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TPACK Competency Evaluation of Preservice Teachers in Microteaching

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Abstract. Technological Pedagogical and Content Knowledge (TPACK) is now recognized for teacher development and preparation programs. The purpose of the study was to evaluate the TPACK competence in microteaching of preservice teachers. The research approach uses qualitative research using the curriculum evaluation design of Stake Countenance Model with data collection including lesson plans, teaching practice activities, performance assessment, and in-depth semi structured interviews. The results of the microteaching evaluation program using an analysis of the ability to integrate pedagogy, content, and technology within the TPACK competency framework. In general, preservice teachers still use technology less, because the lesson plans design dont use learning technology. So for the development of TPACK competencies, preservice teachers provide opportunities for preservice teachers to apply technology in biology learning and use various learning strategies.

Keywords: Microteaching; Preservice Teacher; TPACK.

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INTRODUCTION

Technological Pedagogical and Content Knowledge (TPACK) is now recognized for teacher development and preparation programs. The new era of teaching and learning does not only focus on content, but also on pedagogical, technological, and educational knowledge with learning strategies for teacher preparation programs (Nuangchalerm, 2020). Technology is becoming an integral part of the educational curriculum, and it is important that teachers have knowledge of pedagogical content, and technology to successfully integrate technology into learning (Yildiz & Gokcek, 2017).

Professional Science Teachers are very important to improve the quality of education in Indonesia. They must have four competencies, namely pedagogy, personality, professional, and social, where they not only master the subject matter but also technology and pedagogy. A framework that can demonstrate a teacher's knowledge of pedagogy, content, and technology within the TPACK framework (Setiawan & Phillipson, 2020). The spread of technology to many schools there increasing the potential use in education. however, the availability of simple technological facilities does not necessarily lead to the effective use of technology in education (Malik et al., 2019).

Preservice Teachers (PST) may have a high TPACK rate on a subject, technology, but may also have a low level with others. Therefore, focusing on a particular topic, technology, or pedagogical methodology does not provide realistic results when defining the development of TPACK from PST. For this reason, the focus of implementing TPACK PST on several subjects, technology, and teaching methods will provide more accurate results (Aktaş & Özmen, 2020).

Preservice teachers need computer based teaching materials and use materials with microteaching sessions (Durdu & Dag, 2017b). Research with surveys shows significant results in preservice teachers with the TPACK framework (Can et al., 2017; Şimşek & Sarsar, 2019; Mourlam et al., 2021). Many TPACK studies use survey assessment techniques, while assessments use interviews, in depth assessment and performance assessment, which is still rarely action.

Success in learning, teachers not only know technology and how to use it but knowledge of pedagogy and content. The integrated Technological Pedagogical and Content Knowledge framework provides a broader analytical framework and the quality of teachers in integrating it (Koehler & Mishra, 2009). The development of knowledge of technological pedagogical content in preservice teachers is important for creating learning with technology and digital media (Mourlam et al., 2021).

The use of technology in learning is very

important in helping individuals to adapt to a changing world because more permanent and efficient learning is achieved when technology is used in the teaching and learning process. Learners actively construct knowledge with technology, when technology is effectively integrated into education. The integration of technology into education has become prominent. The teacher has an important role in integrating technology into education because they are responsible for teaching and learning activities in schools. Therefore, teachers are expected to be able to use technology in education effectively (Giles & Kent, 2016).

Professional teacher development programs can be carried out in an alternative way with face to face and online workshops to support each teacher with a personal andragogical approach to technology pedagogical abilities and content knowledge for science teaching and learning (Chaipidech & Srisawasdi 2021). The effects of the pandemic have made the professional development program change from face to face to virtual. The program is also effective in assisting teachers in helping to understand content, pedagogy and technology (Mouza et al., 2022). This research provides an explanation of the results of the TPACK competency evaluation in microteaching courses for preservices biology teachers. It provides benefits as a basis for evaluating biology education curriculum policies. Effective learning in the future needs to consider technology and some time ago the experience of distance learning, due to the effects of a pandemic, this can be a consideration for the preparation of preservice teachers to be able to teach either face to face (offline) or virtual learning.

