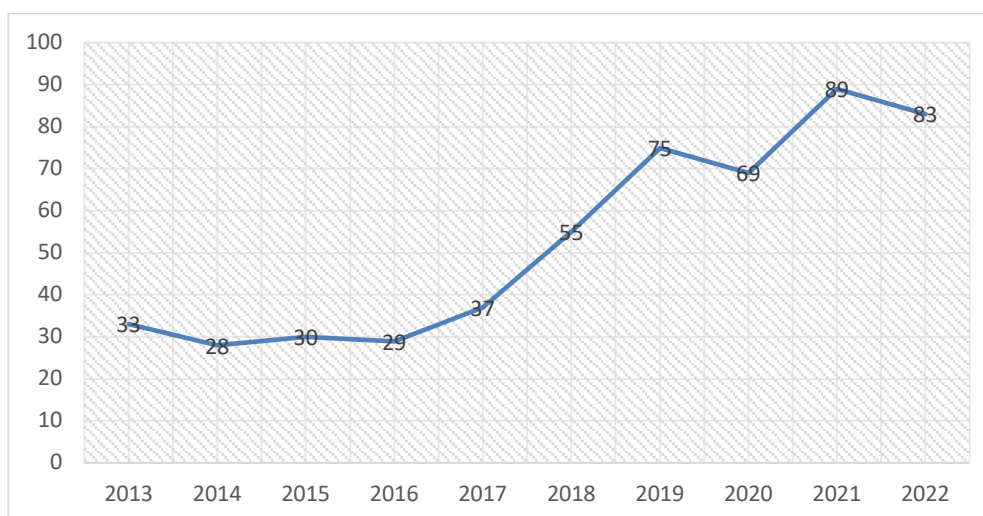


Figure 2. Number of published articles per year

b. Publication

Scopus indexed publications related to the TPACK Model come from various journals. The results of the Scopus data base search can be seen in the table 1.

Table 1. Journals contributing to the TPACK model

No	Journal Name	Number of Articles
1	Journal of Physics Conference	35
2	Education and Information Technologies	15
3	Computers and Education	13
4	Educational Technology Research and Development	12
5	Journal of Digital Learning in Teacher Education	11
6	ACM International Conference Proceedings	8
7	Journal of Educational Computing Research	8
8	Australasian Journal of Educational Technology	7
9	British Journal of Educational Technology	7
10	Interactive Learning Environments	7
11	Journal of Research on Technology in Education	6
12	Education Sciences	6
13	Egitim Ve Bilim	6
14	Journal of Science Education and Technology	6
15	Teacher Training and Professional Development Concepts Methodologies Tools and Applications	6
16	Educational Technology and Society	5
17	International Journal of Learning Teaching and Educational Research	5
18	Asia Pacific Education Researcher	4
19	Communications in Computer and Information Science	4
20	Contemporary Educational Technology	4

Based on the table above, the journals that contribute the most to the TPACK model are the Journal of Physics Conference publishing 35 documents, Education and Information Technologies publishing 15 documents, Computers and Education publishing 13 documents, Educational Technology Research and Development publishing 12 documents, the Journal of Digital Learning in Teacher Education publishing 11 documents, ACM International Conference Proceedings publishes the publication of 8 documents, the Journal of Educational Computing Research publishes the publication of 8 documents, the Australasian Journal of Educational Technology publishes the publication of 7 documents, the British Journal of

Educational Technology publishes the publication of 7 documents, publishes the publication of 7 documents, and Interactive Learning Environments publishes the publication of 7 documents.

c. Publications by Country

There are 15 countries that have the number of publication publications related to the TPACK model in the Scopus database. Based on this, it can be seen in the table 2.

Table 2. Top 15 country publishers

No	Country	Document
1	United States	105
2	Indonesian	54
3	China	52
4	Turkey	50
5	Taiwan	30
6	Spain	27
7	Australia	23
8	Malaysia	22
9	South Africa	16
10	United Kingdom	12
11	Hong Kong	12
12	Singapore	11
13	Finland	10
14	India	8
15	Germanys	8

Based on the table above, the number of articles published by each country can be identified. The country that publishes the most TPACK model journals is the United States with 105 documents. Furthermore, the countries that have the number of publications brought by the United States are Indonesia issuing 54 documents, China issuing 52 documents, Turkey issuing 50 documents, Taiwan issuing 30 documents, Spain issuing 27 documents, Australia issuing 23 documents, and so on. The following can be seen visualization of density by country via VOSviewer in figure 3.

