Technological pedagogical and content knowledge (TPACK) of prospective physics teachers in distance learning: self-perception and video observation

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Abstract

Learning from home in the Covid-19 Pandemic period posed a variety of challenges both for teachers and for students. The ability of teachers to utilize technology in learning is very necessary so that distance learning can run effectively. This study aims to determine the self-perceptions and skills of prospective physics teachers in the Technological Pedagogical and Content Knowledge (TPACK) framework to support distance learning. This research is quantitative research. Self-Perceptions were screened using a questionnaire, 128 research subjects were Physics education students in Samarinda, Indonesia. Then, the skills of prospective physics teachers in the TPACK framework to support distance learning were sought through video observations with 30 research subjects from 128 previous students. Based on data analysis, self-perceptions of prospective physics teachers within the TPACK framework in sufficient category. There is a significant difference between the self-perception of prospective physics teachers who have taken computer training and have never taken computer training. The skills of prospective physics teachers in the TPACK framework are also in the sufficient category. Based on this, educational institutions need to increase learning and training for prospective physics teachers to integrate technology in learning so that their TPACK skills can be improved.

1. Introduction

Covid-19 Pandemic has a very significant impact on human life in the world, one of which is in the world of education. Schools in various countries, including Indonesia, are forced to close and learning is carried out at home to protect everyone's safety. Educational institutions, teachers, students and parents must adapt to this situation. The Ministry of Education and Culture in Indonesia issued a circular of the Secretary General Number 15 of 2020 concerning Guidelines for Implementing Learning from Home during Covid-19 Emergency Disaster in Indonesia [1], one of which aims is ensuring the fulfilment of children's rights to receive educational services during Covid-19 emergency.

The method of implementing learning from home based on these guidelines is by Distance Learning in-and-outside the Network. The role of educators is to facilitate distance learning via online, offline and a combination of both according to the conditions and availability of learning facilities. Educators must adapt to creatively utilize technology, both digital and non-digital technology so that distance learning can run more effectively. Putri, et al [2] stated that the sudden change from face-to-face learning to distance learning requires teachers to use technology. The challenges faced by teachers are not only limited to the availability of facilities and infrastructure to implement distance learning but also the teachers' skill in using technology. In their research, they identified that senior teachers need more effort in integrating technology into learning than junior teachers. Schools already provide training and technical support for teachers, but it takes time for teachers to adapt to the new model of teaching and learning

activities at this time. Based on this, the authors feel it is necessary for prospective teachers, to be introduced to the integration of technology in learning. These skills can be obtained not in a short time, so that when they later become teachers, they already have a lot of experience using technology in learning. They can improve the quality of their teaching both in face-to-face and distance learning.

The skills of integrating technology in learning is one of skills that teachers really need to have in the 21st century, not only needed during Covid-19 emergency, it is just these needs are increasing with the effectuation of learning from home or distance learning. The acceleration of globalization and the rapid development of technology in the 21st century bring various challenges and opportunities in human life. The future is unpredictable, there will be jobs and technology that have not been created at this time, as well as new problems that have not been anticipated. Educators must be open and ready for these things because this situation also brings opportunities for the advancement of human civilization. Children who are still in school, the next 10 or 20 years will become adults who will take part in the development of life. Education plays an important role in the development of knowledge, skills, behavior, and values that enable people to contribute and bring benefits to a sustainable future. Schools need to prepare children to be ready to face various situations and conditions in the future [3].

One of the 21st century skills that students need to have is information, communication and technology literacy, in order to be able to grow these skills in students, teachers must also have these skills. Teachers and prospective teachers as part of education, need to get used to and learn things that are becoming trends in the world today, so that it can help children to learn and adapt and develop to face whatever is in the future. In facing this future, it is not enough if the process of organizing learning is only aimed at making students have some knowledge with the teacher as the center of learning and all instructions given by the teacher. Teachers need organize learning that facilitates students to be able learn to direct themselves and deal with situations or problems that they have never encountered then find their own meaningful and responsible ways with all the potential they have [4].

Based on these things, teachers need to have knowledge of the material to be taught, as well as knowledge in the field of pedagogy to skillfully use effective learning strategies and be able to integrate technology in learning to support the distance learning process. The integration of content knowledge, pedagogy, and technology is better known as Technological, Pedagogical, and Content Knowledge (TPACK) [5]. TPACK is one of the frameworks that integrates Technological Knowledge, Pedagogy Knowledge, and Content Knowledge in a learning context. TPACK was originally developed by Shulman who described about PCK (Pedagogical and Content Knowledge). Further along with the development of science and technology, thinking has evolved into how teachers' understanding of learning technology is linked to PCK to produce effective learning using technology.

