



Research Article

Analysis of technological pedagogical content knowledge ability of teachers in teaching science in elementary schools

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KEYWORDS

TPACK
science learning
elementary school

ABSTRACT

Learning that is integrated with technological advances has become a necessity in accordance with the development of today's times. Technological pedagogical content knowledge (TPACK) is a new breakthrough in learning that improves the quality of learning, especially in science learning. This study aimed to describe the TPACK ability of elementary teachers in teaching science in SDN 071005 Banua Sibohou, which was described from the perceptions of respondents. The type of this research was descriptive quantitative with research subjects of teachers in elementary schools in SDN 071005 Banua Sibohou totaling 15 people. The data collection instrument in this study used a questionnaire, which was carried out using the survey method. The questionnaire contained 25 statements divided into seven subdomains. The findings of the study indicate that the competence of elementary teachers in SDN 071005 Banua Sibohou was still relatively low, PK was in the high category, CK was in the medium category, TPK was in the medium category, TCK was in the medium category, and PCK was in the high category. From the overall results of the study, the TPACK of elementary school teachers in SDN 071005 Banua Sibohou was still in the medium category and has not been able to implement ICT-based science learning, namely combining knowledge, content, and pedagogics with technology. From the results it can be concluded that the TPACK ability of elementary school teachers is in the moderate category.

How to cite: Zega, D.M.N., Harefa, E., Zendrato, A.Y., & Zega, E.F. (2024). Analysis of technological pedagogical content knowledge ability of teachers in teaching science in elementary schools. *International Conference on Education, Teacher Training, and Professional Development*, 23-28. Malang: Universitas Muhammadiyah Malang.

1. INTRODUCTION

The urgency of Sustainable Development Goals (SDGs)-oriented learning at the higher education level is currently in the spotlight. The United Nations has made SDGs the most pressing public policy. Education is one of the factors for the progress of a nation and a form of human capital for economic growth and sustainable development, following the background of the formulation of the SDGs (Sustainable Development Goals) (Cai & Wolff, 2022; Reimers, 2024). The purpose of education is used as the basis for pushing the goals and targets of the SDGs program, one of which is by building the country through quality and proper education. The teacher is one of the elements of education that is the center of development and

innovation. This is in line with one of the targets in the SDGs which states that education must be supported by qualified, trained, and professional teachers. As professional teachers, they need to have information, communication, and technology (ICT) skills to support learning activities and create a fun learning atmosphere (Kostoska & Kocarev, 2019; Telaumbanua et al., 2023).

As a form of TPACK activities in learning, it is a form of technology used by teachers to carry out the learning process, especially in science learning. Science learning is an activity that connects the concepts of physics, chemistry and biology with phenomena that occur in students' lives. Before implementing learning, teachers must prepare devices, teaching materials, and media for use in the classroom. In developing learning media, teachers utilize technological updates. If the concept is never felt by students, then students have more difficulty imagining the meaning of the concept (Harefa, 2023b; Harefa & Huang, 2023). This causes the reduction of students' science knowledge. So that there needs to be an improvement in the intermediary or media (Zebua et al., 2023)

TPACK is the basis for creating effective learning that utilizes technology that can be used to fix learners' problems to understand difficult or easy lessons and build learners' knowledge by developing methods in learning or consolidating old knowledge. Simply put, TPACK describes the abilities a teacher has about when, where, and how to use technology and guide learners to increase their knowledge and expertise in a particular area of interest. There is a framework that can help teachers integrate technology in lesson plans. The framework is the TPACK framework. The TPACK (Technological, Pedagogical, Content Knowledge) framework is a framework that combines three forms of knowledge, which include technological, pedagogical, and content knowledge TPACK is a development framework from the PCK (Pedagogical Content Knowledge) framework introduced by Koehler et al. (2014). TPACK is a framework that includes the use of technology in the learning process, the pedagogical knowledge used, and knowledge related to the content to be taught (Nilsson, 2022). The TPACK framework is in accordance with 21st-century education, where the use of technology is indispensable in the learning process. Several components make up TPACK, including technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and pedagogical content knowledge (PCK). TCK is the utilization of developing technological science to help achieve an effective learning process. PK is the teacher's knowledge of the implementation of learning. CK is the teacher's knowledge of the content that will be delivered to students. TCK is a knowledge that integrates technological knowledge and content knowledge. TPK is knowledge for integrating technological knowledge and pedagogical knowledge. Further explained, PCK is an integration between pedagogical knowledge and content knowledge.