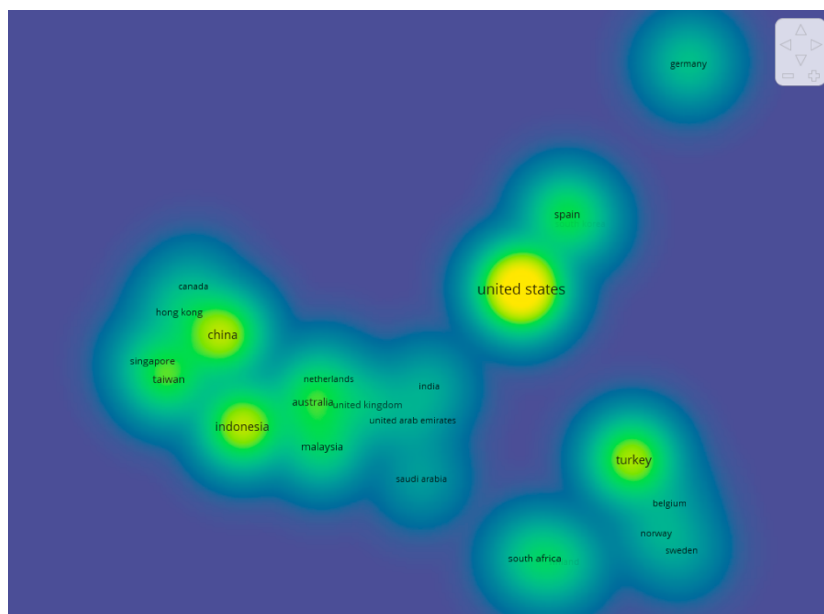


Figure 3. Visualization of density of each country

d. Authors

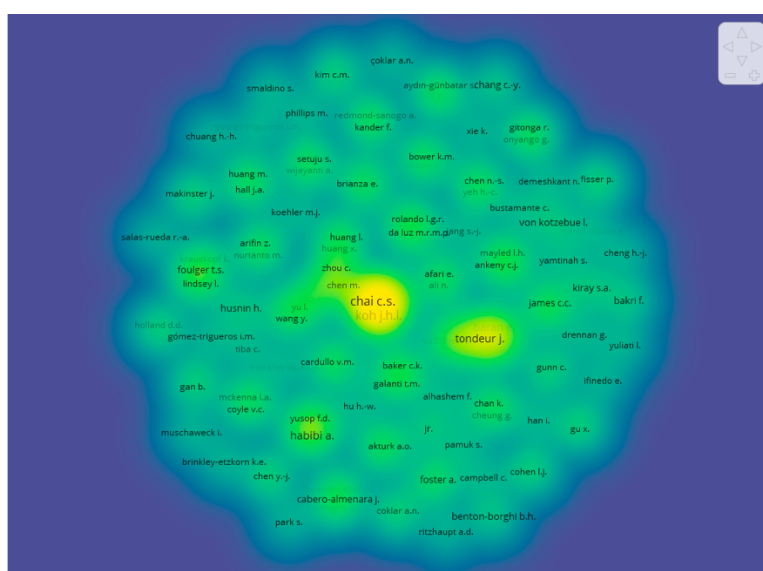
Search results from Scopus data show that there are 20 authors who are prolific in publishing the results of their research related to the TPACK model. the most prolific author Chai, C.S. from the Chinese University of Hong Kong with 13 publications, author Koh, J. H. L. from the

University of Otago with the number of publications 9 documents, author Tsai, C. C. from National Taiwan Normal University with a total publication of 8 documents, author Jang, S. J, author Tondeur, J. from Vrije Universiteit Brussels with the number of publications 5 documents, etc. The results of these searches can be seen in the table 3.

Table 3. Authors who contributed to the TPACK model

No	Authors	Document
1	Chai, C. S.	13
2	Koh, J. H. L.	9
3	Tsai, C. C.	8
4	Tondeur, J.	5
5	Jang, S. J.	5
6	Baran, E.	4
7	Celik, I.	4
8	Habibi, A.	4
9	James, C. C.	4
10	Krauskopf, K.	4
11	Lee, K. W.	4
12	Bakri, F.	3
13	Benton-Borghi, B. H.	3
14	Bower, M.	3
15	Cabero-Almenara, J.	3
16	Chuang, H. H.	3
17	Foulger, T. S.	3
18	Hesse, F. W.	3
19	Hsu, Y. S.	3
20	Husnin, H.	3

Based on the table above, density visualization is then carried out according to the data analyzed through the VOSviewer application. The results obtained from the analysis can be seen in the following visualization results:

**Figure 5.** Visualization author density

From the visualization results shown in Figure 5, it shows that the presence of density on the nodes means that the group of researchers researching about TPACK is interconnected. In addition, there are also researchers who carry out research independently or carry out research independently or individually. The density visualization shows that the brightest colors are the ones that publish the most research results related to the TPACK model. The author who published the most was Chai, C.S. from the Chinese University of Hong Kong with a total publication of 13 documents.