METHODS

This research is a qualitative research case study that aims to evaluate TPACK in preservice teachers. The curriculum evaluation design used using the Stake Countenance Model includes 1). Antecedent Phase (Preparation) 2). Transaction Phase (Process) 3) Outcome Phase (Results) (Stake, R 1996). This study was conducted with eleven teacher preservice teachers (one male, 10 female) selected according to the as sampling method is convenience sampling on the grounds of focused observation and in depth interviews. Evaluation of preservice teacher biology education programs through microteaching lectures, 1 class with 34 preservice biology teachers consisting of 7 males and 27 females. Participants were given the freedom to determine the theme used for the microteaching practice.

Several data sources, consisting of lesson plan documents, teaching performance practices, and semi-structured interviews. Microteaching practice instrument with performance assessment with a rating scale from a scale of 1 is not good to a scale of 5 which has a very good meaning. All instruments are used with reference to the basic component framework of Pedagogical Content Knowledge (PCK) and Technological Pedagogical and Content Knowledge (TPACK).

RESULTS AND DISCUSSION

Performance-based assessments such as the design of project plans, lesson plans, or making portfolios. Analysis of the results of TPACK using performance assessment related to two themes. The first theme is about the evidence of preservice teachers in the development of TPACK and the second is an analysis of the identification of challenges in identifying the integration of TPACK knowledge domains (Wang & Crawford, 2018). Performance assessment uses a performance assessment from the Microteaching Evaluation Scale (MTES) with 5 indicators with a total score of 0-100 (Durdu & Dag, 2017). Performance assessment as a data source in evaluating the TPACK competence of preservice biology teachers. The instruments used include lesson plan documents, and practice assessments. Performance assessment as a practice assessment is in Table 1.

Several respondents were then conducted in-depth interviews, regarding the implementation of learning and alignment with the learning implementation plan document. The document becomes a reference to determine the structure of curriculum requirements in the form of basic competencies, learning objectives achieved, and process standards and expected assessment standards.

The dimensions of Technological Pedagogical and Content Knowledge (TPACK) are as follows: Content Knowledge CK is knowledge of subjects taught by teachers, which includes core concepts, facts, and processes related to content. Pedagogical Knowledge (PK) is knowledge about concepts that develop in students' minds, skills needed to learn, how students will structure knowledge, and how students will be motivated to learn. Technological Knowledge (TK) is knowledge involved in the use of ICT tools. Pedagogical and Content Knowledge (PCK) is knowledge related to considering student

characteristics when teaching subject matter knowledge. Technological Pedagogical Knowledge (TPK) is knowledge to understand the effects of technology according to pedagogical strategies directed at learning and teaching environments and knowing how to strengthen student learning without content knowledge. Technological Content Knowledge (TCK) is knowledge related to the use of technology in presenting, applying, or researching subject knowledge. Finally, TPACK is knowledge as the main center in this model that is, understanding how to use appropriate technology to support the learning of content presented through certain pedagogical strategies (Mishra & Koehler, 2006)

Table 1. Results of Performance Assessment on Preservice Biology Teachers

No	Indicator	Preservice Biology Teachers										
		A	B	C	D	E	F	G	H	I	J	K
1	Preparation of content representation according to basic competencies/curriculum syllabus	4	3	3	3	3	4	4	4	3	4	3
2	Giving apperception to students	4	4	3	3	2	4	4	4	2	5	4
3	Giving motivation to students	4	4	5	4	2	4	4	4	2	4	4
4	Giving objectives learning	3	3	2	3	3	4	4	4	3	4	3
5	Involving students in learning	5	4	4	4	4	4	5	4	4	4	5
6	Implementation of instructional strategy	2	4	4	4	2	2	3	4	4	4	2
7	Using of learning media	4	4	3	4	2	4	4	4	3	3	3
8	Content learning in accordance with the needs of basic competencies or learning objectives	3	3	3	3	3	3	4	4	2	3	3
9	Content learning with attention to the characteristics of students	4	4	4	4	3	3	5	5	4	3	3
10	Implementation of Learning Assessment	4	4	2	2	2	2	4	4	2	4	3
11	Ability to integrate content with learning technology	2	2	2	2	2	2	4	2	2	3	2

Information
5 = very good; 4 = Good; 3 = Fairly Good; 2 = less Good; 1 = Not Good

The results of interviews with preservice teacher include:

I teach environmental material with separating organic and inorganic waste, with bringing the waste into microteaching (PCK) (PST-1).

