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The TPACK Profile of Chemistry Prospective Teachers in Microteaching Class, University of Bengkulu

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ABSTRAK

Rendahnya kemampuan mahasiswa semester atas program studi ini mengenai TPACK (Technological, Pedagogical, and Content Knowledge) menjadi alasan utama dilakukan penelitian ini. Padahal kemampuan ini menunjang mereka untuk menjadi seorang guru nantinya. Ketika sudah diketahui profilnya, maka peneliti sekaligus dosen program studi tersebut dapat menyiapkan dan meningkatkan TPACK mahasiswa tersebut. Penelitian ini adalah penelitian deskriptif dengan pendekatan kuantitatif. Tujuan dari penelitian ini adalah menganalisis profil TPACK calon guru kimia pada kelas microteaching. Subjek penelitian adalah mahasiswa program studi pendidikan kimia, Universitas Bengkulu yang mengambil mata kuliah tersebut. Instrumen yang digunakan adalah angket TPACK. Angket TPACK ini terdiri dari aspek TK, PK, CK, TPK, TCK, PCK, dan TPACK. Angket ini menggunakan skala likert. Hasil penelitian kemudian dikategorikan menjadi 5 kategori di setiap aspek. Kategori ini berguna untuk mengelompokkan mahasiswa. Hasil penelitian ini menyatakan bahwa mahasiswa program studi pendidikan kimia yang mengambil mata kuliah pembelajaran micro memiliki pengetahuan tentang TPACK ini dalam kategori baik. Hampir semua aspek memiliki skor rata-rata pada kategori baik, hanya 1 aspek yang memiliki skor rata-rata cukup.

ABSTRACT

The low knowledge of TPACK among senior semester students is the main reason for conducting this research. Whereas this knowledge supports them to become a teacher. When the profile is known, the researcher as well as the study program lecturer can prepare and improve the student's TPACK. This research is descriptive research with a quantitative approach. The purpose of this study was to analyze the TPACK profile of prospective chemistry teacher in the microteaching class. The research subjects were students of the chemistry education study program, University of Bengkulu who took the course. The instrument used is the TPACK questionnaire. This TPACK questionnaire consists of aspects of TK, PK, CK, TPK, TCK, PCK, and TPACK. This questionnaire uses a Likert scale. The results of the study were then categorized into 5 categories in each aspect. This category is useful for grouping students. The results of this study stated that students of the chemistry education study program who took microteaching courses knew this TPACK in the good category. Almost all aspects have an average score in the good category, only 1 aspect has a sufficient average score.

1. INTRODUCTION

Technology is an inseparable part of human life. The rapid development of technology has attracted the attention of all levels of society. This development includes various elements in this world. One of the elements of education. The use of technology in education has been widely carried out, ranging from being used for teaching assistance or administrative assistance. This is useful for facilitating existing learning activities (Tsovaltzi et al., 2010). When technology is used in learning, it makes students more interested in participating in learning. For this reason, teachers must adapt to the times, namely by developing technological literacy skills in learning. The goal is that students do not feel bored during the learning process in the classroom. The integration of technology in learning is an obligation in the current era of globalization. Teachers try to always do this in every lesson. Technology in learning, especially in science

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learning, can help students investigate scientific facts quickly. This integration makes teachers also have to participate in updating their abilities. The ability of teachers to integrate technology should be in line with their abilities in the fields of education and content.

Teachers as educators who deal directly with students must have the ability, both in terms of pedagogy, content, and technology. The three-go hand in hand in a lesson. For this reason, increasing teacher competence has an important value when viewed from various points of view. Various media and methods used in learning have been successfully developed and implemented. Likewise with the development of content to achieve curriculum targets by the development of science and technology. This requires teachers to master all of them so that they can develop learning in the classroom to produce quality graduates.

Teachers in the education system are the closest figures in interacting with students than other school members. The teacher has the task of planning, implementing, and evaluating a learning process. Teachers must be able to convey the material well because learning is a process of developing skills, attitudes, and cognitive knowledge. Therefore, the teacher must convey the material correctly and appropriately through learning activities. In this case, the teacher must have knowledge of pedagogy which includes learning activities in the classroom, and knowledge of the content being taught. Knowledge of both can identify a particular piece of knowledge in teaching. This knowledge is also known as Pedagogical Content Knowledge (PCK). PCK becomes a guide in distinguishing an expert education from a material. Currently, teachers not only have to have PCK, but in their teaching, teachers must be able to integrate the technology they understand. This is adapted to the current developments. For this reason, PCk was developed into TPACK or technological, pedagogical, and content knowledge.