Furthermore, the distribution of scientific publications about the TPACK model indexed by Scopus has spread to almost all corners of the world. In the span of 10 years (2013-2022) the United States dominated about 20% of the number of publications about the TPACK model. This is quite reasonable to see the position of the United States as one of the superpowers with a sizable population. In addition, the level of education and a fairly complete educational infrastructure are believed to be one of the reasons for the high trend of publication of the TPACK model. Although this assumption is very *debatable*, it is actually something interesting to study further. The results of bibliometric analysis of the countries that contributed greatly to the research trends of the TPACK model certainly invite interesting questions to be explored further. By taking the limit of 15 countries that contributed to the trend of publication of TPACK models, the 14th and 15th places of India and Germany from 2013 to 2022 which only contributed as many as 8 articles about TPACK models certainly invited various questions. Thus, further studies are needed on the background of interest in conducting research on the TPACK model in various countries in this hemisphere.

Another thing that is quite eye-catching is the author who contributed to the publication trend of the TPACK model indexed by Scopus in the 2013 to 2022 time span or in the last 10 years. Based on the results of bibliometric analysis by taking 20 authors with the most contribution to the Scopus indexed TPACK model "Chai, C.S." occupied the top position with the number of publications as many as 13 publication documents. This is believed to be the impact of his research interest in educational technology. Not surprisingly, judging from the level of citation to his work in the article entitled "A review of technological pedagogical content knowledge" is quite widely used as a reference by various researchers in the field of TPACK. Referring to the Mendeley application search feature, it was noted that the number of citations in this article reached 215 right at the time this article was being worked on. With this number of citations, believed to be also the result of the recommendations of their research, they suggested that more studies, developments and research within the scope of technology lead to the TPACK model (Chai et al., 2013). In addition, they also suggested a more in-depth study of the conception of learning that intersects with the use of technology; so is the integration of technology in learning (Chai et al., 2013).

Judging from the visualization results, the emergence of TPACK as a keyword turned out to give birth to several large groups that intersected with each other. From this study, based on the results of VOS viewer visualization, there are seven clusters with various colors according to the degree of occurrence. Colors indicate groups, while image labels indicate keywords or terms that appear frequently. Clustering is used to obtain insights or an overview of bibliometric clustering, while image mapping is used to get a comprehensive picture of a bibliometric network (Eck & Waltman, 2016). Thus, this study found that scientific research publications with the theme of the TPACK model from 2013 to 2022 indexed by Scopus have a strong and direct relationship integrated with the concepts of technology integration, teacher education, learning, vocational education, students to computer education.

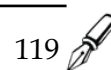
CONCLUSION

This study concludes that the trend of scientific publications using the TPACK model continues to increase from year to year. 2021 can be claimed to be the year with the highest number of publications of Scopus-indexed TPACK models. In terms of the countries that contribute the most, the United States is in the top position. Then, when viewed from the perspective of the journal, the Journal of Physics Conference is listed as the journal that contributes the most to the dissemination of TPACK model articles indexed by Scopus. Chai, C. S., showed his contribution as the most contributing researcher from 2013 to 2022. In addition, TPACK is the keyword that most often appears in TPACK model articles published in Scopus-indexed journals in the 2013-2022 time frame. In addition, the visualization results using VOSviewer revealed that seven clusters have keyword-based networks, with TPACK, technological pedagogical content and teaching, appearing most often. In addition, there is a significant opportunity for further research on issues related to TPACK. Based on the results of this study, researchers claim that

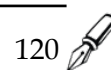
bibliometric analysis of the TPACK model published in Scopus-indexed journals in the range of 2013 to 2022 (10 years) can be used as a reference for the future development of TPACK model research. Nevertheless, researchers realized that this study was still very limited, so they recommended two things. First, the study isn't just limited to Scopus-indexed journals. Secondly, it needs more in-depth research on the integration of the seven components of TPACK in learning.

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