Teachers will find it easier to deliver material by utilizing existing technology (Belda-Medina & Calvo-Ferrer, 2022; Harefa, 2023). Additionally, in line with what was conveyed by Lachner et al., (2021), the advantage of implementing TPACK is being able to create independent and interactive learning for students. Teachers must be able to use technology so that learning is carried out creatively and innovatively. The application of TPACK to each teacher is of course, different. The different applications of TPACK and the importance of the TPACK framework in learning make researchers want to do further research related to the application of TPACK in learning implementation plans. Research related to the application of TPACK has been carried out by Putri et al., (2020), this research examines the teacher's pedagogical knowledge (PK), with the results of the research showing that the teacher only knows two learning theories, two learning models, and four learning methods. Other related research has also been carried out by Schmid et al. (2021), which shows the results in which there are still several TPACK components that have not been integrated into the lesson plan. Another study by Akyuz (2018) found that the average ability related to TPACK of teachers in state elementary schools in the Tenganan district, Semarang regency was within the acceptable criteria.

Furthermore, the technical aspect is the utilization of ICT in the package to make learning more interesting, interactive, and creative. Therefore, considering the importance of the TPACK ability of SDN 071005 Banua Sibohou teachers as a solution in an effort to improve the quality

of education, this study focused on analyzing the ability of teachers to integrate TPACK in teaching science at SDN 071005 Banua Sibohou.

2. METHOD

This research was a quantitative descriptive approach, which aimed to describe situations or events that occurred in school. The research subjects consisted of 15 teachers working at SDN 071005 Banua Sibohou. The purpose of this research was to collect actual and detailed information that described the facts that occurred in the school. The research method used is the descriptive survey method. The data analysis technique used is the descriptive data analysis technique, which describes and summarizes the data briefly. With the aim of providing an understanding of the initial data and data distribution. Then, the tools used to collect data in the study were observation and questionnaire sheets distributed to each teacher at SDN 071005 Banua Sibohou.

The purpose of this method was to provide a detailed description of the TPACK (content, pedagogical, and technological knowledge) abilities of teachers at SDN 071005 Banua Sibohou. The instrument used was a questionnaire with 25 statement items and seven sub-dominants based on TPACK introduced by Mishra and Koehler. The results of the study were analyzed using descriptive analysis techniques, to determine the presentation of teachers' TPACK abilities at SDN 071005 Banua Sibohou. The indicators used in the questionnaire are in the following Table 1.

Table 1. Indicators used in TPACK

TPACK Component	Indicators
TK	<ul style="list-style-type: none"> • Good mastery of the technology used • The technology used is attractive to learners • Technology used successfully increases learners' interest and motivation • The technology used is easy to operate • The technology used is in accordance with the times • The technology used is in accordance with the level of understanding of students
PK	<ul style="list-style-type: none"> • Have a variety of strategies/ways of instilling concepts to students • Using varied assessment methods and techniques • Mastering and managing the class well • Taking reflective action to improve the quality of learning
CK	<ul style="list-style-type: none"> • Mastering the material taught • Provide relevant examples to improve student understanding • Delivering material logically, clearly, and in accordance with the lesson plan • Answering student questions appropriately • Using the latest sources, such as books, and journals, to improve learning • The technology used helps solve problems
TPK	<ul style="list-style-type: none"> • Using computer applications in learning • Choosing technology that is appropriate to the learning approach and strategy • Using internet facilities to communicate with students for example, to collect assignments or share teaching materials
TCK	<ul style="list-style-type: none"> • The technology used is relevant to the material being taught • The technology used can improve student understanding • Develop student activities and tasks that involve the use of technology
PCK	<ul style="list-style-type: none"> • Choosing learning approaches and strategies that are appropriate to the material being taught • Provide questions to measure students' understanding of the material taught • Preparing lesson plans by yourself and consulting with the supervisor

3. RESULTS AND DISCUSSION

In this study, the three basic components of knowledge are combined to evaluate the ability of SDN 071005 Banua Sibohou teachers in TPK, TCK, PCK, and TPACK. The results of this study based on a questionnaire distributed to teachers of SDN 071005 Banua Sibohou using the survey method. The results can be seen in Figure 1.

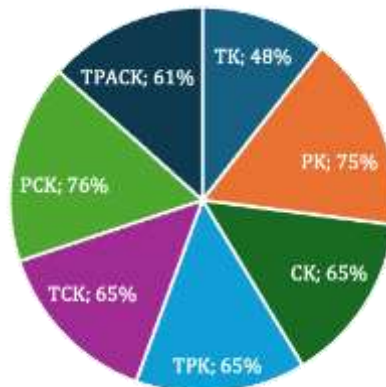


Figure 1. Percentage of TPACK ability of elementary teachers at SDN 071005 Banua Sibohou.

