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Preface

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Preface
National Seminar of Physics Education
Universitas Lambung Mangkurat, Banjarmasin, Indonesia
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The National Seminar of Physics Education/ Seminar Nasional Pendidikan Fisika (SNPF) 2021 was organized by the Physics Education Study Program, Teacher Training and Education Faculty, Universitas Lambung Mangkurat (ULM) in collaboration with the Physical Society of Indonesia (PSI), South Kalimantan branch. The SNPF covers several fields of study, including strategy, models, methods, media, and evaluation in learning physics, chemistry, biology, mathematics, physics research results, artificial intelligence, future science development, and general education.

The theme raised was "Optimizing STEM Learning in Creating a Generation that is Excellent, Character, and Competitive in the Era of Society 5.0". This seminar is a scientific forum that is very appropriate for sharing and disseminating research results and the best contribution in facing the Era of Society 5.0 by strengthening efforts to produce a generation that is Excellent, Character, and Competitive, which are great opportunities for this nation.

On behalf of the committee, we would like to thank the Chancellor of Universitas Lambung Mangkurat, Dean of the Teacher Training and Education Faculty, Head of the Mathematics and Natural Sciences Major, advisory board, steering committee, all committee members, reviewers, presenters, and participants. Special thanks are also given to the Proceedings of the IOP Conference. On behalf of the SNPF 2021 committee, we would like to thank all parties for their participation in supporting this publication. We hope to see everyone at the next conference.

Kind regards,

Dewi Dewantara, M.Pd.
Chair of the SNPF 2021

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Fostering TPACK in pre-service physics teachers during the covid-19 pandemic

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Fostering TPACK in pre-service physics teachers during the covid-19 pandemic

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Abstract. The pandemic situation forces the educational system to respond to a variety of issues. During the pandemic, it's essential to learn more about Technological-Pedagogical-Content-Knowledge (TPACK) and how it can be incorporated into pre-service physics teacher preparation. This qualitative research collects data from ten online teaching videos and ten offline teaching videos of 20 pre-service physics teachers. This study attempts to comprehend the appearance of each TPACK component by analyzing the videos with an observation sheet. The observation sheet explored seven components of TPACK, which are Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Knowledge (TK), Pedagogical and Content Knowledge (PCK), Technological and Content Knowledge (TCK), Technological and Pedagogical Knowledge (TPK), and the last is Technological, Pedagogical and Content Knowledge (TPACK) itself. The result showed that pre-service teachers were determined good TPACK skills, but lacked in certain components. From the result, in both online and offline microteaching, participants rarely showed their TPK. In online activities, it is also seen that participants were faced difficulties in applying their PCK. The different nature of online and offline microteaching drives the need for teacher education institutions to plan and implement microteaching in the pedagogical courses to improve pre-service teachers' TPACK in both situations.

1. Introduction

The COVID-19 pandemic has greatly affected higher science education which caused offline learning on campus to be banned [1,2]. Though it is too early to accurately predict the widespread implications for higher education, as the scope and consequences are immense and unclear [1], education systems need to adapt to this new situation in scientific ways. Online learning seems to be the best alternative considering the current health emergency [3]. Before the pandemic, the implementation of online learning was insignificant [2], especially in developing countries such as Indonesia.

Science teacher education programs have now offered online classes for pre-service teachers. The positive result of the pandemic is that with advanced technology, online interaction between lecturers and pre-service teachers has become more frequent than ever [1]. There are still challenges to overcome. One of them is how to teach these pre-service teachers field-based experiences [4]. Microteaching is one of the courses that are best conducted with traditional face-to-face learning. Therefore, the outcome of the microteaching course could be different if done online. This becomes a worrisome issue considering microteaching is a course that helps to develop pre-service teachers' TPACK [5,6] It is essential for teachers to create technical knowledge and incorporate it into content, teaching, and learning in a specific context [7]. Therefore, the ability of pre-service teachers to integrate technology, pedagogy, and content, or TPACK, is strongly needed [6].

TPACK ability is a crucial part of ensuring the proper conduct of online learning during a pandemic [8,9]. Learning activities are based on knowledge of the material to be taught (content knowledge), knowledge of how to teach a material, and knowledge of how to use various technologies, all of which have intersections or intersections to support each other [6] and pre-service teachers need master this knowledge [10]. TPACK is a framework for integrating Technological Knowledge, Pedagogical Knowledge, and Content Knowledge in a learning context. TPACK came from PCK described by Shulman. As science and technology have evolved, so has thought on how teachers' understanding of learning technology is tied to PCK to support successful learning using technology [10]. TPACK aims to define the knowledge teachers need while integrating it in their teaching, which includes seven components [11]. The TPACK diagram includes three core categories of knowledge, including pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK), in which these three cores are then combined to create the other components that are Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical and Content Knowledge (TPACK) itself [12].