There have been many studies conducted relating to the development of instruments to assess TPACK of teachers or prospective teachers because the researchers found that assessments of teacher TPACKs were important [6], research on development and validation of ICT-TPACK-Science [7], research to identify self-portrayal or self-perception of TPACK teachers or prospective science teachers [6][8][9], research conducted to improve the TPACK of teachers or prospective science teachers [10][11], TPACK research to improve various types of student learning outcomes [12][13][14]. The enthusiasm of researchers to conduct research related to TPACK shows the importance of teachers to understand the concept of TPACK so that they can continue to adapt and prepare students so that they are ready to face the future with rapid technological development.

From previous studies of TPACK teachers or prospective science teachers, there has not been much research on TPACK relating to its role in supporting distance learning, especially in the current pandemic situation. Therefore, the authors conducted research related to this matter with the aim of identifying self-perception and TPACK skills of prospective physics teachers in supporting distance learning.

2. Methods

This research is quantitative research. The first study was conducted with 128 research subjects in physics education study programs in Samarinda, Indonesia. Research subjects were asked to fill out a questionnaire about their self-perception related to TPACK they have. The questionnaire consisted of 36 statements with five Likert Scales. The questionnaire is an adaptation of the questionnaire developed by Schmidt, Baran, and Thompson, in 2014. TPACK in this questionnaire consists of seven components of Technology Knowledge (TK), Pedagogical Knowledge (PK),

Content Knowledge (CK), Technological and Content Knowledge (TCK), Technological and Pedagogical Knowledge TPK, Pedagogical and Content Knowledge PCK, and TPACK. In the analysis of the data, a t-test was also conducted to find out whether or not there was a significant difference between the self-perception of TPACK prospective physics teachers who had attended computer training and had never attended training. Furthermore, 30 of the 128 previous research subjects were re-included for further research. They are asked to make planning and learning media in the form of videos that can be used to support distance learning. Planning and learning media created by prospective physics teachers are used by researchers to identify their skills within the TPACK framework. Observations were made using observation sheets with five Likert Scales arranged based on the TPACK indicator which allows to be observed via video. Consists of 17 observation items, an adaptation of the questionnaire developed by Schmidt, Baran, and Thompson, in 2014. For categorizing self-perceptions and skills of prospective physics teachers in TPACK framework the benchmark assessment method is used, it can be seen in in table 1 below:

Table 1. Self-perception and skills of prospective physics teacher categorization

The Range of Value	Categorization
$100 > x \geq 80$	Excellent
$80 > x \geq 70$	Good
$70 > x \geq 60$	Sufficient
$60 > x \geq 40$	Not Good
$40 > x \geq 0$	Very Bad

3. Result and Discussion

3.1 TPACK self-perception of prospective physics teachers

In this study, 128 students completed the questionnaire in the physics education study program in Samarinda, Indonesia. Then the answers from prospective physics teachers are processed in the form of scores and the average scores are analyzed using Microsoft Excel and an average score of 3.44 is obtained. If the average score is expressed in terms of values, a value of 68.71 is found in the sufficient category through the following calculation:

Average score of TPACK Self-perception = $average\ score\ /maximum\ score\ x$ 100 = 3,44/ 5 x 100 = 68,71 (1)

TPACK data acquisition is then broken down again for each component, including Technology Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technology and Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), Technology and Content Knowledge (PCK) TCK), and Technology and Pedagogical Content Knowledge (TPCK). Results The average value of each component of TPCK can be seen in the following figure 1:

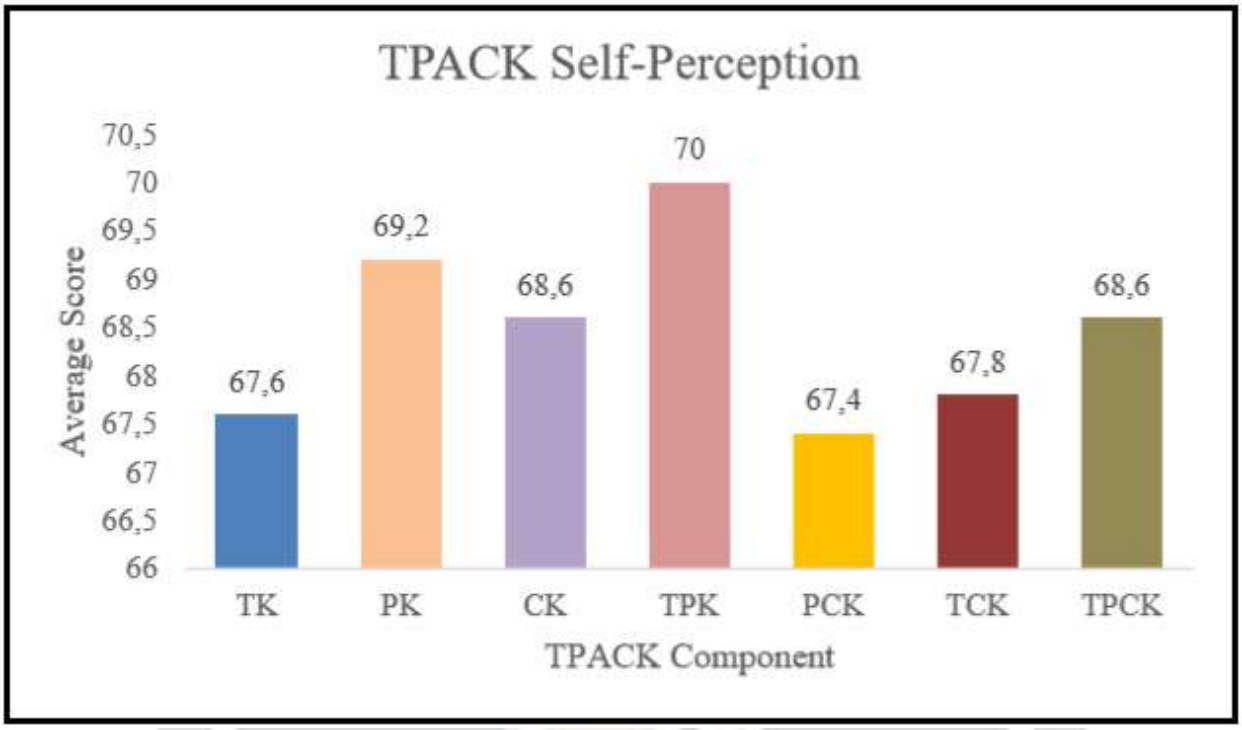

Figure 1. Graph of TPACK self-perception of prospective physics teachers in every TPACK component

Figure 1 shows that the TPACK Self-Perception of Prospective Physics Teachers for TPK component is in the good category while TK, PK, CK, PCK, TCK, and TPCK are in the sufficient category. The highest average value is in the TPK component and the lowest is in the PCK component. These results are in line with research conducted by Luik, et al [15] where prospective teachers in Estonia have good knowledge on the components of integrating technology in learning (TPK).

If grouped based on participation in computer training, there are 70 prospective physics teachers who have attended computer training and have never attended computer training as many as 58 people. The results of the average score of TPACK self-perception of physics teacher candidates who had attended computer training was 3.52 and the physics teacher candidates who had never attended computer training were 3.32. If the average score is expressed in terms of scores, each score of 70.4 is in the good category and 66.4 is in the moderate category. The comparison graph can be seen in Figure 2 below:

