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Online Microteaching: Unveiling Female Pre-service Physics Teachers Technological Pedagogical and Content Knowledge (TPACK)

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Abstract.

Global trends show that men dominate physics-related jobs. However, there is a unique phenomenon, especially in Indonesia in the physics teacher education program where there are more female students than male students. This study aims to determine the TPACK of female pre-service physics teachers consisting of 15 pre-service teachers taking microteaching courses and making their online learning videos. The videos were used as a data collection tool. A microteaching observation sheet was used to analyze data obtained from observations with two raters. The observation sheet consisted of 6 aspects which were content knowledge (CK), pedagogical knowledge (PK), technological knowledge (TK), pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK) with four indicators for each aspect and the maximum score per aspect is four. The overall TPACK score was obtained by calculating the average of all aspects. Although the overall result of female pre-service physics teachers is 2.1 which is sufficient, technological-related aspects need more concern. The results showed that female pre-service physics teachers lack technological pedagogical knowledge (TPK). On the contrary, they have high pedagogical knowledge (PK). Teacher education programs should provide opportunities for female pre-service teachers to develop their TPACK. Online microteaching can be the key to helping female pre-service physics teachers to integrate technology into their learning.

Keywords: microteaching, technological pedagogical and content knowledge (TPACK)

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1. INTRODUCTION

In the twenty-first century, the rapid development of information and communication technology (ICT) has provided a massive acceleration to all aspects of education [1, 2]. These changes are creating new expectations for today's schools and teachers. To meet these expectations, today's students are expected to gain so-called twenty-first century skills [3]. The learning process and environment should open equal access to qualified tools, technologies, and learning resources resulting in students being ready to be in the digital era [2]. Thus, teaching is a profession that demands more excellent skills and expertise [4, 5], especially in technology [3].

However, effective teaching with ICT has become more challenging [6]. To successfully utilize digital technology tools in an educational context, pre-service teachers should be able to integrate their technological knowledge and apply it in a particular educational context [7]. This suggests that twenty-first-century skills must be included in teacher education [3], but most pre-service teacher preparation programs offer instructional technology courses that focus on technology skills only where it's not sufficient to prepare pre-service teachers for the pedagogical integration of technology [8]. Even if pre-service teachers know how to operate a piece of technology, they might not know how to use it effectively to promote student learning [9].

Accordingly, it is crucial for a teacher training program to nurture pre-service teachers' for technology integration to specific content areas and pedagogical approaches [1, 10]. Many educational researchers recognize the TPACK (Technological Pedagogical and Content Knowledge) framework as a theoretical basis for developing pre-service teachers' understanding of how to use technology constructively to support students' learning [9] and their 21st-century skills development [3]. In the integrative model, TPACK is not a different form of knowledge. It is a combination of Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK) and resulting in intersection domains such as Pedagogical Content Knowledge (PCK); Technological Content Knowledge (TCK); and Technological Pedagogical Knowledge (TPK).

To be successful teachers in their future careers, both female and male pre-service teachers need to develop their TPACK. But, many researchers have indicated a difference in the TPACK of pre-service teachers concerning gender. Female pre-service teachers tend to have a low understanding of technology related domains [11], especially TK [12, 13] and CK [14]. But, in the other hand they have high understanding in pedagogical related domains such as PK [13] and PCK [4, 13]. One probable explanation is that women are considered natural carers for children [15], therefore the function of

teachers is connected with women, and a desire to educate is regarded as feminine [16]. However, many of the previous studies used survey as their data collecting tools, and compared to survey studies, studies with performance assessment methods provide deeper insight into the nature of pre-service teachers' TPACK [17]. Therefore, this study aims to understand female pre-service physics teachers' TPACK through microteaching videos analyzed by two people with an observation sheet.

2. RESEARCH METHOD

This study employed a descriptive quantitative method to assess to assess female pre-service teachers' TPACK in online learning. The purpose of quantitative description is not a detailed understanding of a particular a phenomena, but rather a more general comprehension of trends in said topic [18]. Purposive sampling was used in this study, which depends on the researcher's discretion in picking persons with characteristics established for a goal relevant to the investigation [19, 20]. Purposive sampling techniques differ from random sampling procedures in that they ensure that specific sorts of instances are removed from those who may possibly be included in the research study's final sample.

These 15 female pre-service teachers were chosen from Mulawarman University and the University of Jember's final-year Physics Education students. They completed the microteaching course and created a learning video on a specific physics topic. The microteaching videos were then used to assess pre-service teachers' knowledge and skills within the TPACK framework. Preliminary analysis is performed to categories the videos based on the topics taught, duration, and audio and visual quality.