I don't know technology use in ecological learninig (TCK), maybe I use Quizziz for technology assessment, and even then I need to study first (TPK) (PST-1).

Identification of biotic and abiotic components delivered at the high school level I realized that it was almost the same as the junior high school (CK) level. I had difficulties when the material was explored, because microteaching activities were in the room (PST-1).

I has used videos to introduce enzymes. The video is playing about the need for enzymes in metabolism, but I haven't linked the material on enzymes in daily life (TCK), I intentionally let students watch the full learning video, so they have enough time to understand the material (TPK), (PST-3)

Evaluation of microteaching programs through the Stake Model includes a). The preparation phase is in the lesson plan document b). The process phase is in the teaching practice activities. c) The resulting phase is the assessment of teaching practice and semi-structured interviews. Based on the practical experience of learning there are several variations of preservice teachers teaching, using two and three dimensional media and using technology media such as video teaching materials and powerpoint presentations.

At the beginning of microteaching, many used PowerPoint (ppt) media, but many preservice teachers only focused on slides powerpoint (ppt), so it was necessary to limit the use of powerpoint so they would not be watched, so that preservice teachers were encouraged to make visual media. (PST-8)

I have not idea, to using technology in the water cycle material in Figure 1 (TK). The visual media created in (Figure 1) will indeed need storage space, so they need to be prepared further (PST-4)

I realize that the water cycle material presented at the high school level is similar to the material for the junior high school level (PST-4),

the muscle type material is also similar to the junior high school level (PST-7), I also the material about the reproductive organs is similar to the material junior high school level (PST-8) (CK).

The results of the lesson plan document study, preservice teachers focus on identifying the anatomical structure of the reproductive system.

1) Students are able to describe human reproductive organs.
2) Students are able to explain the function of human reproductive organs
3) Students are able to analyze the structure and function of human reproductive organs (PCK) PST-8

Knowledge of the curriculum structure of essential content and material that distinguishes between school levels is knowledge needed for preservice teachers. In addition, the skills of connecting knowledge of teaching materials contextually and attention to social issues that develop in society need to be improved by pre-service teachers in the microteaching program. Holbrook & Rannikmae, (2007) stated that science learning will be easy to learn when it is associated with phenomena in human life.

This PCK component can be used to fully define TPACK because PCK is transformed into TPACK through the use of appropriate technology. PCK components: (a) orientation towards learning; (b) knowledge and belief about science curriculum; (c) knowledge and beliefs about students' understanding of a particular science topic; (d) knowledge and beliefs about judgment in science; and (e) knowledge and beliefs about instructional strategies for teaching science (Magnusson, Krajcik, & Borko,1999).

Contextual learning can help educators connect material content to real world situations and motivate students to connect knowledge and applications in life, so students can find meaning in the learning process (Bern & Erickson, 2001). Based on interviews with preservice teachers, it is necessary to understand the orientation and objectives of learning and knowledge of the curriculum structure and materials that are essential in learning. Biology learning at the high school level is expected to develop in the ability of analytical knowledge with characteristics in the form of connecting information with one another. Connecting structure with function in a phenomenon that often occurs in everyday life, for example, why does menstruation and pregnancy occur? Why can the organs of the hand move?.

Figure 1. Simulation using the Water Cycle Material with Pop-up Media Demonstration

Preservice biology teachers in involving students to study in a good category, this is in accordance with the PCK indicator about understanding the characteristics of students. Some teachers still need to improve their self confidence. The ability to teach when not using technology directly, PCK becomes the framework used to see the effectiveness and efficiency of learning.

I planned to use problem based learning on the digestive system material, but I didn't have enough time because from the beginning I explained the introduction of the digestive organs (PCK) (PST-5).