Pre-service teachers with high TPACK skills have an increased chance of achieving their programs' goals to become well-polished teachers [11]. Professional competence is the teacher's ability to master the subject matter broadly and deeply [13]. Many pieces of research have been done to examine TPACK, such as [12] which investigated the role of TPACK in the physics classroom, [14] which analyzed technological pedagogical content knowledge self-confidence of prospective pre-school teachers during the pandemic, and [6] who investigated teaching ability of prospective teacher in terms of TPACK in microteaching courses. However, little has been researched to investigate the fostering of pre-service physics teachers' TPACK during the pandemic. Therefore, this research was carried out to find the TPACK abilities of prospective physics teachers in online and offline microteaching.

2. Method

This qualitative research investigated 20 physics pre-service teachers' TPACK during the COVID-19 pandemic in online and offline learning. The sample selection in this research is purposive sampling. Puposive sampling relies on the researcher's judgment for selecting persons [15] with characteristics that are defined for purpose that is relevant to the study [16]. Purposive sampling procedures differ from random sampling in that they ensure that particular types of instances from those who could potentially be included are included in the final sample in the research study. A relatively small and purposefully selected sample may be used in a qualitative study to increase the depth of understanding [17]. These pre-service teachers were purposively selected among the final year students of Physics Education, Mulwarman University, and made a microteaching video about teaching a specific physics topic. These samples are chosen considering the fact that Physics Education in Mulwarman University conducted the microteaching course in the academic year 2020/2021. The microteaching course was conducted both online and offline so that it is in accordance with the purpose of this research. The microteaching videos were then used to identify the pre-service teachers' skills within the TPACK framework. Preliminary analysis is carried out to classify the videos based on the topics taught, duration and whether it's done online or offline.

This research instrument was investigating seven components of TPACK, which were Content Knowledge (CK), Pedagogical Knowledge (PK), Technology Knowledge (TK), Pedagogical and Content Knowledge (PCK), Technological and Content Knowledge (TCK), Technological and Pedagogical Knowledge (TPK), and Technological, Pedagogical and Content Knowledge (TPACK). The observations were made using observation sheets with two Likert Scales arranged based on the TPACK indicator, which allows observation via video. From the data obtained, data analysis was carried out by calculating the average TPACK value for each component. The observations were processed in the form of scores, and the average scores were analyzed using Microsoft Excel. If the average score is expressed in terms of values, it can be found through the following calculation:

$$\text{The average value of TPACK skill} = \frac{\text{average score}}{\text{maximum score}} \times 100 \; [10]$$

Then, the comparison of TPACK skills of the pre-service teachers based on online and offline learning is conducted.

3. Result and Discussion

The distribution of 20 microteaching videos is as follows:

Table 1. Microteaching videos distribution

Code name	Learning Type	Lesson Topic	Duration
DR	Online	Moment of Force (Torque)	20 m 30 s
MHS	Online	Work and Energy	23 m 33 s
FFM	Online	Kirchoff's Second Law	19 m 32 s
DS	Online	Archimedes' Principle	20 m 16 s
HN	Online	Moment of Force (Torque)	25 m 43 s
SDTM	Online	Pascal's Law	24 m 25 s
NP	Online	Optical Instrument (Magnifying Glass)	15 m 52 s
Z	Online	Hydrostatics	19 m 28 s
MZOA	Online	Electromagnetic Induction	21 m 19 s
RTA	Online	Mechanical Wave	20 m 50 s
DPA	Offline	Thermal Expansion	27 m 4 s
DO	Offline	Moment of Inertia	23 m 14 s
LJ	Offline	Uniform Circular Motion	28 m 42 s
MY	Offline	Uniform Linear Motion	25 m 47 s
NR	Offline	Heat and Black Principle	26 m 14 s
PAR	Offline	Impulse and Momentum	19 m 29 s
RS	Offline	Hooke's Law	24 m 33 s
ST	Offline	Work and Energy	24 m 36 s
RA	Offline	Uniformly Accelerated Linear Motion	27 m 6 s
FDS	Offline	Surface Tension	19 m 41 s

This study is essential to understand how teachers can apply technological, pedagogical, and content knowledge (TPACK) into online and offline learning during COVID-19. The seven constructs of TPACK are comprehensive because they recognize the interaction between content, pedagogy, and technology. In this study, 20 final-year physics students from Mulawarman University, Samarinda, were observed by analyzing the learning videos they have made. Each component of TPACK data collection was then broken down further, including Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technology Content Knowledge (TCK), Technology Pedagogical Knowledge (TPK), and Technology Pedagogical and Content Knowledge (TPACK). The pre-service teacher' TPACK skills is shown in Figure 1.

