Analysis of Technological Pedagogical and Content Knowledge of Accounting Pre-Service Teachers

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Abstract

This research aims to analyze and compare the level of mastery of Technological Pedagogical and Content Knowledge (TPACK) of the accounting pre-service teachers. This is quantitative survey research. The population is all accounting pre-service teachers who are taking the Learning Design and Strategy course in the even semester of the 2019/2020 academic year, totaling 119 students. The whole sample is used as the research population. The data are collected using a survey method in the form of personal measurements (Self-report-measure) using a questionnaire. The results show the TPACK components including Content Knowledge, Technological Knowledge, Pedagogical Content Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge, and Technological Pedagogical Content Knowledge in the three classes are in a good category, except that class A in the Pedagogical Knowledge component which has a fair category. The findings conclude that all accounting pre-service teachers who are classified by gender, age, experience in technology training, and experience as tutors have good TPACK abilities. Every educational institution and education personnel should conduct TPACK analysis to find out whether the prospective teachers already master the teaching knowledge and concepts to teach well based on the demands and characteristics of 21st-century learning.

How to Cite

Mudrikah, Saringatun & Santoso, Jarot TB. (2021). Analysis of Technological Pedagogical and Content Knowledge of Accounting Pre-Service Teachers. *Economic Education Analysis Journal*, 10 (1), 12-24.

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INTRODUCTION

Quality Education is one of the goals formulated in the Sustainable Development Goals (SDGs) agreed upon by the United Nations forum, because quality education can determine the progress of a country. A developed country is a country whose education system is capable of generating competitive human resources in the current disruptive era. One of the factors that influence the education quality is the teacher. The teacher is an important factor in the learning process because he is at the forefront of the process of education implementation. The teaching skills possessed by a teacher are very crucial in determining the learning quality which will later affect the quality of students' learning outcomes.

According to Law No. 14 of 2005 concerning Teachers and Lecturers (article 10 paragraph 1), it is stated that the competencies that must be possessed by a teacher include: pedagogical, professional, social, and personality competencies. Prospective teachers-before they carry out their duties as real teacher-should have mastered specific knowledge and skills in supporting the learning process. A prospective teacher is one who facilitates the students to carry out investigations using technology to strengthen their understanding of concepts and train their scientific skills. Therefore, the Ministry of Education of the Republic of Indonesia, through the implementation of the 2013 Curriculum, obliges all prospective teachers to always integrate technology in every teaching and learning activity (Ministry of Education and Culture, 2013).

The Covid-19 pandemic outbreak has extremely changed the learning system that has been usually done face-to-face into online learning-based distance learning. For the teachers today, of course, mastery of technology is a very important requirement to continue to carry out the learning process. Therefore, technological knowledge is one of the competencies that the teachers must-have, not only the Pedagogical Content Knowledge (PCK)

competency. Additional technological knowledge to complement pedagogical knowledge and content knowledge (PCK) is needed because technological developments require the educational world to use technology in learning activities. Additional aspects of this technology are known as Technological Pedagogical and Content Knowledge (TPACK).

Accounting teachers must also always follow developments and improve their knowledge given the rapid development of accounting sciences. The entry of Village Government Accounting course, where this subject has never existed in the previous curriculum, becomes a challenging topic that must immediately well-managed. Accounting teachers must know and be able to understand well about the latest accounting standards that apply in Indonesia. An accounting teacher must also be aware of the challenges of the accounting profession, understand the blueprint that will be faced as an accountant, and understand the theories and practices of implementing the Village Government Accounting Standards so that later they can teach their students properly and correctly. All of these matters are closely related to the Technological Pedagogical and Content Knowledge (TPACK).

Technological pedagogical content knowledge (TPACK) is a new type of knowledge that the teachers must master to integrate technology properly into the learning. TPACK was originally developed by Shulman's (1987, 1986) who defined Pedagogical and Content Knowledge (PCK), and then described how the teachers understand learning technology and it was linked to PCK and others to generate effective learning using technology. TPACK continues to develop from time to time through a series of publications. In its development, TPACK has become a framework that can be used to analyze teachers' knowledge related to technology integration in learning (Koehler, Mishra, & Cain, 2013).