I am still nervous when teaching, so in practice I am confused about the order of delivery of PCK teaching materials (PST-2, PST-7, and PST-8).

The learning method that is often used by teachers is the discussion method, where the use of elements of technology in the discussion method is also still limited to using the internet as a material to find information for students during the discussion. Learning media that is often used by teachers is only power point which only contains text and is less interesting. The use of learning media should be a major concern for a teacher. The selection and use of instructional media must be considered carefully, taking into account aspects of the suitability of the media with teaching materials and also the characteristics of students (Purwono, et al, 2014).

Teachers when planning learning with technology, they make decisions about the types of activities related to technology for learning effectiveness and are representative in learning content. The thought process involves: (1) analyzing the structure of the technology-enhanced activity types to assess their suitability for developing the desired content learning outcomes, and (2) selecting the most effective technology enhanced activity types. For example, teachers, who have knowledge of various types of

technology related activities are suitable for developing problem-solving skills, such as WebQuests, Web Inquiries, and Spreadsheets. Then how to understand that to develop problem solving skills in mathematics probability lessons. The selection of the most effective technology would be a spreadsheet for a visual representation of the relationship on a graph (Jaipal-Jamani & Figg 2015).

Figure 2. Simulation of students learning through the Video Structure of Plant and Animal Cells

The use of learning videos in microteaching practice activities, often in the process of seeing the material on the videos of students who are silent while watching, sometimes the other side of motor activity is not given a good stimulus.

The learning conditions is quiet while watching the video, it doesn't matter the most important thing is that the video has a short time at Figure 2 TPK (PST-2).

Based on this, it is necessary to attention of frameworks to the TPACK and PCK in utilizing learning videos as learning resources. Learning videos are expected to increase active participation for students through interactive dialogue, videos have a source of data information that supports the achievement of learning objectives and videos also have the opportunity as a source of assessment. So the selection of the right learning video and the appearance of the video in an attractive, effective and efficient manner, it becomes a strategy that needs to be owned by preservice teachers.

The results of the assessment system documentation are in the good category, and some are in the poor category. Often the documented assessment does not include an assessment rubric or processing a total assessment score in student worksheets (Figure 3). The assessment in the PCK framework needs to be completed, so that it is more focused on assessing learning achievements.

I don't know the mechanism for the assessment process for the student worksheets given. I also feel that it is not optimal when has used videos for students, because it has not provided the opportunity for students to be actively involved (PCK) PST-9.

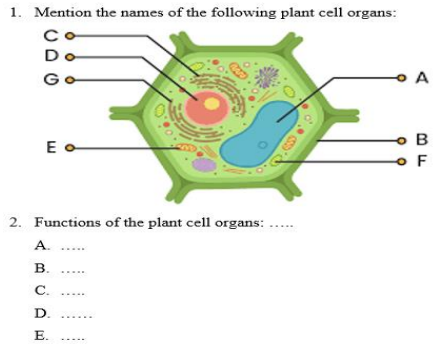

Figure 3. Student worksheets on the identification and organelles function of plant cell

TPACK development efforts by using selective and appropriate technology in inquiry learning includes: (1) presenting an interesting introduction, (2) facilitating data collection, (3) facilitating data analysis, and (4) facilitating communication and discussion of results. These results suggest that using digital images to facilitate whole-class inquiry holds great promise as a starting point for teachers new to inquiry instruction (Maeng et al., 2013). The instructor task to organize and deliver content to achieve learning objectives. Moreover, developing countries must consider to the socio-technical constraints of all students when designing learning content (Jr et al., 2021)

TPACK is a model for the expertise of the teaching profession to teach effectively with digital technology (Schmid et al., 2021). TPACK is a way to assess the effectiveness of lesson delivery with the integration of technology, the framework becomes an ideal application in all aspects of learning, all aspects of which are important in teaching and learning processes (Santos & Castro, 2021). Technology in learning allows it to continue to grow and be varied. TPACK reminds us that learning must be in accordance with student characteristics, curriculum objectives, learning can take place effectively and efficiently.

