Research Trends Based on Technological Pedagogical Content Knowledge (TPACK) in Indonesia: A Systematic Review

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Abstract:
The integration of technology in education for a decade is increasingly needed, along with advances in the development of technology and information in the industrial era 4.0. One of the models used is the use of technological pedagogical content knowledge (TPACK) which has a very important role for learn-ing in Indonesia. This study aims to provide a comprehensive view of research using TPACK in Indone-sia and provide several possible directions for further TPACK research. A total of 745 documents were taken from the Google Scholar and Crossref databases related to research related to TPACK conducted in the period 2011 to 2021. This study used the PRISMA method in screening and obtained 90 articles that met the qualifications. The analysis related to TPACK is the number of years of research, distribution based on the journal category sinta, type of research, research targets, distribution of provinces, the most cited articles and journal that frequently publishes articles related to TPACK during 2011-2021 in Indonesia.

INTRODUCTION

The need for the use of information and communication technology in this era of globalization is not something that can be ruled out. The need to fulfill science and technology becomes a very important need. For a teacher, technological knowledge is a competency that must be mastered to support improvements in the learning process. To package such learning requires special competencies for a teacher. It is not enough just to learn material (content), or the ability to design learning (pedagogic) but must be able to combine the two which are then collaborated with the ability to use technology (technological). This ability is called TPACK (Technological Pedagogical and Content Knowledge). the TPACK framework consists of seven knowledge components, namely: Content Knowledge (CK); Pedagogical Knowledge (PK); Technological Knowledge (TK); Pedagogical Content Knowledge (PCK); Technological Content Knowledge (TCK); Technological Pedagogical Knowledge (TPK); and Technological Pedagogical Content Knowledge (TPACK).

The term Pedagogic Content Knowledge (PCK) emerged more than 30 years ago, an idea issued by Shulman about teacher knowledge (Shulman, 1986). Shulman revealed that an educator needs to have pedagogic knowledge and content knowledge. Shulman introduced the term PCK to attract attention especially in content knowledge and knowledge of pedagogy to become a better teacher.

TPACK stands for Technological Pedagogical Content Knowledge. TPACK can be interpreted as knowledge of technology, pedagogy, and content. This concept originated from the PCK framework which is a combination of the concepts of pedagogical knowledge and learning content developed by Dr. Lee Schulman. The TPACK concept was developed by Milik Mishra and Matthew J. Koehler with the consideration of rapid technological developments in society. In principle, TPACK is a combination of technological knowledge, pedagogy, and content that is applied according to the context. Mishra and Koehler explain that quality teaching requires an understanding of the interconnectedness of the three knowledges, namely technology, pedagogy, and content.

The idea of Technological Pedagogical Content Knowledge (TPACK) appeared formally in educational journals in 2003 and began to be widely discussed in 2005 which was originally abbreviated as TPCK but changed to TPACK to make it easier to pronounce (Chai, 2013). Technological Pedagogical Content Knowledge (TPACK) is a development of Shulman's Pedagogical Content Knowledge (PCK). Technological Pedagogical Content Knowledge (TPACK) is a framework for integrating technology in teaching (Koehler, 2014)(Rosenberg, 2015). Further explain the three main knowledge studies in Technological Pedagogical Content Knowledge (TPACK) namely technological knowledge, content knowledge, and pedagogical knowledge and the interaction between each of these two knowledges and between all these knowledges.

Research on the literature review of TPACK has been carried out by several researchers, Wu (Wu, 2013), Rosenberg & Koehler (Rosenberg & Koehler, 2015), Tseng et.al. (J. Tseng, 2019)(J.-J. Tseng et al., 2022), and Irwanto (Irwanto, 2021) conducted research related to TPACK with an international scope with sources from international journals indexed by Scopus and WoS. In Indonesia, the search results for the Garuda journal database did not find articles discussing literature reviews related to TPACK. From this background, the author wants to conduct a literature review research focused on Indonesia.

Information about research trends and possible directions at TPACK can help researchers and educators understand research developments in this area and then plan for future

investigations. Therefore, the current study aims to analyze the current status and provide a broad overview of TPACK research between 2011 and 2021. For this purpose, the articles used are journals published in Indonesia. Thus, the current study provides a comprehensive and accurate view in this area to assist researchers and educators around the world in conducting research related to TPACK and publishing their papers in the future.

