Bibliometric Study of the Technological, Pedagogical, Vocational Knowledge (TPVOK) Framework for Vocational Education

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ABSTRACT
To determine research directions and forecasts, this qualitative study focuses on a bibliometric analysis of research trends within the Technology, Pedagogy, and Vocational Knowledge (TPVOK) framework. Based on the 2017–2022 timeframe, this study uses a content analysis methodology with the Web of Sciences (WoS) and Scopus databases. In this study, growth trends, author country, keyword analysis, and author distribution were analyzed using VOSviewer. Publish, or Perish software is used to perform database searches. The screening results yielded up to 87 published article data entries from 28 countries, 30 of which were data-saturated. The findings reveal that, between 2017 and 2022, the highest development of publication growth regarding TPVOK occurred in 2020, namely reaching 21 published articles (24.38%), while the lowest occurred in 2018 with 9 articles (10.345%). The mapping results reveal 127 terms grouped into 8 clusters. Vocational Education only has 40 links, and vocational teachers have 20 links. So, the results of this study recommend these two terms to be appointed as the TPVOK research theme. So that the novelty of the research results can be a new contribution from previous research. The development of TPVOK research in quantity proves that research in this field is still a topic of interest and continues to grow from year to year in Indonesia.

Keywords: *Bibliometrics, TPVOK Framework, Vocational School, Vocational Knowledge.*

1. INTRODUCTION

Teaching and learning to students who use technology is currently a trend in global education [1]-[2]. However, the creators updated the learning theories that underpin online learning. In reality, this idea is regarded as novel in comparison to traditional prior knowledge. Therefore, researchers advise technology to play a beneficial role in online learning [3], noting that motivation, interest, inventiveness, and attitudes, as well as knowledge and skill competencies, have all grown. Environmental resources play a significant and determining role in success variables, though.

In the twenty-first century, the use of technology in education is expanding quickly in tandem with the field's rapid technological advancements. To complement their instruction, teachers might use a variety of technological tools, including animation [4]–[6], simulation [7]–[9], augmented reality [10]–[12], and an online learning platform [13]–[15]. Teachers must understand how to connect learning technology with practical learning methodologies and subject matter in order for technology to be used in the classroom effectively [16].

The usage of TPACK in teaching and learning is advised by prior research findings [17]. The TPACK framework consists of three basic knowledge, namely

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knowledge of content-pedagogy-technology, where the three are equally important for developing capabilities in integrating technology [18].

In addition to covering disciplines of knowledge pertaining to practical work skills, vocational knowledge should also serve two other purposes: it should advance people's personal development and their understanding of the social significance of their line of work. The fusion of discipline knowledge and situational knowledge must be accommodated in vocational knowledge. Situational knowledge is intimately tied to duties in certain domains of employment, while disciplinary knowledge is related to particular scientific theories [19]–[21].

The study's findings have an advantageous effect on education. The objection is raised, nonetheless, that TPACK is an approach and that the learning objective is vocational education. So, in order to determine whether TPACK is appropriate for vocational education, a literature review is required. The research objective to be achieved is what conceptual model is in accordance with the understanding of knowledge in vocational education. By concentrating on content knowledge components on vocational knowledge, technological, pedagogical, and vocational knowledge (TPVOK) is a progression of TPACK. Regarding this aspect of vocational knowledge (VC), certain specialists have proposed hypotheses.

2. METHOD

The study was carried out between January and May of 2023. The following graphic illustrates the stages of the bibliometric-based content analysis strategy utilized in this study, which combines qualitative research approaches.

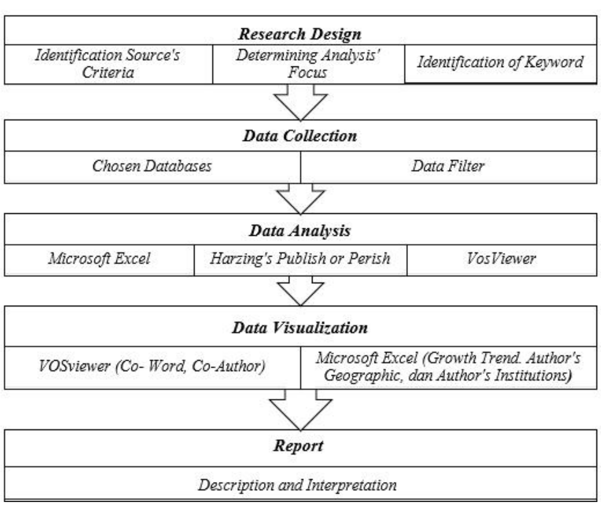

Figure 1 Research flowchart

The diagram above, which was modified from a flowchart by Zupic and Cater [22], shows the progression of the research done for this study. The steps are as follows:

1) The first step is the stage of choosing the study plan. This step is broken into three parts: choosing the sources to utilize, choosing the topic for the analysis, and choosing the keywords.
2) Selecting the chosen database and filtering the data are the 2 parts of the second step, which is data collecting. It was decided that data using Web of Science and Scopus indexing was used in this investigation.
3) The data analysis stage, which is broken down into two stages: the analysis of data created on Publish or Perish and the analysis on VOSviewer, is the third step.
4) The data visualization stage, which comes after the growth trend analysis, author location analysis, keyword analysis, and author cooperation from VOSviewer, is the fourth step.
5) The bibliometric analysis method concludes with the fifth step. At this point, a description of the results is used to explain the various analysis results that have been acquired.

3. RESULT AND DISCUSSION

3.1. Development of Research Publications Technological Pedagogical Vocational Knowledge (TPVOK)

The results of TPVOK research documents in Scopus and Web of Science (WoS) indexed journals through Publish or Perish obtained 87 published articles. To get results that are in accordance with the scientific disciplines, it is necessary to carry out filters or filters that can be narrowed to the Technological Pedagogical Vocational Knowledge (TPVOK) disciplines, namely with the limitations of the keywords Technological Pedagogical Content Knowledge (TPACK), Technological Pedagogical Vocational Knowledge (TPVOK), Technology, Andragogy, Work, and Content Knowledge (TAWOCK), and Vocational. The development of the growth of publications on the topic of TPVOK in the 2017 – 2022 range taken from the Scopus and Web of Science (WoS) databases through the Publish or Perish software shows fluctuating developments. The highest development of publication growth regarding TPVOK occurred in 2020, namely reaching 21 published articles (24.38%). Meanwhile, the lowest publication occurred in 2018, with a total of 9 articles (10,345%).

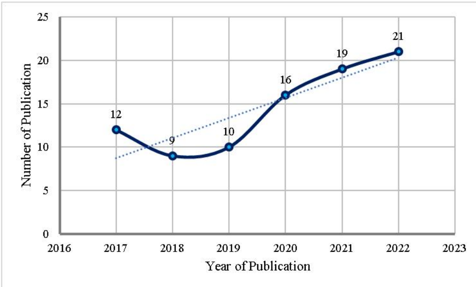

Figure 2 Development of TPVOK research publication articles Scopus and WoS database

In 2018, research in the field of TPVOK experienced a decrease in the number of documents, namely 3 articles compared to the previous year. In addition, a decrease also occurred in 2019 when compared to 2017, with only 10 published documents. Even though it has decreased in several years, the development of TPVOK research in quantity proves that research in this field is still a topic of interest and continues to grow from year to year in Indonesia. In detail, the growth of publications regarding the field of TPVOK can be seen from the distribution of publication data from countries, as shown in Table 1.

Table 1. Distribution of TPVOK article publications in view of country distribution

No	Country	Number of Publications	%	No	Country	Number of Publications	%
1	Indonesia	8	9.195	15	Netherlands	3	3.448
2	Austria	7	8.046	16	Brazil	3	3.448
3	Belgium	6	6.897	17	Canada	3	3.448
4	Czech Republic	5	5.747	18	Finland	2	2.299
5	Sweden	5	5.747	19	Jordan	2	2.299
6	Malaysia	4	4.598	20	Colombia	2	2.299
7	China	4	4.598	21	Switzerland	2	2.299
8	United Kingdom	4	4.598	22	Norway	2	2.299
9	Estonia	3	3.448	23	Spain	2	2.299
10	Germany	3	3.448	24	Philippines	1	1.149
11	France	3	3.448	25	Poland	1	1.149
12	United State	3	3.448	26	Taiwan	1	1.149
13	Denmark	3	3.448	27	Ukraine	1	1.149
14	Slovak Republic	3	3.448	28	India	1	1.149

3.2. TPVOK Research Publication Development Map Based on Authors (Co-authorship)

After the dataset is stored in the RIS (Research Information Systems) type using the Publish or Perish metadata. Furthermore, the dataset was analyzed using the VOSviewer application by selecting the option 'data create a map based on bibliographic data.' The method used to calculate the dataset is full counting with the aim that the calculations are carried out as is, according to researchers who have taken the topic of TPVOK. Figure 4 shows the network visualization and overlay on co-authorship, which is indicated by the presence of nodes (circles) representing authors or researchers and edges (networks) representing relationships between authors or researchers.