The TPACK framework is a significant improvement effort in terms of guiding, providing active student participation, making assessments and evaluations, the suitability of the chosen teaching method, and the accuracy of the information/concepts provided when teaching

science subjects with technology. Possible reasons for this positive effect include using worksheets with technological tools such as simulations, influence of course lecturers as role modeling, introduction of new technologies to preservice teachers in training courses, and using class discussions to provide feedback (Aktaş & Özmen 2022). The ideas discussed using collaborative technology can guide preservice teachers classroom. The results of online group reflections are turned into action, helping to link theory, reflection, and practice (Allaire, 2015).

Knowledge of learning technology requires awareness for preservice teachers to learn to add insight. Biology learning is expected to be able to explore current learning issues, and contextual application of technology. The learning is expected to encourage students to be interested in learning and develop analytical thinking, problem solving, creative, and innovative or often known as high-level thinking skills.

The application of technology in learning has indeed become an option in microteaching as shown in Table 1, many preservice teachers do not integrate technology, pedagogy and content, because their learning plans do not use learning technology. However, the current era of learning allows learning to be done online or blended, so teacher skills need to integrate content, pedagogy and technology in a TPACK competency. The application of technology also needs to be varied with the use of virtual laboratories and online assessments, because it is a competency that is needed in the future.

Important components for an effective technopedagogical education are determined by including, a) understanding the technology used in instruction in every aspect, b) knowing learning strategies and presentation techniques for teaching a particular subject, c) knowing the students' level of knowledge and how to use technology in an appropriate way. appropriate, d) knowing the technology and materials needed to improve learning in explaining the subject (Niess, 2005). Based on this it shows that the basic PCK provides a major role in developing TPACK competencies.

The integration of technology in education, in particular, has become very important recently and special education teachers are expected to have a level of competence in integrating technology in education special education settings and other important components such as technology-related knowledge and skills (Demirok & Baglama, 2018). Lectures on technology may be enhanced in teacher training programs to increase the knowledge and skills of preservice teachers for learning professionalism (Birkollu et al., 2017).

First, providing preservice teachers with the opportunity to apply ICT in the learning process during their field experience will contribute to the development of their TPACK practice. The results also illustrate that teachers' use of ICT to understand subject content is associated with the highest scores (Baran et al., 2017).

Second, using various learning strategies such as the Synthesis of Qualitative Evidence (SQD) model: (1) using teacher educators as modeling (2) reflecting on the role of technology in education, (3) learning to design technology, (4) collaboration with peers, (5) assisting authentic technology experiences, and (6) providing ongoing feedback (Tondeur et al., (2019). The results of the narratives of preservice teacher respondents stated that so far, they had not seen videos on good learning methods. Therefore, good examples of learning videos are needed by using various appropriate learning strategies. In addition to face to face modeling, remote learning modeling is required.

Online distance learning that occurred due to the Covid-19 pandemic has made teachers improvise in making interactive classes using various technologies such as social media or learning applications. Distance learning is not limited by time and place, teaching and assessment processes must be adapted to practicum using virtual laboratories and assessments based on student activity in online discussions (Kartimi et al., 2021)

While research on face toface Professional Development (PD) programs has an impact on the learning and practice of new teachers, the Covid-19 pandemic has necessitated a change in the way the program is delivered. Due to the ongoing challenges and uncertainties of the pandemic, it is important to examine how online PD approaches can leverage the advantages of technology to prepare for Computer Science (CS). The findings show that teachers benefit from virtual learning, in increasing trust when teaching, implementing lesson design, and implementation in learning practices. This shows implications for the effective design of online Professional Development, it has helped build teachers' understanding of content, pedagogy, and technology (Mouza et al., 2014).

CONCLUSION

Preservice teacher education program through microteaching courses. The most preservice teachers still do not use technology, because the lesson plans is without learning technology. Preservice teachers still need to improve their competencies including learning confidence, understanding essential material in the curriculum structure, contextual material, understanding the assessment process in learning, using a variety of technologies and using learning videos effectively and encouraging student participation. The basic PCK is still needed as a basis for developing preservice teachers in learning without using technology, while using technology the TPACK framework can be used. So for the development of TPACK competencies, provide opportunities for preservice teachers to apply technology in learning biology and use various learning strategies.

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