The research questions discussed in this study are:

1. What is the trend of annual publications in the field of TPACK during 2011-2021 in Indonesia?
2. What is the trend of publishing articles related to TPACK based on the types of research written during 2011-2021 in Indonesia?
3. How is the distribution of articles related to TPACK by Province during 2011-2021 in Indonesia?
4. Which articles are often cited regarding TPACK research during 2011-2021 in Indonesia?

METHOD

Systematic review is known as a method that combines many original studies by classifying based on criteria and carried out in a structured and planned manner so as to increase the depth in reviewing and making summaries in research evidence (Crombie & Davies, 2009). This method searches, assesses and compiles all relevant empirical evidence to provide a complete interpretation of the research results. Systematic reviews also help identify research gaps in understanding within a field.

In this study, the data collected will be analyzed, especially article data based on the title, method and application in the expert system and its suitability in data mining principles according to the stages in a systematic review. It is hoped that this method can identify gaps in research so that it can be used in further research in developing new ideas and improving skills by using the existing literature (Chalmers & Glasziou, 2009).

This research was built consisting of four major stages, the details of the major stages are explained separately. The stages and details of the stages will be followed by the implementation method. In the literature search process, the selection of search results is done by filtering the search results based on predetermined criteria (Dang & Pekkola, 2016). The criteria used are inclusion and exclusion which are then used as the basis for selecting literature.

The steps in the search are divided into several processes, namely identification, screening, eligibility, and inclusion. This step is in accordance with the guidelines in PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses). PRISMA is an evidence-based minimum set of evidence that aims to assist authors in reporting the various systematic reviews and meta-analyses that assess benefit. PRISMA focuses on ways in which authors can ensure transparent and complete reporting of this type of research (Liberati et al., 2009).

Systematic reviews are limited to research in the form of articles. The articles used are research articles that have been reviewed and published in English-language journals. In managing articles obtained from online databases, the authors use

At the identification stage, three literature searches are used which will be carried out on an online database that has a large repository for academic studies, namely Google Scholar and Crossref database. In the second process of the identification stage, a search is also carried out on the supporting data. Fig. 1 is a data collection method using PRISMA.
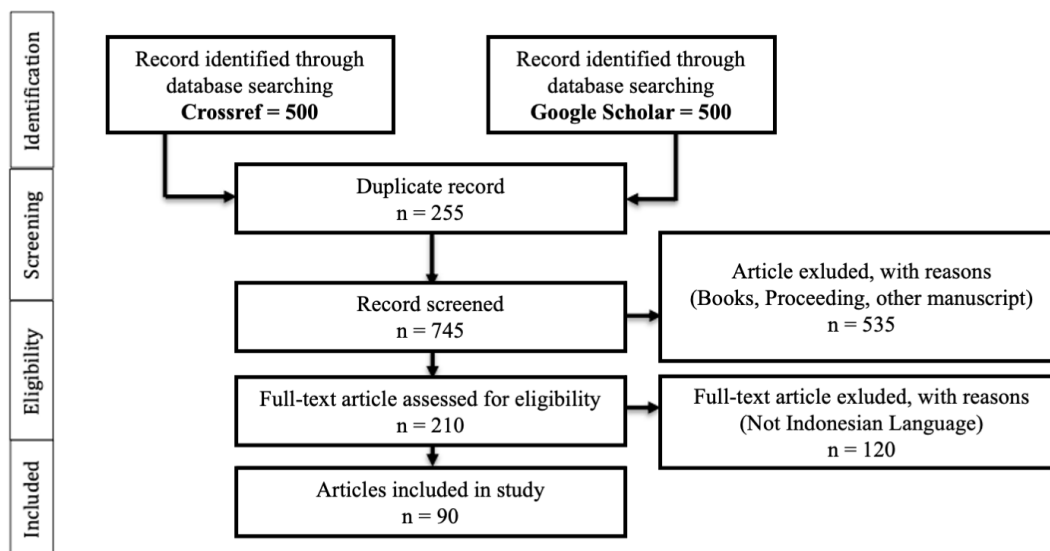
Fig 1. The Process of Research Article Selection using PRISMA

Research Design

In this systematic review, a protocol developed by (Wu, 2013) was used to achieve the proposed objectives. The researcher then conducted a comprehensive search for all journal papers about TPACK from the Google Scholar and Crossref database for the 2011-2021 period. Document search was carried out January 2022.

Inclusion Criteria

The researcher set specific criteria for including documents in the current study. For instance, papers should be written in Indonesian and published in journal papers between January 2011 and December 2021. As a note, books or book chapters, conference proceedings, editorial materials, and corrections were excluded from the analysis.