Two observers used an observation sheet to observe the videos, which consisted of six domains of TPACK: Content Knowledge (CK), Pedagogical Knowledge (PK), Technology Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK). Two observers, one of them being the first author and the other a professional physics teacher, analyzed the videos with 4 indicators for each domain, and the frequency of indicators that appeared in the video determines the score of every pre-service teacher's skill. Cohen's Kappa was used to measure the inter-rater reliability of the two observers. Cohen's kappa, represented by the lower-case Greek letter (7), is a reliable statistic that may be used for interrater reliability testing. It can vary from -1 to +1, similar to correlation coefficients, where 0 indicates the degree of agreement predicted from random chance and 1 reflects a perfect agreement between the raters [21], as shown below in Table 1.

TABLE 1: Interpretation of cohen's kappa.

Value of Kappa	Agreement Level	Reliable Data (%)
0 – 0.20	None	0 – 4
0.21 – 0.39	Minimal	4 – 15
0.40 – 0.59	Weak	15 – 35
0.60 – 0.79	Moderate	35 – 63
0.80 – 0.90	Strong	64 – 81

The final data analysis was carried out by calculating the average score for each domain score of each pre-service teacher using Microsoft Excel. If the average score is expressed in terms of values, it can be found through the following calculation:

$$CK\ average\ value = \frac{each\ pre-service\ teacher's\ score}{15} (1)$$

After calculating each domain's average value, then the TPACK overall value was also analyzed using Microsoft Excel with the following calculation:

$$TPACK\ overall\ value = \frac{each\ domain's\ average\ value}{6} (2)$$

3. RESULTS AND DISCUSSION

In this study, 15 female pre-service teachers were observed through their microteaching videos with an observation sheet to understand their TPACK skills by two observers. The interrater reliability analysis was conducted on the collected data with SPSS software. The result showed that the data of each domain had a coefficient of reliability of >0.8, which was categorized as strong. Then the average scores of each domain are analyzed using Microsoft Excel and can be seen in the Figure 1.

As seen in the Figure 1, female pre-service teachers have a high average value in CK, PK, PCK, and TCK but a low average value in TK and TPK. This shows that female pre-service teachers have the excellent content knowledge to teach and know many great ways to deliver them to the students. They taught the contents thoroughly and connected the current material to the prior material. These pre-service teachers are also seen showing the application of the topic in daily life to make it more understandable. Pre-service teachers in online learning must be able to sort the material that will be given in the classroom [22], and this the CK score shows that they were quite selective in assessing the gathered information. As in the PK domain, the female pre-service teachers frequently had many interactions with the students, such as opening the lesson

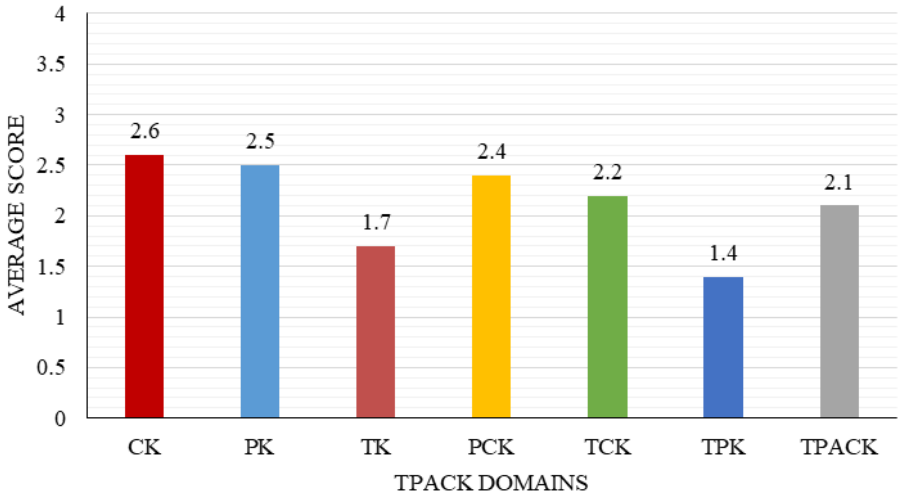

Figure 1: Female pre-service teachers' skills.

with a greeting and asking them about their wellbeing. They also gave good feedback to the students who answered or asked questions.

From the PCK perspective, female pre-service teachers attempt to teach the content with many different teaching models, such as Problem-Based Learning and Discovery Learning. Before the lesson started, the pre-service teachers explained the instructional objective of the class as it's essential for students to plan their studies and prepare for examinations and for teachers to plan instruction and devise tests. The pre-service teachers also show good strength in PCK, considering many of them facilitate the students and encourage them to conclude the lesson.