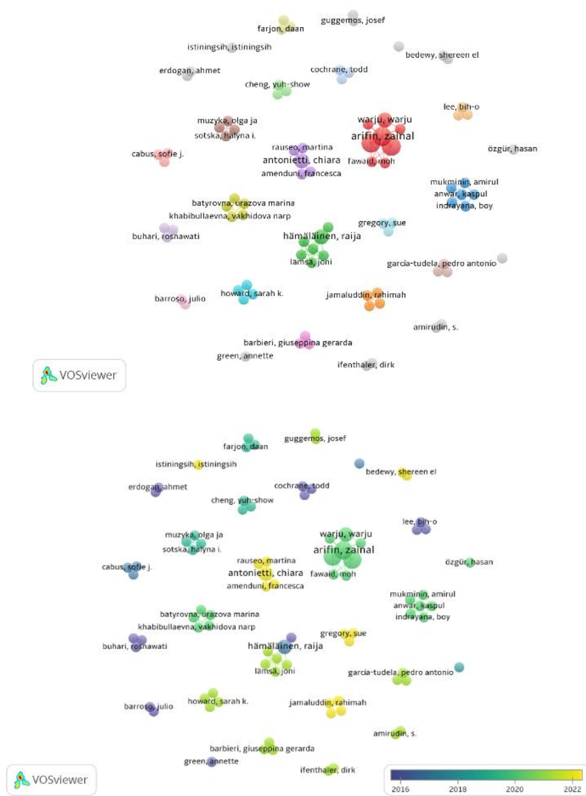

Figure 3 Network and overlay visualization on co-authorship

A set of nodes equipped with edges explains that there is a correlation or relationship between researchers in TPVOK research. Bibliometric analysis based on researchers or authors centered on Zainal Arifin, who is active in conducting research in the field of TPVOK. Overlay visualization that traces the year of publication on the author's historical articles in research in the field of TPVOK. This mapping is marked by the presence of nodes that have varied colors and edges that connect one researcher to another. The dark color on the nodes indicates research that has been carried out in the past for a specified period of time. For example, in the image, the darkest node color (purple) represents 2017 and the lightest (yellow) represents 2022.

3.3. TPVOK Research Publication Development Map Based on Keywords (Co-Occurrence)

The fields of the terms are extracted based on the title and abstract, while the method used to calculate the dataset is full counting with the aim of the calculations being carried out as is in accordance with research related to the field of TPVOK that has been carried out. The minimum number of occurrences of a term is 3 documents, resulting in 87 published articles that have an occurrence relationship. Bibliometric analysis was carried out by making visualizations in the form of network, overlay, and density, which aims to determine the bibliometric network between articles from the downloaded metadata [23]–[26]. Mapping and clustering in bibliometric analysis through VOSviewer software are complementary, which means they complement one another [17], [27], [28]. In addition, clustering is used to show an overview or insight regarding bibliometric grouping 89Figure 3 shows the network visualization of co-occurrence in the VOSviewer output of 87 articles.