Data Analysis

The terms used in the search for sample papers included "TPCK", or "TPACK", and "technological pedagogical content knowledge" to obtain related articles. To ensure that the target papers were relevant to the research objectives, the researcher identified the titles, abstracts, and keywords of the papers manually. In this study, the sample papers were only taken from the Education discipline. Based on the initial search, there were 745 papers.

The researcher then read each paper and double-checked all documents to ensure that the target papers fit with the criteria and there were no duplications. To select the final articles for review, the researcher first checked the titles, then the abstracts, and finally the full text. After filtering the data, 636 articles–which did not match the topic under analysis–were eliminated.

In the selection process, the researcher read the full text of all the papers assisted by a research assistant. In order to provide an accurate and comprehensive systematic review, we discussed the relevance of the manuscripts to the main research questions of whether they met the inclusion criteria. If there was any doubt whether the document met the inclusion criteria,

the researcher then conducted an independent evaluation. As a result, a total of 90 contributions met the inclusion criteria and were selected for review.

RESULT

This section presents the results of the analysis of articles selected from the Google Scholar database and crossref related to TPACK during the 2011–2021 range. The results are presented in six sections, including the number of annual publications, types of research conducted on TPACK, research targets, distribution of articles by province, most cited articles and which journals frequently publish articles related to TPACK.

Distribution of Publication in TPACK by Year

The first research question is analyzed in Figure 2. Figure 2 reflects the growth in TPACK publications in the period January 2011 to December 2021.
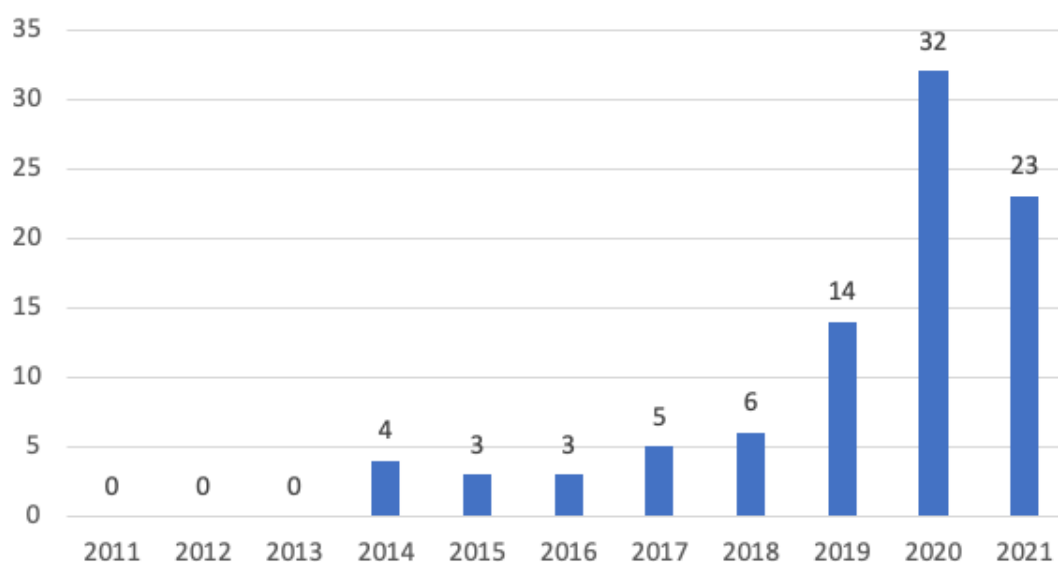

Fig 2. Number of published by years

Based on the picture above, it can be concluded that TPACK research in Indonesia began in 2014 as many as 4 articles. In 2015 and 2016 there were 3 articles. In 2017 it increased to 5 articles. In 2018 it increased to 6 articles. In 2019 there was a significant increase in the number of articles to 14 articles. In 2020 during the covid-19 pandemic, TPACK research was very high reaching 32 articles and in 2021 there were 23 articles. This TPACK research is very high, considering that because there is an urgent need to integrate technology into pedagogical content knowledge among researchers and educators, it is likely that there will be more publications on TPACK in the future.