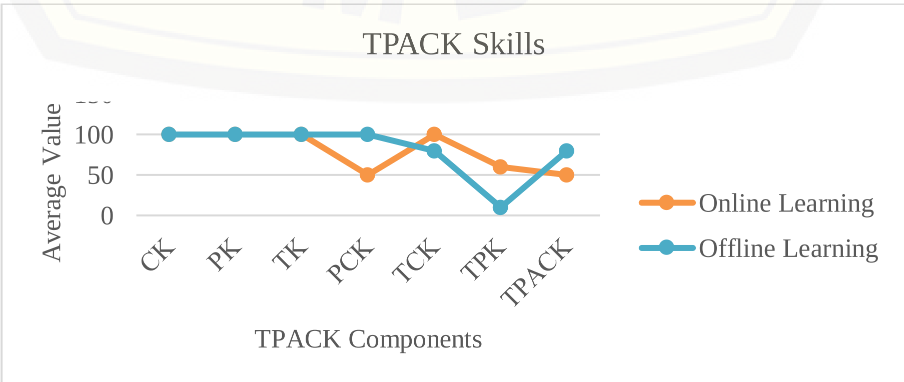

Figure 1. Graph of Physics Pre-service teachers' skills in TPACK components

Out of seven components measured, Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK) are the ones that have the highest average value of 100. This result shows that pre-service teachers both in online and offline learning master learning physics content and skills in using technology and creating an effective learning environment. However, pre-service teachers in online learning's average value suddenly dropped in Pedagogical Content Knowledge (PCK) with the value 50, the videos show that the pre-service teachers still struggle to choose learning methods based on the topics taught. They barely had any discussion with the students and corrected students' perceptions on the topics. In contrast, the offline learning side still stands tall with their 100 value. Most of the pre-service teachers chose to conduct physics practice in the laboratory to assist students in gaining a better understanding of the lesson. This allowed them to have a deeper discussion with the students and help them to achieve the purpose of the practice. This result indicates the research in developing exemplary physics lessons is needed. Pre-service teachers need to explore more the implementation of specific teaching model in specific topics, such as in STEM education [18].

In Technological Content Knowledge (TCK) domain, pre-service teachers in online learning show an increase in their value of 100. It is reasonable since in online learning, they have to rely in technology to present the content. All of them have at least used PowerPoint to show the material, and few others have also used virtual laboratory, whereas almost none of the pre-service teachers in offline learning use any technology to present their content. Though the tools used to conduct the physics practice were some of the most recent technologies, explains how the pre-service teachers. The TCK domain is strongly influenced by the CK and TK domain. Pre-service teachers that have a low CK domain will address low conceptualization in their teaching [19]. And the next component which is Technological Pedagogical Knowledge (TPK), the average value of pre-service teachers in online and offline learning has dropped significantly which are 60 and 10 respectively. They failed to integrate technology into their learning environment as shown by taking attendance of the students manually, whereas they could use Google Form, Microsoft Form, or any Learning Management System (LMS). The pre-service teachers also rarely put assignments into a platform so the students can submit their works efficiently.

In the last component which is Technological Pedagogical and Content Knowledge (TPACK) itself, the value of pre-service teachers' in online learning has dropped once again to 50, it shows that the teachers' can not apply the appropriate technology in assessing the learning process and outcomes. In the other hand, the pre-service teachers' in offline learning has redeem themselves with a higher value of 80. This means they have more understanding in applying the appropriate technology in assessing the learning process and outcomes.

The results demonstrate that there is a different pattern of TPACK skills between pre-service teachers that teach in online learning and offline learning. The average value of pre-service teachers in online learning has decreased in PCK (Pedagogical Content Knowledge), where videos demonstrate that pre-service teachers continue to struggle to pick learning methods depending on the topics presented. Whereas almost no pre-service instructors in offline learning utilize any technology to convey their curriculum under the TCK (Technological Content Knowledge) domain. In the TPK (Technological Pedagogical Knowledge) domain, the average value of pre-service teachers in online and offline learning has considerably decreased. They neglected to incorporate technology into their teaching and learning environment. It should be emphasized that pre-service teachers have distinct areas that need to be addressed in both online and offline learning. It is not surprising given that the sessions are held in different settings; thus, the way pre-service teachers perform may also be impacted.

4. Conclusion

From this research results, it can be concluded that the physics pre-service teachers in both online and offline learning have overall good TPACK skills, though the pre-service teachers in offline learning has a slightly higher average value. The pre-service teachers in both conditions of lack the skills in TPK component. This shows that they need more practice to integrate technology in learning. The pre-service teachers that conducted online learning especially lacked the skills in PCK that show that they have yet to learn more about creating the right learning environment for a certain topic. These findings highlight the importance of expanding courses that address components that are deficient in the learning processes of prospective physics teachers.

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