TPACK is one of the abilities that must be possessed by a teacher in this century. TPACK is the ability to implement the technological knowledge that he has mastered in the form of learning in the classroom on certain materials. TPACK is divided into 7 main aspects, namely technology knowledge (TK) or technological knowledge, pedagogical knowledge (PK) or pedagogic knowledge, content knowledge (CK) or content knowledge, technological pedagogical knowledge (TPK) or pedagogic and technological knowledge, technological content knowledge (TCK) or technology and content knowledge, pedagogical content knowledge (PCK) or pedagogic knowledge and content, and TPACK itself (Herring et al., 2016; Mishra & Koehler, 2006). These seven sections are very important as initial knowledge before becoming a teacher, including prospective chemistry teachers or students of chemistry education study programs.

Teachers are given challenges regarding incorporating technology in teaching and learning activities (Niess, 2011). The use of technology in learning can improve and develop a teacher's digital literacy. This is the basis for PCK (Pedagogical Content Knowledge) which is owned by Shulman (1986) which was developed into TPACK by Mishra and Koehler (2006). TPACK is a combination of technology, content, and pedagogy that must be owned by teachers. The TPACK framework has 3 main components in knowledge, namely pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK). The interaction of the three can produce 4 other components called pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) itself (Herring et al., 2016). TPACK contexts can be seen in Figure 1.

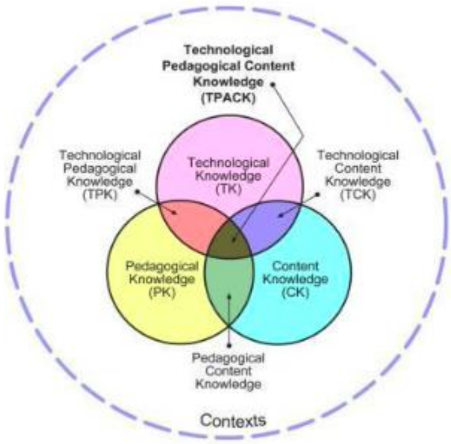

Figure 1. TPACK Contexts (Mishra & Koehler, 2006)

TPACK is referred to as a framework that can describe the knowledge that a teacher must have in designing and implementing curriculum and learning by applying technology to a subject (Niess, 2011).

This framework provides insight into teacher knowledge in integrating technology effectively in learning (Graham, 2011; Kereluik et al., 2010; Polly & Brantley-dias, 2009). The application of TPACK requires a good understanding of technology by redesigning it to suit the specifics of the content and pedagogic of the subject (Kereluik et al., 2010). For this reason, a deep understanding is needed in preparing qualified teacher candidates and understanding this TPACK.

This TPACK framework can provide a means for researchers to research the TPACK of teachers and prospective teachers. In addition to knowing the knowledge abilities of teachers and prospective teachers, TPACK can also provide clarity on specific interventions in research and development projects (Baran et al., 2011). This framework offers research in teacher education, professional development, and the use of technology by teachers. In addition, it can build a relationship between technology, content, and a teacher's pedagogy when in the classroom (Koehler, Mishra, & Cain, 2013). This framework can also help improve the application of theory in a practical sense as well as strengthen it from a theoretical perspective (Kopcha et al., 2014). Methods that can be used to measure TPACK are teacher knowledge surveys and assessment of learning planning and implementation documents (Abbitt, 2011; Koehler et al., 2011). Both methods can increase the validity associated with TPACK studies (Abbitt, 2011; Cavanagh & Koehler, 2013; Graham, 2011).