TPACK consists of three types of basic knowledge, namely Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). The combination of

the three basic knowledge results in four new knowledge; Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). The following is an overview of the TPACK framework:
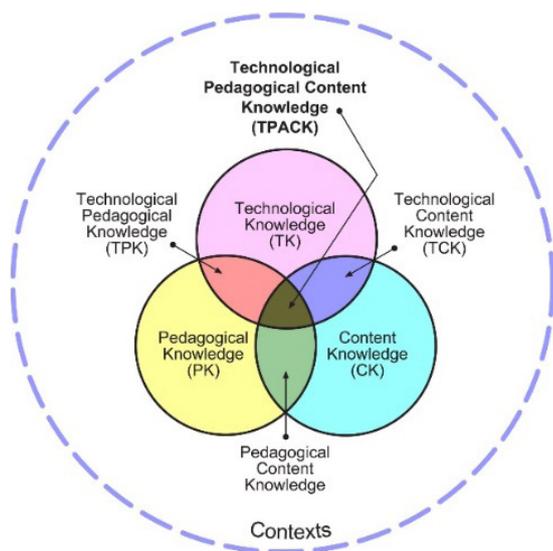

Figure 1. Technological Pedagogical Content Knowledge (TPACK) Framework (Koehler et al., 2013)

Figure 1 clearly shows the interrelation between the three basic knowledge that create four new concepts. The interaction of the three main components of knowledge, namely PK, CK, and Kindergarten, requires the teachers to have an intuitive understanding of it by delivering the material using appropriate teaching methods and technology. The TPACK framework forms a Venn diagram with three overlapping levels (Koehler et al., 2013).

TPACK emphasizes how technological, pedagogical, and content knowledge can be put together that will make learning effective and successful in a learning context.

TPACK is seen as a dynamic framework, describing the knowledge that teachers must have to design and implement curriculum and teaching while guiding the students to think and learn using technology in various subjects (Jang & Tsai, 2012). The TPACK

framework provides a way of thinking about teachers' knowledge regarding the effective integration of technology into the learning environment. Implementing TPACK in classroom learning requires a good understanding of technology, where technology can be selected and redesigned to suit specific pedagogies and related contents.

Research on TPACK has been done a lot, both for teachers and prospective teachers. The TPACK framework has provided a means for researchers and educational technology practitioners to research teachers' TPACK. Baran, Chuang, & Thompson, (2011) stated that besides identifying the knowledge of teachers and prospective teachers, TPACK also provides clarity on specific interventions in research and development projects and thereby increase the ability to design and test good technological approaches in learning. The TPACK framework offers several possibilities for researching teacher education, teacher professional development, and teacher use of technology. Also, it allows the teachers, researchers, and lecturers to build interactions among technology, contents, and pedagogy while they are in the classroom (Koehler et al., 2013). The TPACK framework developed by Koehler et al., (2013) includes seven following important components:

Pedagogical Knowledge (PK); PK or pedagogical knowledge means the teacher's in-depth knowledge of learning strategies. General knowledge of pedagogy includes understanding how the students learn, classroom management skills, lesson planning, and student assessment. Chai, Ling Koh, Tsai, & Lee Wee Tan, (2011) explained that PK is knowledge about the students' learning, teaching methods, different educational theories, and learning assessments to teach certain learning materials. Koehler et al., (2013) revealed that PK is a series of skills that the teachers must develop to manage and organize teaching and learning activities to achieve expected learning outcomes.

Content Knowledge (CK); CK refers to specific knowledge or characteristics of a

discipline or subject matter. Shulman (1986) explains that CK is knowledge of the actual materials that must be studied or taught to the students, including knowledge of the main facts, concepts, theories, and procedures in a given subject, knowledge of the explanation of the framework that regulates and connects ideas, and knowledge of the rules of finding clues and evidence. Content knowledge differs greatly among fields, and the teachers must understand the deeper fundamentals of knowledge of the disciplines they teach. Knowledge of content, especially accounting, is very important for an accounting teacher. Koehler & Mishra (2006) explain that teachers who do not have sufficient content knowledge will incorrectly convey the contents of the subject to the students, and this is commonly called a misconception.