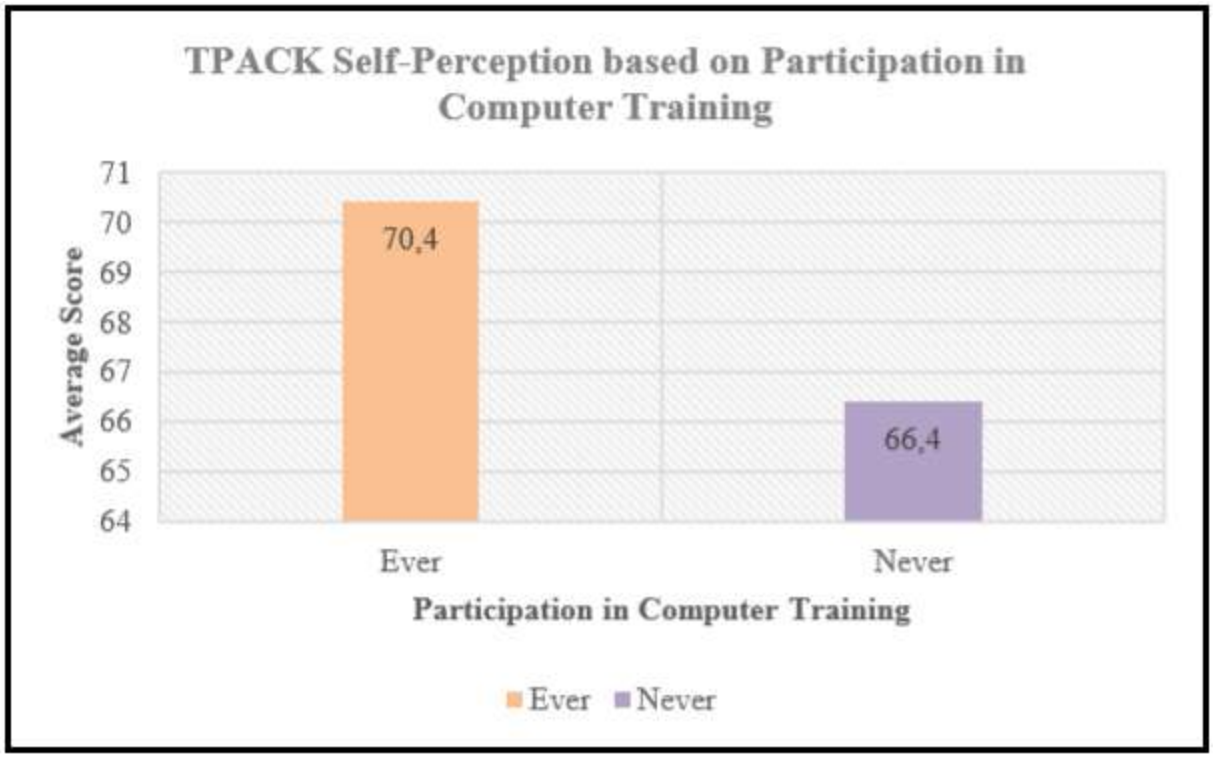

Figure 2. Graph of TPACK self-perception of prospective physics teacher based on participation in computer training

TPACK Self Perception Prospective Physics Teachers who have attended computer training are better than those who have never attended computer training. Based on the analysis using the T-test to determine the significance level of the data, the value of t arithmetic was 1.935 and t arithmetic was 1.65 with $\alpha = 0.05$. From these results, it is known t count> t table which means there is a significant difference in the self-perception of TPACK candidates for physics teachers who have attended computer training with those who have never attended computer training.

From this research, it is known that there are factors that might influence the ability of TPACK students, one of which is the experience of a prospective physics teacher, one of whom is by attending computer training activities. physics teacher candidates who have attended computer training have a better TPACK self-perception than physics teacher candidates who have never attended training. By participating in technology integrated learning training, it will increase the experience of prospective physics teachers so that their TPACK self-perceptions can increase, this is in line with the results of research conducted by Bahcivan and Aydin [16] namely the relationship between self - confidence of prospective science teachers and their experiences.

3.2 skills of prospective physics teachers in the TPACK framework to support distance learning

The skills of prospective physics teachers in the TPACK Framework are analyzed by observing planning and learning videos that have been created in order to support distance learning so that it can run more effectively. The observations were processed in the form of scores and the average scores were analyzed using Microsoft Excel and an average score of 3.29 was obtained. If the average score is expressed in terms of scores, a score of 65.69 is obtained in the sufficient category.

Analysis of the data per TPACK component shows the PCK indicator obtains the lowest average compared to other components of 3.17 or a value of 63.47 with a sufficient category. The highest average score is found in the TK component with an average score of 3.87 or a value of 77.42 in either category. Prospective physics teachers have good knowledge of technology, both digital and non-digital technology. However, when the technology needs to be integrated in learning so that learning becomes more effective, these skills are still limited. For example, prospective physics teachers already have the ability to use technology to create instructional media, but media that are limited to writing and audio, not because they cannot include images or other features in the media but prospective physics teachers have not realized by adding these features it is possible can facilitate students in understanding learning.