PK or pedagogical knowledge is knowledge about student learning, teaching methods, educational theory, and learning assessment in teaching a material (Chai et al., 2013). With this knowledge, teachers or prospective teachers can understand how to develop knowledge and skills in conditioning students in effective learning. PK is a skill that must be developed by teachers and prospective teachers to manage and regulate teaching and learning in the classroom (Koehler, Mishra, & Cain, 2013). CK or content knowledge is knowledge about actual learning material and must be taught to students (Shulman, 1986). Content knowledge differs between each field and teachers must understand the basics of the content taught in the classroom. In science learning, the content delivered includes knowledge of scientific facts and theories, scientific methods, and evidence-based reasoning (Koehler, Mishra, Akcaoglu, et al., 2013).

Kindergarten or technological knowledge in TPACK is associated with an understanding of information and communication technology (ICT) (Koehler, Mishra, Akcaoglu, et al., 2013). This knowledge is defined as the knowledge of teachers and prospective teachers about the latest technology (Karaca, 2015). Currently, technology in learning is related to software, hardware, and email that can support the learning process. A teacher must have good knowledge of technology to develop 21st-century learners.

PCK or Pedagogical Content Knowledge is knowledge about representing content knowledge and adopting pedagogical strategies to make specific content/topics easier for students to understand (Chai et al., 2013; Shulman, 1986). PCK combines content and pedagogy to develop better teaching practices in delivering lesson content (Schmidt et al., 2014). It can be understood that the teacher must choose an appropriate learning strategy for the content delivered so that the implementation of learning goes well.

Chai, Koh and Tsai (2013) define TCK or Technological Content Knowledge as knowledge of how to use technology to deliver learning materials differently, for example, knowledge of using online dictionaries, SPSS, subject-specific ICT tools, and others. Submission of material differently in question is conveying material creatively so that the teaching and learning process is fun for students. Schmidt *et al.* (2014) explained that TCK refers to knowledge of how technology can create new representations for certain content. Schmidt *et al.* (2014) explained that TPK refers to knowledge of how various technologies can be used in learning and understanding that using technology can change the way teachers teach. TPK is a teacher's understanding of how the learning process can change when technology is used in a certain way (Koehler, Mishra, & Cain, 2013). This knowledge allows teachers to understand what technology can be used to achieve learning objectives, and understand the selection of the most appropriate tools according to the pedagogical approach (Koehler, Mishra, Akcaoglu, et al., 2013). Using technology in learning can produce new methods in the teaching and learning process, as well as facilitate learning in the classroom.

TPACK is the foundation of effective teaching with technology. TPACK is an understanding of how technology can be used creatively to meet pedagogical needs in delivering certain content (Koehler, Mishra, Akcaoglu, et al., 2013). Schmidt *et al.* (2014) explained that TPACK refers to the knowledge needed by teachers to integrate technology into learning according to the disciplines that the teacher teaches. Teachers must have this knowledge to intuitively understand the complex interactions between the three basic components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods and technologies.

Students of education study programs or who are prepared to become teacher candidates are expected to have the ability in terms of content, education, and technology. In pedagogic ability, a prospective teacher must be able to design, prepare, conduct, and evaluate learning. In content ability, prospective teachers must be able to explain chemical material properly and correctly to their students later. Meanwhile, in terms of technology, prospective teachers must have good literacy in using technology in learning. Students of the education study program are required to take microteaching courses which are useful for training them in teaching and delivering material well. In this course, their abilities in terms of pedagogy, chemical content, and technology are measured. For this reason, an analysis of the TPACK ability profile of prospective chemistry teachers is carried out to prepare prospective teachers who are qualified and understand pedagogy, chemistry content, and technology in learning which will later become their work.

The purpose of this study was to analyze the TPACK profile of students from the chemistry education study program, Bengkulu University, who were taking microteaching courses. This course is quite appropriate to be used in measuring the TPACK of these students because this course is carried out before internship activities at school. After being analyzed, it is hoped that there will be an increase in student TPACK in various ways so that they are ready to do internships at school.

2. METHOD

This research is descriptive research using a quantitative approach. This approach refers to data processing in the form of numerical data. The samples used were students of the chemistry education study program, Bengkulu University who were taking microteaching courses.