Technological Knowledge (TK); TK used in the TPACK framework is associated with an understanding of Information and Communication Technology (ICT). Technological knowledge (TK) is defined as the teachers' knowledge about the latest technology used in the educational environment. Chai, Koh, & Tsai (2010), Can, Erokten, & Bahtiyar (2017) stated that TK means knowledge about how to use ICT hardware and software. The teachers need to have the technological knowledge to seek and learn new technologies that can be used to support accounting learning.

Pedagogical Content Knowledge (PCK); The PCK framework starts from a belief that teaching is not only about the transfer of knowledge to students but about how to teach good content so that the students can understand the material easily and effectively. PCK is also defined as the knowledge about representing content knowledge and adopting pedagogical strategies to make content or specific topics easier for students to understand (Shulman, 1986); (Chai et al., 2011).

Technological Content Knowledge (TCK); Chai et al., (2011) defined TCK as knowledge about how to use technology to convey learning materials differently. TCK refers to knowledge of how technology can cre-

ate new representations for certain contents. Teachers who master technology and content knowledge can easily understand that by using certain media, they can change the way the students learn to understand the learning materials. The technology in question is Information and Communication Technology (ICT) which can support the accounting learning process in vocational high schools. TCK describes knowledge about the interrelationships between technology and learning contents. Not only mastering the subject materials, but the teachers must also have a deeper understanding of how the delivery of the materials can be changed by applying certain technologies. Therefore, they need to understand which technology is most suitable for delivering specific topics and how the materials might change technology or vice versa.

Technological Pedagogical Knowledge (TPK); TPK refers to knowledge of how various media can be used in learning and it also means an understanding that using technology can change the way the teachers teach. TPK is the teachers' understanding of how the learning process can change when technology is used in specific procedures (Koehler & Mishra, 2006), (Koehler et al., 2013). This knowledge enables them to understand what kind of media can be used in achieving learning objectives, and understand the selection of the most appropriate tools according to the pedagogical approach. Koehler et al., (2013) argued that TPK requires the teachers to be forward-looking, creative, open-minded, and seek the benefits of using technology in learning, not for their interests but for improving the quality of learning and students' understanding.

Technological Pedagogical Content Knowledge (TPACK); TPACK is an understanding of how technology can be used creatively to meet pedagogical needs in delivering certain content (Koehler et al., 2013). TPACK refers to the knowledge needed by teachers to integrate technology into learning according to their specific disciplines. The teachers must possess this knowledge to understand intuiti-

vely the complex interactions among the three basic components of knowledge (CK, PK, TK) by teaching using appropriate pedagogical methods and technologies.

Research using the TPACK framework has been carried out to measure the use of ICT in various topics (Chai et al., 2011); (Chai et al., 2010); (Ozudogru & Ozudogru, 2019). Research on understanding TPACK is also associated with gender, age, experience in attending IT courses, and teaching experience; in this case, the experience of having worked as a tutor (Jang & Tsai, 2012; Lin, Tsai, Chai, & Lee, 2013; Restiana & Pujiastuti, 2019; Hidayati, Setyosari, & Soepriyanto, 2019; Koh & Sing, 2011), where these three factors affect several TPACK components. This research focuses on analyzing the mastery of TPACK of accounting teacher candidates in accounting education students of Universitas Negeri Semarang in 2019/2020.

METHODE

This is quantitative research using a survey method. The survey is in the form of self-report-measure. It is the easiest TPACK analysis method and widely used by many researchers (Mouza, Yang, Pan, Yilmaz Ozden, & Pollock, 2017). The researcher decides to choose this method because there are so many research respondents that require a method that is appropriate to the context of the research.

The research is conducted in the Department of Economic Education (Accounting Education) at Universitas Negeri Semarang. The population of this research is all accounting teachers' candidates who are currently studying in the Department of Economic Education (Accounting) of Universitas Negeri Semarang, totaling 119 students.

The sample is taken using the census method based on Sugiyono (2002) who stated that "saturated sampling is a sampling technique when all members of the population are used as the samples". Another term for saturated samples is the census. The research sample is 119 accounting pre-service teachers divided into class A as many as 48 students, class B as many as 49 students, and 22 students in IUP class. They are all currently taking a Learning Design and Strategy course in the even semester of the 2019/2020 academic year.