**Distribution of Research Method & Research Type**

Our findings related to the distribution of research methods found 4 types, namely qualitative, quantitative, mixed methods, and non-empirical. Below is a picture of the distribution of the research method.
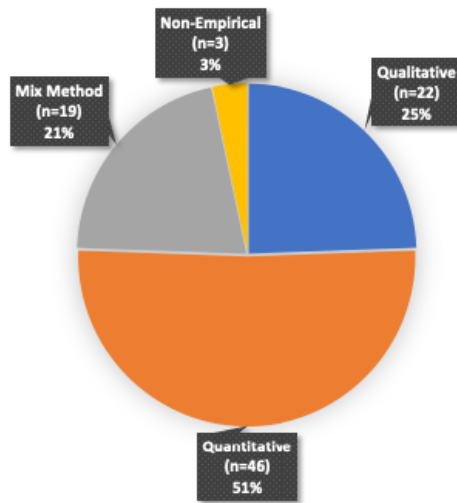
Fig 3. The distribution of research method

From the fig. 3, Research related to TPACK is dominated by quantitative as many as 46 articles, followed by qualitative there are 22 articles, mix method research there are 21 articles and non-empirical research there are 3 articles.

From the results of the article analysis conducted, there are 5 types of research conducted related to TPACK, including development research, experimental research, action research, research related to analysis of one aspect of TPACK and literature review research.
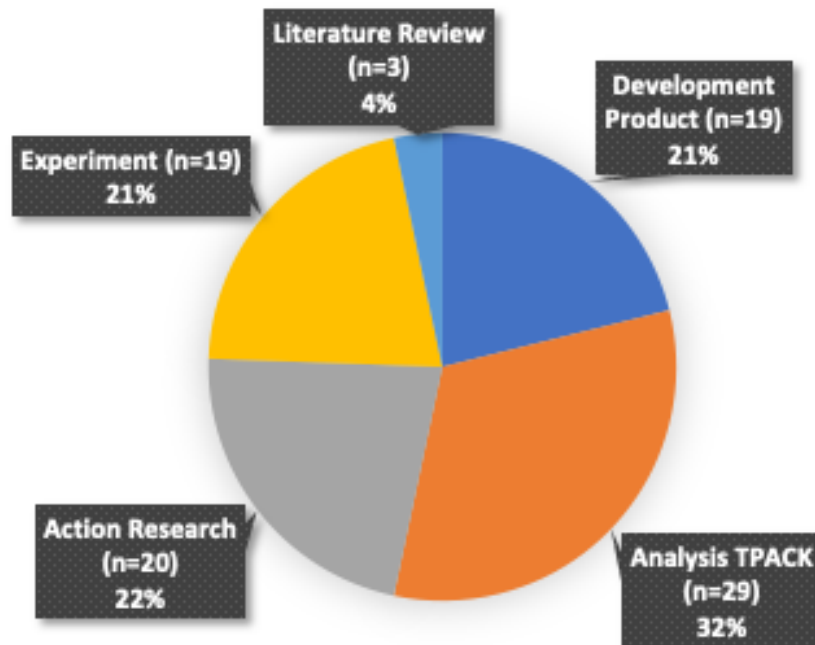

Fig 4. Research type of TPACK

Based on the fig. 4, research related to the analysis of one element of TPACK in Indonesia is the most widely carried out, with 29 articles. Action research is 20 articles, product development research is 19 articles, experimental research is 19 articles and literature review research is 3 articles.

The following is a table 1, related to research conducted over the last 3 years.

Table 1. Type of research during the last 3 years

Author	Year	Research type
(Malichatin & Kudus, 2019)	2019	Analysis TPACK
(Nuha et al., 2020)	2020	Analysis TPACK
(Mudrikah & Santoso, 2021)	2021	Analysis TPACK
(Hikamudin et al., 2019)	2019	Action reseach
(Nurmansyah, 2020)	2020	Action reseach
(FITRIANI, 2020)	2021	Action reseach
(Farizi et al., 2019)	2019	Development poduct
(Purnawati et al., 2020)	2020	Development product
(Nurjaman et al., 2019)	2021	Development product
(Octaviana & Setiawan, 2019)	2019	Experiment
(Subhan, 2020)	2020	Experiment
(Sari et al., 2021)	2021	Experiment
(Firdaus & Yuwono, 2019)	2019	Literature review
(Amelia et al., 2021)	2021	Literature review