The instrument used is a TPACK questionnaire adapted from research (Sahin, 2011; Schmidt et al., 2014). This instrument uses a Likert scale, ranging from 1 strongly disagree to 5 strongly agree. TPACK questionnaires are distributed and filled out by students before entering class. The TPACK questionnaire consists of 48 statements with 7 main aspects. These seven aspects are technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological, pedagogical, and content knowledge (TPACK). Each aspect contains related statement items. Each aspect is then searched for the average score and categorized into 5 categories. These categories can be seen in Table 1 (Azwar, 2015).

Table 1. Category and Score Range

Category	Score Range
Very Good	$x \geq 4.00$
Good	$3.33 \leq x < 4,00$
Adequate	$2.67 \leq x < 3.33$
Poor	$2.00 \leq x < 2.67$
Very Poor	$x < 2.00$

3. RESULT AND DISCUSSION

Result

The profile of the TPACK ability of prospective students for Chemistry Education study program, Bengkulu University has been analyzed. The benefit of this measurement is to find out the TPACK mastery profile which describes the level of mastery of each aspect (Koehler, Mishra, & Cain, 2013). The presentation of the average score is divided into 2, namely the overall average score and the average score for each aspect. The average score of all aspects can be seen in Figure 2.

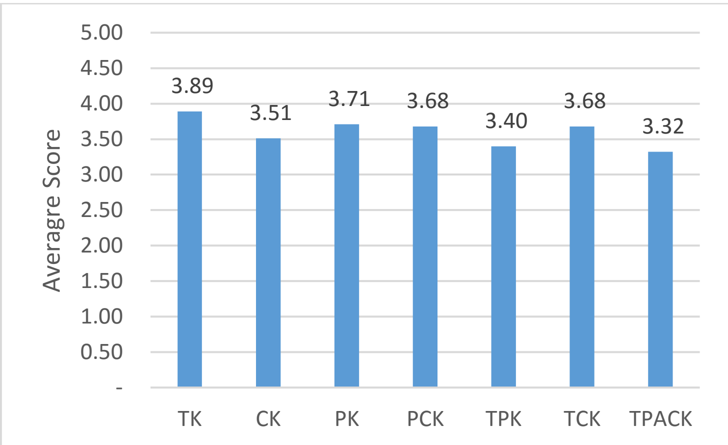

Figure 2. The Average Score for all aspects

The next section is the presentation of the percentage in the TK aspect. The first aspect is the Technological Knowledge (TK) aspect which has 6 statements. The results of this aspect analysis can be seen in Figure 3.

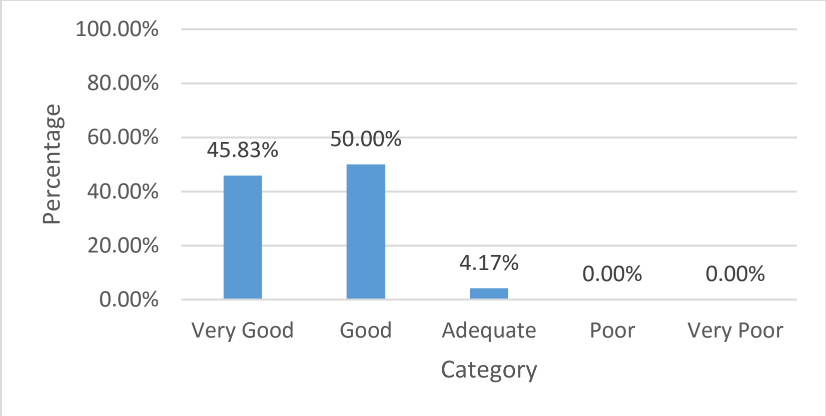

Figure 3. Percentage of Categories in TK Aspect

The second aspect presented is about Content Knowledge (CK), in this case, is the knowledge of prospective chemistry teachers regarding chemical content. The percentage of each category in this aspect can be seen in Figure 4.