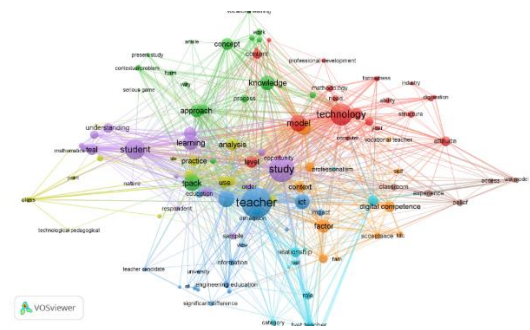

Figure 4 Network visualization on co-occurrence

Figure 4 shows the network visualization of co-occurrence which explains the network or relationship of one term to another in research in the field of TPVOK in the period 2017 – 2022. Of the 87 TPVOK articles indexed by Scopus and Web of Science, 127 terms were grouped into 8 clusters that can be identified through the node color of each keyword. Cluster 1 consists of 23 items symbolized in red, including Ability, Attitude, Computer, Conceptual Framework, Content, Development, Digitalization, Multidisciplinary Digital, Non-Formal Education, Pre-Servive Vocational Teachers, Professional Development, Skills, and Technology. Cluster 2 consists of 19 items symbolized in green, including Andragogy, Approach, Concept, Content Knowledge, Contextual Problems, Knowledge, Study, TAWOCK, TPACK, Vocational Learning, and Work. Cluster 3 consists of 18 items symbolized in blue, including Communication Technology, Education, Engineering Education, Higher Education, ICT, Teacher, and University. Cluster 4 consists of 16 items symbolized in yellow, including Framework, Research, STEAM, Teacher Training, Technological Pedagogy, and Training. Cluster 5 consists of 16 items symbolized in purple, including Application, Creativity, Innovativeness, Instruction, Learning, Student, and Laboratory. Cluster 6 consists of 13 items symbolized by the color cyan, including Competency, Professionalism, Schol Environment, Technological Pedagogy, TPACK Competency, TVET, and TVET Teacher. Cluster 7 consists of 12 items symbolized by the color orange, including Acceptance, Context, Digital Competence, Factor, Integration, Intention, TAM, VET, Vocational Education, and Vocational Teacher. Cluster

8 consists of 7 items symbolized by the color brown, including Classroom, Experience, Pre-Servive Teacher, Technology Integration, and WST Model.

Next is mapping and clustering TPVOK research trends based on historical traces or years of research publication [29]–[31]. The information obtained from the Overlay visualization results in Figure 4 can be used as a reference for identifying and detecting the state of the art of research in the field of TPVOK conducted in the period 2017 – 2022.

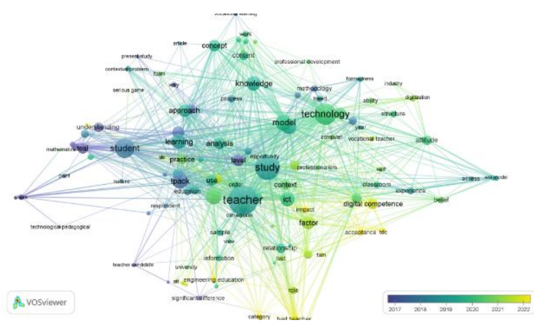

Figure 5 Overlay visualization on co-occurrence

From the results of bibliometric analysis through Publish or Perish metadata imported into the VOSviewer software, it produces an Overlay visualization. In this visualization, the colors on the nodes represent keywords that indicate the year of publication [32]–[34]. For example, the keyword "technology" has a light green node, which means that an article containing this keyword was published in 2020. Another example is the term "teacher", which in the Overlay visualization is depicted as having colored nodes; this means that the term "teacher" in research on new TPVOK was discussed by researchers in 2018-2019. The term Teacher, Technology, Knowledge, and Study is often the most effective way to show the organizational system and navigation system in TPVOK. Therefore, in much earlier research, researchers used it in conducting research on TPVOK. Furthermore, bibliometric analysis using density visualization. From the results of the visualization shown in Figure 6, it can be identified that there are dense areas that have a high density at one node with other nodes.

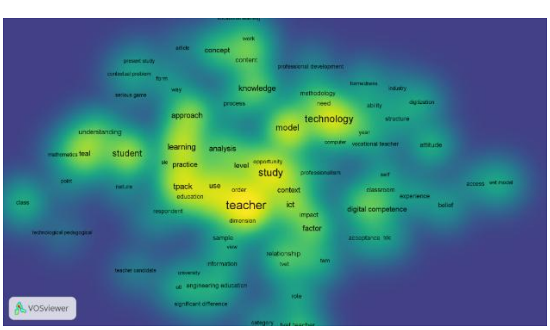

Figure 6 Density visualization on co-occurrence

The saturation level identified in the number of keywords marked in yellow means that the area is a topic that has been extensively researched and indexed by Scopus and Web of Science, for example, the keywords Teacher, Technology, Knowledge, Study. Meanwhile, nodes marked with dark colors indicate that these topics have not been studied much. This can foster opportunities to conduct research or research on these topics, for example, the keywords engineering education, TVET teacher, technological pedagogy, professional development, and vocational training, which are connected to the TPVOK field. With bibliometric analysis on density visualization, which shows strain and low intensity, it shows that research on TPVOK related to engineering education, TVET teacher, technological pedagogical, professional development, and vocational training is still relatively low, which makes research on this topic still very broad. to research.