Based on the data obtained, there are 5 targets in research related to TPACK, including elementary students, junior high school students, high school students, university students and teachers at school. Below is a picture related to the TPACK research target.
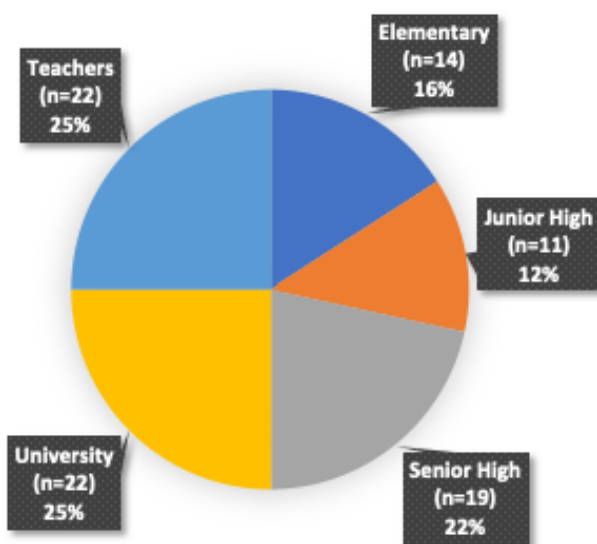

Fig 5. Research target in TPACK

From the fig. 5, The research targets in the TPACK were 22 articles for teachers, 22 for college students, 19 for high school students, 11 for junior high school students and 14 for elementary students.

Distribution of Research by Provice in Indonesia

Currently, Indonesia has 34 provinces. The details of the 34 provinces are 10 provinces on the island of Sumatra and 7 provinces on the islands of Java and Bali. Then 2 provinces on Nusa Tenggara Island and 6 provinces on Sulawesi Island. Furthermore, the islands of Kalimantan and Maluku have a total of 7 provinces. Finally, Papua has 2 provinces so that in total Indonesia has 34 provinces. Our findings regarding the distribution of tpack research in Indonesia by province found data as shown below.
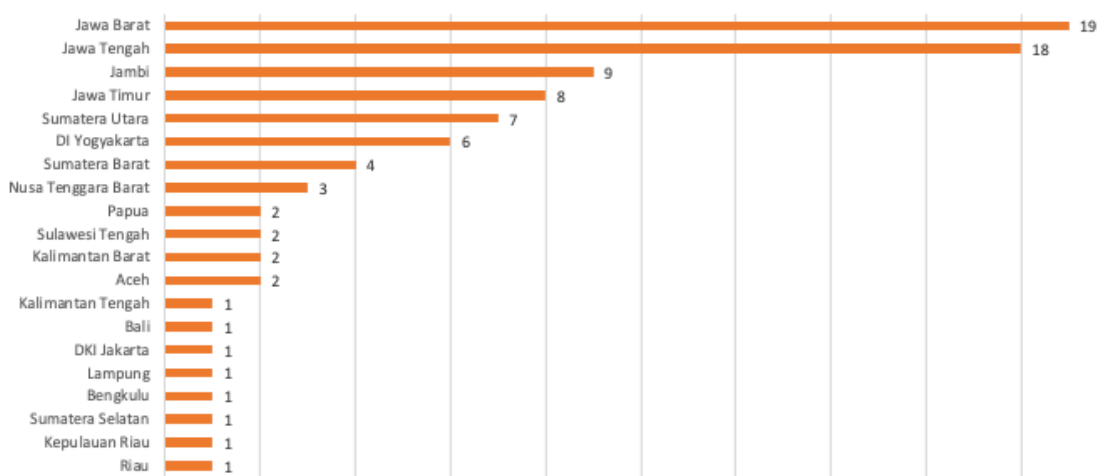
Fig 6. The distribution of research by provinces

From the fig. 6, not all provinces have research related to TPACK. The highest research was dominated by research from West Java province with 19 articles, followed by Central Java province with 18 articles, Jambi province with 9 articles, East Java province with 8 articles, North Sumatra province with 7 articles, Yogyakarta province with 6 articles, province West Sumatra has 4 articles, West Nusa Tenggara Province has 3 articles. Then there are 2 articles each from the province of Papua, the province of Central Sulawesi, the province of West Kalimantan and the province of Aceh. Lastly, there is 1 article each from Central Kalimantan Province, Bali Province, DKI Jakarta Province, Lampung Province, Bengkulu Province, South Sumatra Province, Riau Archipelago Province and Riau Province.