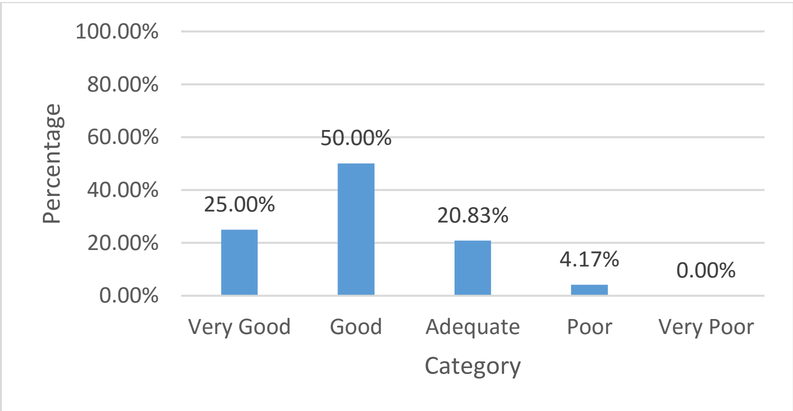

Figure 4. Percentage of Categories in CK Aspect

The next aspect is the Pedagogical Knowledge (PK) aspect. This aspect relates to students' knowledge of pedagogy or education. This aspect is very important in supporting their success in teaching. The percentage of each category in this aspect can be seen in Figure 5.

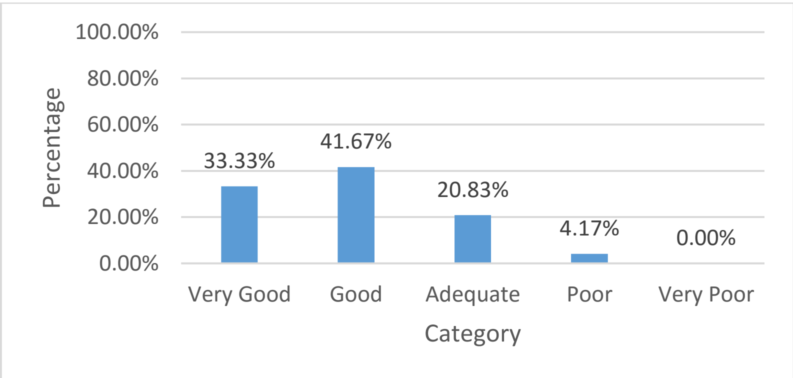

Figure 5. Percentage of Categories in PK Aspect

The next aspect is the pedagogical content knowledge (PCK) aspect. This aspect relates to the knowledge of prospective teachers regarding the delivery of chemistry content in classroom learning. For this reason, student-teacher candidates must have adequate knowledge of pedagogy and chemical content. The percentage of each category in this aspect is presented in Figure 6.

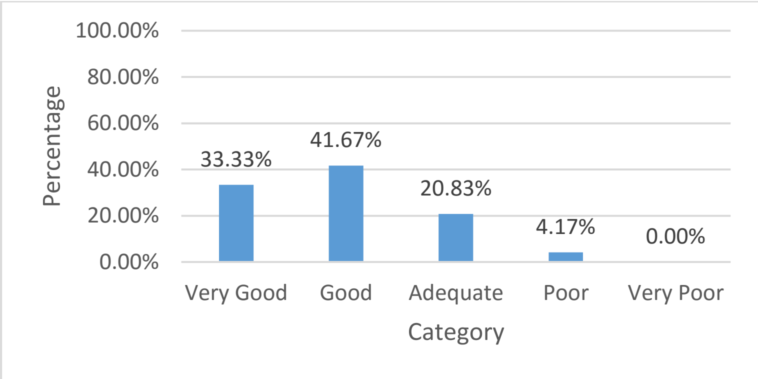

Figure 6. Percentage of Categories in PCK Aspect

The next aspect is the Technological Content Knowledge (TCK) aspect. This aspect relates to the combination of technology and chemical content mastered. The percentage of each category in this aspect can be seen in Figure 7.