Ocak and Baran [8] state that the benefits of technology, easy access from technology sources, and compatibility with the material to be taught are some important factors that influence teachers in choosing technology in learning. This is in line, when the physics teacher candidates make plans about the experimental activities that can be done at home only related to the Doppler effect material, some physics teacher candidates choose to use virtual experiments because of the limited means and infrastructure that they can use at home to conduct real experiments. Spiteri and Rundgren [17] state that there are four factors that influence the use of digital technology by teachers, among others 1) teacher knowledge relating to what, how, and why technology is used, 2) attitudes towards the use of digital technology related to self-confidence, belief, and self-efficacy and 3) skills that also affect and are influenced by 4) school culture.

Comparison between Prospective Physics Teachers' Self Perception and Skills in TPACK Framework can be seen in Figure 3 below:

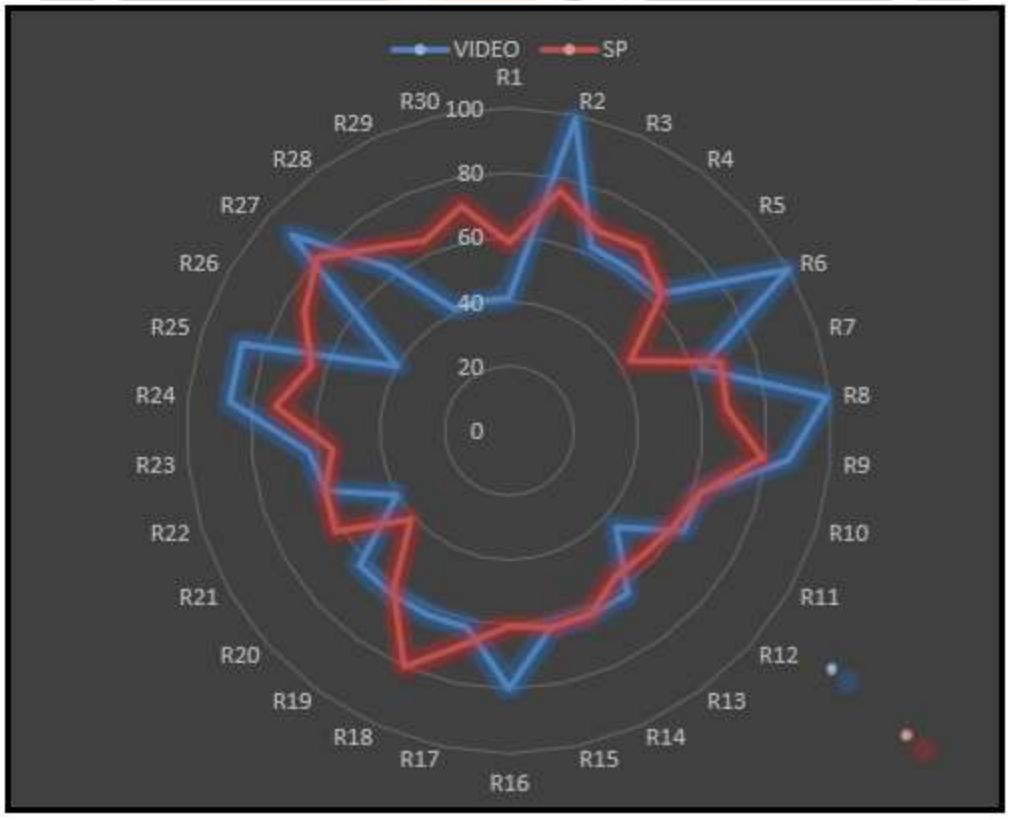

Figure 3. Prospective physics teachers' self-perception and skills in TPACK framework for each respondent

4. Conclusion

Based on the results of the study it can be concluded that the self-perception and skills of prospective physics teachers in the TPACK framework are in sufficient categories. Prospective physics teachers who have attended computer training have a better self-perspective about the TPACK they have compared to those who have never attended training at all. The skills of prospective physics teachers in the TPACK framework in the TK component are in the good category while the other components are only in the sufficient category. This shows that prospective physics teachers have good knowledge and skills in the field of technology, but still need to practice to integrate technology in learning. Therefore, teacher training and education institutions as institutions that play a role in producing educators, need to increase training for students to be able to integrate technology, pedagogy, and science content in learning. Students as a prospective physics teacher will later become teachers in the technological era who must prepare their students to survive in the current flow of globalization which continues to develop rapidly.

5. References

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