Table 2. Distribution research by island in Indonesia

Distribution by Island	Total
Java and Bali Island	53
Sumatera Island	27
Kalimantan Island	3
Nusa Tenggara Island	3
Sulawesi and Maluku Island	2
Papua Island	2

In table 2, the distribution of the research is divided into major islands in Indonesia. From the table above, it can be concluded that research related to TPACK is still dominated by the islands of Java and Bali with 53 articles, followed by research from the island of Sumatra with

27 articles. Then there are 3 articles each from the island of Kalimantan and Nusa Tenggara, finally there are 2 articles from the islands of Sulawesi and Maluku and from the island of Papua.

The Most Cited Paper in TPACK Studies

Table 3 visualizes the 9 most cited papers in TPACK research between 2010 and 2021to TPACK in Indonesia during 2011-2021.

Table 3. Most Cited Paper TPACK

Author	Title Article	Year	Cited
(Fitriyani et al., 2020)	Motivasi belajar mahasiswa pada pembelajaran daring selama pandemik covid-19	2020	259
(Suryawati et al., 2014)	Analisis keterampilan technological pedagogical content knowledge (TPCK) guru biologi SMA Negeri Kota Pekanbaru	2014	38
(Agustina, 2015)	Pengembangan PCK (pedagogical content knowledge) mahasiswa calon guru biologi FKIP universitas muhammadiyah surakarta melalui simulasi pembelajaran	2015	32
(Wijaya, Purnama, et al., 2020)	Pengembangan media pembelajaran berdasarkan konsep Tpack pada materi garis dan sudut menggunakan hawgent dynamic mathematics software	2020	30
(Wijaya, Murni, et al., 2020)	Pengembangan media pembelajaran berbasis tpack menggunakan hawgent dynamic mathematics software	2020	26
(Sholihah et al., 2016)	Peranan TPACK terhadap Kemampuan Menyusun Perangkat Pembelajaran Calon Guru Fisika dalam Pembelajaran Post-Pack	2016	24
(Mairisiska et al., 2014)	Pengembangan Perangkat Pembelajaran Berbasis TPACK pada Materi Sifat Koligatif Larutan untuk Meningkatkan Keterampilan Berpikir Kritis Siswa	2014	19
(Nofrion et al., 2018)	Analisis technological pedagogical and content knowledge (TPACK) guru geografi di Kabupaten Solok, Sumatera Barat	2018	17
(Irmita & Atun, 2017)	Pengembangan Perangkat Pembelajaran Menggunakan Pendekatan Tpack Untuk Meningkatkan Literasi Sains	2017	12
(Mayasari et al., 2015)	Pengembangan lembar kerja siswa (LKS) berbasis karakter melalui pendekatan saintifik pada materi fluida statik untuk sekolah menengah atas	2015	12

Discussion

Technological Pedagogical Content Knowledge (TPACK) has an important role for teachers in making decisions, teachers must be active agents in designing curriculum for each lesson. The curriculum is a combination of several interrelated components to create meaningful learning practices.

In addition, TPACK can also serve as a measure of instructor knowledge, potentially influencing the offering of training and professional development for teachers at all experience levels. Finally, the TPACK framework is useful for describing the type of knowledge most needed for successful technology integration in the classroom.

Research related to TPACK is still dominated by areas with facilities and infrastructure, especially those related to technology, which of course can be obtained more easily if in Java, Bali and Sumatra. The reason is the lack of government attention to areas outside Java, Bali and Sumatra. The government is considered still lacking in paying attention to education in the area. This can be seen when the government prioritizes development efforts in various urban schools in Java, Bali and Sumatra.

In general, research related to TPACK has increased from year to year because teachers have been led to use technology in classroom learning, so TPACK is vital in learning. For this reason, an active role from the government, schools and teachers is needed to be able to implement TPACK, especially outside Java, Bali and Sumatra.

CONCLUSION

In summary, a review of 90 studies published between 2011-2021 at TPACK in Indonesia shows that research in this area has moved forward over time. Since 2014, literature on TPACK has gradually appeared in google and crossref databases. This clearly shows that the number of published papers increased rapidly during this period. In particular, the highest number of articles was published in 2020, followed by 2021. Among the sample papers, it was found that the acronym TPACK was listed as frequently as in the title or abstract and/or keywords, with 80 papers each. In the last 11 years, the most commonly used TPACK research methods in Indonesia are analytical and action research methods. Furthermore, the target of implementing TPACK is more widely used at the university and high school levels.

Recommendations for further research are related to TPACK research during the Covid-19 pandemic. During the outbreak, the use of technology for learning, especially online learning, increased significantly so that the role of TPACK was very large, especially related to technology.

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