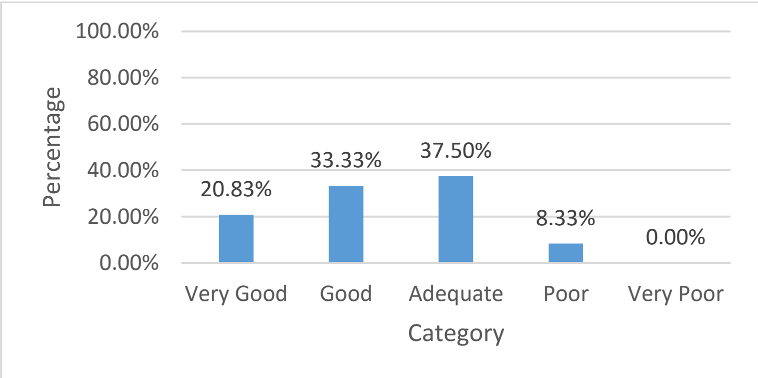

Figure 7. Percentage of Categories in TCK Aspect

The sixth aspect is the Technological Pedagogical Knowledge (TPK) aspect. This aspect relates to the knowledge of prospective chemistry teachers about the technology and pedagogy they are good at to be applied in learning. The percentage of each category in this aspect can be seen in Figure 8.

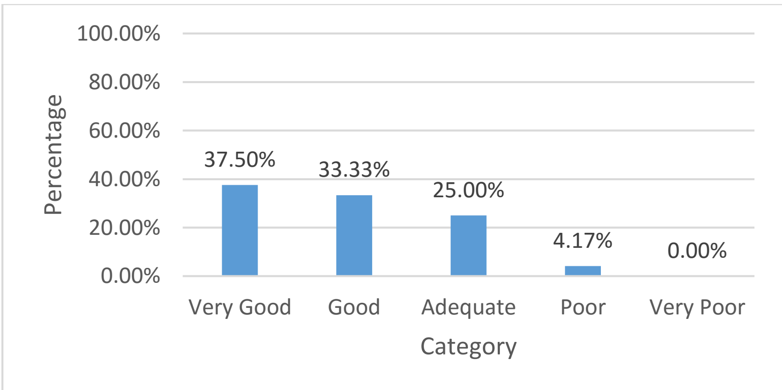

Figure 8. Percentage of Categories in TPK Aspect

The last aspect is the TPACK aspect or what is called technological, pedagogical, and content knowledge. This is the knowledge that prospective teachers must have in today's digital era, namely knowledge of technology, pedagogy, and chemical content that are implemented simultaneously in a lesson. The percentage of each category in this aspect can be seen in Figure 9.

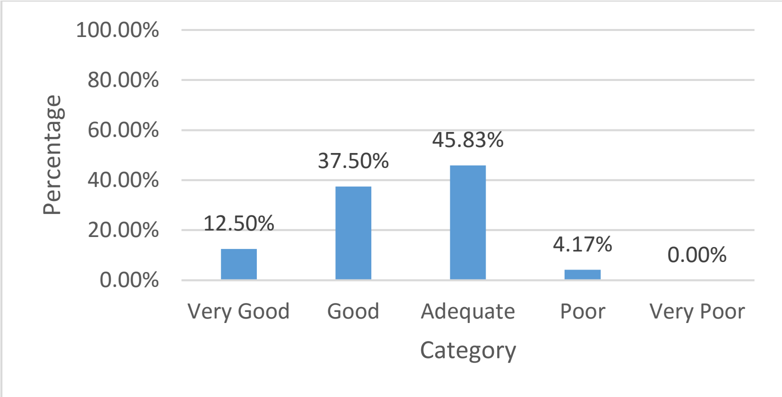

Figure 9. Percentage of Categories in TPACK Aspect

Discussion

Based on the Figure 2, the highest average score is the technological knowledge (TK) aspect. While the lowest average score is the TPACK aspect. The six aspects, except TPACK, are in a good category, while TPACK is in a sufficient category. This is because this aspect is the most complex in implementing technology, pedagogy, and chemistry content in a classroom lesson. On Figure 3, in this class, the majority have good technological knowledge, and none have less technological knowledge. Moreover, the second-largest percentage is in the very good category. This proves that these student-teacher candidates already know technology to support their daily lives. Technological Knowledge (TK) is the knowledge that teachers have about current technology. Teachers must know about technological developments that exist in people's lives today, including prospective teachers.

In kindergarten, prospective chemistry teachers are required to be able to solve technical problems that exist in everyday life. This problem is a problem related to today's technology. These technical completion skills have an important role in their association with technology. In addition, they must have good technological literacy, so that they know about current technological developments. Technological developments which they consider important have contributed to improving the quality of technological literacy. By looking at their age, they easily learn every latest technology that they consider needed in their lives. They are used to being familiar with the technology.