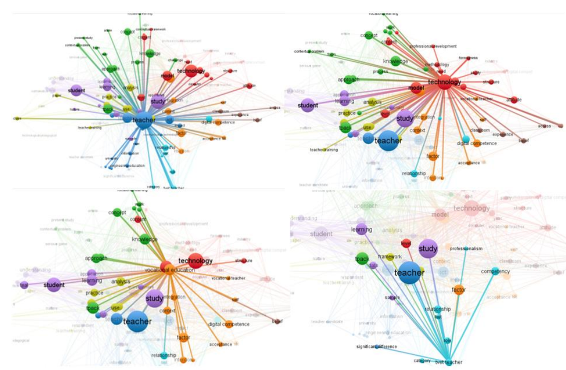

Figure 7 Network visualization of teacher, technology, pedagogical content, knowledge, vocational education, and TVET teacher

Figure 7 displays the relationship network of the terms Teacher, Technology, Pedagogical Content, Knowledge, Vocational Education, and TVET Teacher with other terms namely Vocational Training, Digital Competence, Concept, Pedagogical Context, Content, Student, Learning, TPACK, Work, Engineering Education, etc.. This network of relationships can be interpreted in terms of knowing the research framework that can be built from a combination of several terms that are revealed. Research by [35] reviews the TAWOCK conceptual model of content knowledge for professional teaching in vocational education. Furthermore, [36] review research on how digital vocational teachers are to assess digital competence in vocational education and look at the underlying factors. In addition, [37] reviewed research on can teacher digital competence affect technology acceptance in vocational education.

In addition, this study recommends proposed themes that can be raised as research from the results of the mapping of TPVOK from the results of the VOSviewer mapping. These themes include contextual variations on teacher conceptions of ICT-enhanced teaching in technical education, teaching with and teaching about technology for the professional development of in-service technical education teachers, and Profiling vocational teacher readiness for teaching and learning. Furthermore, the theme of technological integration of prospective teachers is explained by attitudes and beliefs, competencies, access, and experience, multidisciplinary digital competencies of pre-service vocational teachers, tracing TPACK felt by vocational teachers, and applying the Technological Pedagogical and Content Knowledge (TPACK) model to develop courses vocational education can be used.

It can be seen from the mapping results, Vocational Education only has 40 links, and TVET Teacher only has 20 links. From the data that has been analyzed, it can be seen that there has been little research related to these two terms so far. In contrast to the terms Teacher and Technology, which are more relevant and often associated with TPVOK research. Therefore, it can be concluded that the TPVOK under study is still developing and is associated with other terms. So that this research will have a good and higher impact to be used as new research material. So the output mapping results from VOSviewer on research on TPVOK recommend studies that can be studied based on terms that are combined with terms that are rarely researched and can have an impact on research novelty.

4. CONCLUSION

The results of TPVOK research documents in Scopus and Web of Science (WoS) indexed journals through Publish or Perish obtained 87 published articles. To get results that are in accordance with the scientific disciplines, it is necessary to carry out filters or filters that can be narrowed to the Technological Pedagogical Vocational Knowledge (TPVOK) disciplines, namely with the limitations of the keywords Technological Pedagogical Content Knowledge (TPACK), Technological Pedagogical Vocational Knowledge (TPVOK), Technology, Andragogy, Work, and Content Knowledge (TAWOCK), and Vocational.

The development of the growth of publications on the topic of TPVOK in the 2017 – 2022 range taken from the Scopus and Web of Science (WoS) databases through the Publish or Perish software shows fluctuating developments. The highest development of publication growth regarding TPVOK occurred in 2020, namely reaching 21 published articles (24.38%). Meanwhile, the lowest publication occurred in 2018, with 9 articles (10.345%).

Distribution of TPVOK Article Publications in View of Country Distribution that obtained 87 articles from 2017-2022 spread across 28 countries. Of the 87 TPVOK articles indexed by Scopus and Web of Science, 127 terms were grouped into 8 clusters that can be identified through the node color of each keyword. It can be seen from the mapping results, Vocational Education only has 40 links, and TVET Teacher only has 20 links. So the results of this study recommend these two terms to be appointed as the theme of the TPVOK research. So that the novelty of the research results can be a new contribution from previous research.

AUTHORS' CONTRIBUTIONS

Writing original draft, Shilmi Arifah: writing review and editing, Arris Maulana, Riyan Arthur, Firroz Hirzy, Daryati and R. Eka Murtinugraha

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