The TK ability of SDN 071005 Banua Sibohou teachers is in the low category (48% are still unable to use technology), PK in the high category (75% can master pedagogical knowledge), CK in the medium category (65% can master learning materials), TPK in the medium category (65% can combine technology with pedagogics), TCK in the medium category (65% can combine technology with content), and PCK in the high category (76% can combine content with pedagogics). Overall, the TPACK of teachers at SDN 071005 Banua Sibohou is still in the medium category (61%).

TPACK is a blend of content, pedagogical, and technological knowledge that includes how to facilitate student learning through pedagogical and technological approaches according to the specific material studied in learning (Kapici & Akcay, 2023). A teacher must have the understanding to interact and have abilities such as the three basic knowledge components viz: PK, CK, and TK to deliver materials using pedagogical methods and technology (Nilsson, 2022; Schmid et al., 2021). Based on the explanation of the research results obtained, it can be seen that the TPACK ability of the SDN 071005 Banua Sibohou is categorized as good (medium) with a percentage of the value obtained of 61%. This can also be seen from the collaboration results of the three components consisting of the subdomains obtained, namely the TK ability of teachers, which is still in the low category, with a result of 48%. In this case the teacher is still less able to use technological tools. PK ability was obtained with a percentage of 75% in the high category. This shows that the teacher's ability to master pedagogics is in the high category. CK ability is obtained with a percentage of 65% in the medium category. From the CK results, the teacher's ability to master learning materials is included in the medium category.

TPK skills have reached a good level, which is confirmed by the data showing that 65% of teachers at SDN 071005 Banua Sibohou have an understanding of how various technologies can be integrated with learning. TPK includes an understanding of the link between technology and education. Therefore, the high percentage of TPK ability is mostly influenced by the pedagogical skills of the teachers. Similar to TCK skills, teachers at SDN 071005 Banua Sibohou have also reached a good level of proficiency. This is supported by data showing that 65% of these teachers have knowledge of the interaction between technology and learning content. Although in general, these teachers master the science subject matter to be taught, they are not yet fully capable of choosing and using technology appropriately to support the science learning material to be delivered in the classroom. This high level of ability in TPK and TCK may also be influenced by the PK and CK abilities of teachers at SDN 071005 Banua Sibohou in

the context of science learning. The situation is evident in the PCK skills, where 76% of teachers at SDN 071005 Banua Sibohou are in the high and good-level categories.

Based on the results of the data analysis, the overall percentage of TPACK skills of teachers at SDN 071005 Banua Sibohou in terms of TK, PK, CK, TPK, TCK, and PCK can be described that as many as 61% of them have good abilities in PK, CK, and TPK. However, they still have limitations in TK, PCK, and TCK. In accordance with research conducted by Li et al. (2022) that, a teacher's TPACK ability is influenced by the number of learning experiences, so that it is directly proportional to the improvement of TPACK ability. This finding indicates that although teachers at SDN 071005 Banua Sibohou have been able to integrate pedagogy and content knowledge with technology in some aspects, they are not fully prepared in terms of technology mastery (TK), the ability to manage content and pedagogy knowledge (PCK), and the relationship between technology and content (TCK). Overall, this illustrates that the implementation of information and communication technology-based science learning is still not optimal at SDN 071005 Banua Sibohou.

5. CONCLUSION

After thoroughly reviewing the data, the conclusion that can be drawn is that in general, the percentage of TPACK abilities of teachers at SDN 071005 Banua Sibohou, analyzed through the prisms of TK, PK, CK, TPK, TCK, and PCK, shows that teachers at SDN 071005 Banua Sibohou have good abilities in PK, CK, and TPK. However, there are weaknesses in TK, PCK, and TCK. In other words, teachers at SDN 071005 Banua Sibohou have strong skills in mastering technology, managing content knowledge and pedagogy, and integrating technology with learning approaches. However, there are still challenges in understanding technology deeply, connecting technology with content knowledge, and designing effective learning strategies with the use of technology. This conclusion indicates that teachers at SDN 071005 Banua Sibohou cannot carry out information and communication technology-based science learning, where content knowledge and pedagogy are combined with technology. Therefore, it is recommended that training for teachers at SDN 071005 Banua Sibohou be organized. This training should include materials related to the teacher competency test, with the aim of improving teachers' pedagogical and professional competence in implementing learning, especially in the context of science learning at the primary level.

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