The largest percentage on Figure 4 is in a good category, but there are still a few who are in the less category. Aspects of Content Knowledge (CK), especially knowledge of chemistry content, has an important role in the fluency of prospective chemistry teachers in delivering teaching materials. Mastery of chemistry is expected to be possessed by every prospective chemistry teacher because they are prepared to become chemistry teachers. It is also used to avoid misconceptions that occur in learning.

This aspect of the assessment points relates to their understanding of chemistry. The item that gets the highest average score is item 11 about knowledge of the theory and basic concepts of high school chemistry. This item also relates to another item about sufficient proficiency in high school chemistry. High school chemistry material in the study program is studied in school chemistry courses and microteaching. This course reviews high school chemistry materials and their basics. These two courses require students to be able to explain the basic material of chemistry in a fairly deep scope. This makes each student study this material more deeply so as not to make mistakes when explaining the material.

The next point is about them in following the latest references to chemical content. Recent references in chemistry consist of books and journal articles. This reference is useful for developing material that already exists. Therefore, students are required to follow these references so as not to be left behind on information and current chemical developments. This item also relates to other items regarding variations and strategies in developing knowledge of high school chemistry. Students in studying and developing the material are expected to be able to provide appropriate strategies. Students who have sufficient chemical content skills will also use a scientific way of thinking. This is because chemistry is a branch of science that requires this way of thinking to understand it.

The aspects of CK that have the lowest average score are about developing classroom activities based on existing basic theories, knowledge of the historical development of chemical theory, and participating in scientific activities, such as conferences. The basic theory of chemistry that they understand should be developed into a learning activity. This knowledge will be useful when they become a teacher. Regarding knowledge about the history of the development of chemical theory, students only get material that has been developed. In other lectures, the history of the development of chemical theory is not taught. The chemical material they get is material that already exists in books and the internet today.

Based on the Figure 5 above, most of the prospective teacher students have good pedagogical knowledge, but there are still some who have less knowledge. The second-largest percentage is in the very good category. The PK statement items that get the highest average score are regarding knowledge to assess students' academic performance and the methods used. Student-teacher candidates should be able to assess student academic performance. As it is known that there are 3 assessments in the 2013 curriculum, namely in the cognitive, affective, and psychomotor domains. These three domains go hand in hand with learning. The way to assess the three can also be different, it can be from a written test, observation, or a questionnaire for self-assessment. This item also relates to other items regarding students' understanding and misconceptions. Prospective teachers must know the ability of students in the classroom, whether students already understand or even misconceptions occur in capturing the material given by the teacher. If there is a misconception, students' understanding must be immediately straightened to fit the existing material.

Items with the same average score are regarding the suitability of teaching using various strategies and approaches. The students they will teach will have different abilities. The level of understanding will also be different, some students easily understand, some students take a long time to catch. However, as prospective teachers, they must be able to adapt their teaching to the abilities of these students. Prospective teachers should have a varied learning approach so that each meeting will have a good impression on the students. The variation of this learning approach is also by the demands of the 2013 curriculum, namely the learning approach used must make students more active in participating in learning. This item also relates to other items on classroom organization and management. As prospective teachers, they must have the ability to manage the class well. The way of organization in the classroom, how to teach, and how to carry out these variations have been given in this microteaching course so that they already understand it all.

The results on Figure 6 obtained in this aspect are the same as the previous aspects. The largest percentage is in a good category, and the second-largest is in the very good category. The picture also shows that there are still some who are in the less category.

Based on the picture above, the item with the highest average score is the item on how to evaluate student performance in the classroom. Prospective teachers should have the ability to evaluate student performance in a lesson. This activity is carried out during the learning process and at the end of the lesson. This evaluation is useful for analyzing the shortcomings and weaknesses in learning which is then used as a reflection for the next meeting.

The next item that gets an average score of 3.75 is the item about being found by prospective teachers to make connections between chemistry and the relationship between chemistry and everyday life. Chemistry is a part of human life. Many daily activities are related to chemistry. For this reason, prospective teachers must be able to connect the chemistry material being studied with everyday life. Chemistry learning can use contextual learning, namely learning related to the circumstances around students in everyday life. Learning like this will make students better understand the material being explained. Prospective teachers can improve their pedagogical abilities, teaching skills and subject matter by practicing teaching in a classroom environment (Karaca, 2015). With such circumstances, they will get used to teaching the subject matter well.