However, pre-service teachers' average value suddenly dropped in TK. The videos show that the pre-service teachers don't have decent skills in using technology. Given the lack of videos or visuals in the lesson, most of them offer the lesson in "boring" situations. This doesn't mean pre-service teachers can not include images or other features in the media, but they have not realized that adding these features is possible and can facilitate students in understanding learning [23]. In online learning, they are required to create at least one presentation using a particular program, yet many of them fail to make an intriguing presentation even with the assistance of PowerPoint. They also struggled to use the PowerPoint and Zoom Meeting applications effectively.

On the other hand, female pre-service teachers had a higher average value in the TCK domain. Given the nature of online microteaching, they must employ at least one application to provide the material, and they prefer to use interactive media. Some of them made use of a digital whiteboard and a virtual laboratory that was compatible with the topic presented. Pre-service teachers who chose a teaching model required to do an

experiment or practice used PhET “Interactive Simulations” because the microteaching is done online and can’t do the practice in the laboratory. Even though female pre-service teachers excel in the TCK domain, the same case doesn’t apply in the TPK domain, considering they have the lowest average value out of all the domain. Pre-service teachers treat online microteaching as a traditional face-to-face learning by taking attendance manually and directly giving the homework at the end of the lesson, instead of using Learning Management System (LMS) such as Google Classroom or Schoology. This shows that their skills to integrate technology into learning, especially in online microteaching are still limited [24].

After assessing all six domains, it’s no surprise that the total TPACK of female pre-service teachers had taken a downward turn, given that the complicated component was regarded a problem for pre-service teachers [25]. This may affect how the students take their lesson considering it’s important for teachers to deliver the contents with the right approach and utilize the available technology. Female pre-service teacher’s individual TPACK overall value is shown in Figure 2.

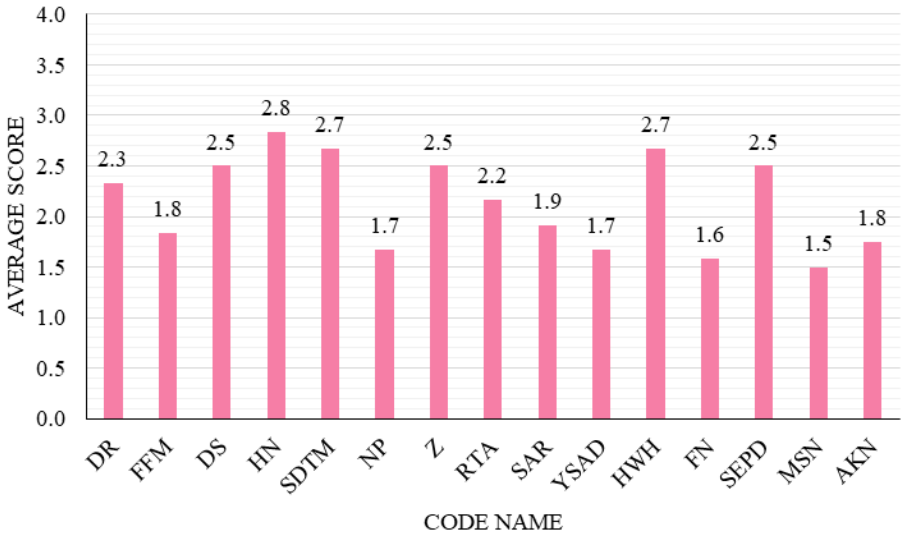

Figure 2: Female pre-service teachers’ TPACK skill.

The minimum TPACK score for female pre-service teachers is 1.5 and the maximum is 2.8, indicating that they have adequate TPACK skills. Many of them expertly controlled the class by connecting with the students and selecting the best approach to teach a certain topic. Nonetheless, they struggled to incorporate technology into the lecture, although the score differs from one person to another. These findings suggest that teacher preparation programs should provide pre-service instructors with training to

encourage the development of TPACK. More TPACK examples from teacher educators are also required during the microteaching course.

4. CONCLUSION

The findings indicate that female pre-service physics instructors have enough understanding of CK, PK, PCK, and TCK but lack proficiency in TK, TPK, and TPACK. This indicates that pre-service teachers require extra assistance in technological fields. As a result, teacher preparation programs, as institutions that foster educator candidates, must expand training for students in order to combine technology, pedagogy, and physics subject into learning. The number of technology-related optional courses should be raised to boost technical awareness among female pre-service teachers. They will eventually become instructors in the technology era, where they will have to educate their students to live in the present flow of globalization, which is fast developing.

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