The next point is about selecting the appropriate approach and preparing RPP or Learning Implementation Plans by the latest curriculum. The selection of this appropriate approach determines the achievement of learning objectives. These learning objectives were created when designing the lesson plans. During the learning simulation, the student-teacher candidates are sure that they can achieve this learning goal at every meeting. In addition to learning objectives, in the lesson plans, prospective teachers also believe that they can develop assignments and exercises to encourage students to think in solving problems in chemistry. This explanation is evidenced by the results of other related items.

Based on the Figure 7, the largest percentage is in the poor category, and the second-largest is in a good category. These two categories have a distance that is not too different. In this aspect, some are in the less category. The point in this aspect is about the implementation between technology and chemical content. This student-teacher candidate knows the technology used in understanding chemical material which is still lacking. They must improve by learning the latest and existing technologies that can be used to explain chemistry, for example, virtual laboratories in place of practicals, augmented reality molecules that can be used to visualize molecular shapes, and other technologies that support the explanation of the matter. Along the way, they know the technology in chemistry well. They know some of the emerging technologies in the chemical field. Another point, these students understand well enough about technology to participate in scientific discourses and meetings.

The category that gets the largest percentage on Figure 8 is the very good category and followed by the good category which is not too different. However, in this category, there are still those in the less category. The highest average score is an item about thinking about technology can affect the learning approach used in the classroom. Technological developments make prospective teachers able to develop learning better. This technology can improve the quality of learning. These teacher candidates conduct teaching simulations involving technology. Their learning becomes more interesting and will have a positive impact on students (Astiningsih & Partana, 2020; Fitriyana et al., 2020; Ulfa et al., 2017; Wardani et al., 2017).

The next point is about how to use technology in the classrooms they teach. Prospective teachers should have the ability to provide innovation by implementing technology in their learning. This is quite difficult because different materials may have different innovations. Prospective teachers must be able to think at each meeting to give an interesting impression to students. Prospective chemistry teachers are required to be able to make good lesson plan. In this lesson plan, there is a technology that must be chosen in implementing it in learning. The technology used will help to achieve the learning objectives. They should be able to prepare lesson plans that require learning technology. The technology chosen by prospective teachers in the lesson plans is expected to improve the quality of learning in the classroom (Öztürk, 2011). They learn a lot from friends, the internet, or books in adapting existing technology for teaching activities which of course will be different for each meeting. ICT must always be integrated in education study programs so that it can produce the use of technology for prospective teachers (Karaca, 2015).

Based on Figure 9, the category that gets the largest percentage or almost half of it is the sufficient category. The second-largest percentage is in a good category. However, this aspect is also the same as other aspects, namely, there are still those who are in the less category. Prospective chemistry teachers certainly can choose technology that can improve the quality of chemistry content in classroom learning. This selection must use broad thinking so that students do not feel bored with the technology used in each meeting. Prospective teachers must have this ability in developing chemical content in learning. In learning simulations, prospective teachers should use strategies that are combined with chemical content, technology, and learning approaches. Combinations like this have been studied during college. It is hoped that this combination will make them accustomed to developing technology, pedagogy, and chemical content when they enter real school. This teacher candidate should also be able to teach lessons with this combination. So there is no awkwardness and technological stutter in conducting teaching simulations in the classroom. Factors that influence this aspect are the availability of technology, the teacher's proficiency with software, and the teacher's pedagogical reasoning ability (Chai et al., 2013). Therefore, in preparing students who have TPACK abilities, they must understand these factors.

4. CONCLUSION

From the results and discussion, it can be concluded that students of the chemistry education study program who take microteaching courses have good knowledge of TPACK. Almost all aspects have an average score in the good category, only 1 aspect has a adequite average score. Improving the ability of TPACK must be done in preparing good teacher candidates. This is because, in the current era of globalization, it is better to have adequate technical knowledge that can be combined with knowledge of pedagogy and content in learning. What is being done is by holding training, lesson studies, or other methods that can increase the TPACK of these prospective teacher students.

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