The data are collected using a questionnaire. The questionnaire is developed from the TPACK questionnaire that was made by Schmidt et al., (2009) and Sahin, Celik, Oguz Akturk, & Aydin, (2013). The questionnaire is made in the form of 5 Likert scales consisting of; 1) strongly disagree; 2) disagree; 3) in doubt; 4) agree, and 5) strongly agree. The entire validity of the instrument items is tested using the Pearson product-moment correlation, while the reliability is checked using Cronbach's Alpha.

The students fill out the questionnaire via Google form through the shared link. The data analysis is carried out descriptively based on Rahmadi (2019) with a rating scale, namely: 1) 1.00 - 1.50 (very poor), 2) 1.51 - 2.50 (poor), 3) 2.51 – 3.50 (fair), 4) 3.51 - 4.50 (good), and 5) 4.51 - 5.00 (very good).

RESULT AND DISCUSSIONS

The students' TPACK is classified based on each class, namely classes A, B, and the international program class or IUP (International Undergraduate Program). The grouping is based on gender, age, experience in training/ courses related to technology, and experience as a course tutor.

Table 1. Category of Accounting Pre-service teachers Indicators

Category	Class		
	A	B	IUP
Gender			
Male	8	4	2
Female	40	45	20
Age			
<22 years	43	45	21
22-24 years	5	4	1
25-27 years	0	0	0
28-30 years	0	0	0
>30 years	0	0	0
IT Training Experience			
None	42	41	18
Ever	6	8	4
Tutor Experience			
None	37	41	18
<1 year	6	5	3
1-2 years	3	2	1
3-4 years	2	1	0
5-6 years	0	0	0
>6 years	0	0	0

Source: Processed research data, 2020

The Technological Pedagogical and Content Knowledge (TPACK) ability of pre-service accounting teachers is classified based on gender, age, experience in IT training or courses, and experience as a tutor. Based on the analysis results, 119 students are selected as the sample consisting of more female students the male ones of each class. There are more students whose ages are under 22. Most of them have ever taken an IT training or course, and based on their experience as tutors, more students have never had experience working as a tutor. There are only 16 respondents who have ever been a tutor in a private institution. Therefore, based on the TPACK research sample indicator, it is found that the students as pre-service accounting teachers are mostly identified by the female gender whose ages are under 22. Based on the research sample, there

are already several students who have attended IT training/courses and also some who work as private tutors. They worked as a tutor for one until four years in average.

The data obtained through pre-service accounting teachers from class A, B, and IUP are measured based on the components of Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK)) Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPCK).

Table 2. Pedagogical Knowledge (PK)

Statement	Class A	Class B	Class IUP
Knowing how to plan the lessons in the classroom	4,94	4,96	4,41
Knowing general procedure for implementing learning in the classroom	3,98	3,98	3,91
Knowing how to organize and manage the classroom	3,08	3,02	3,05
Adapting teaching styles to the students who have different characters	3,02	2,94	3,05
Adjusting the learning process based on what the students already understand and don't understand	3,02	3,12	3,14
Using various models, approaches, strategies, methods, media, techniques, and learning tactics in the classroom	3,79	4,08	3,95
Identifying the students' misconceptions on a concept or material	2,98	3,16	3,32

	Class A	Class B	Class IUP
Assessing the students' learning outcomes using various types of instruments	3,17	3,88	3,77
Total average	3,50	3,64	3,58

Source: Processed research data, 2020

Pedagogical Knowledge (PK) is in-depth knowledge of the processes and practices in learning (Koehler & Mishra, 2006). Based on the analysis in Table 2, the PK ability of accounting pre-service teachers from class B has a higher average score compared to class A and IUP. The difference between class A and class B is 0.15, while the difference between class B and IUP is 0.07. The average score of class A is in the fair category, and the average scores of class B and IUP students are declared good

The next TPACK component is Content Knowledge (CK). The CK ability of accounting prospective teachers is presented in detail in Table 3 below.

Table 3. Content Knowledge (CK)

Statement	Class A	Class B	Class IUP
Having a good knowledge of accounting materials	3,23	3,86	3,91
Using various methods & strategies to develop an understanding of accounting material	3,90	3,98	4,00
Using rational thinking	3,85	3,96	3,95
Getting along with scientific developments and the latest issues in accounting	3,33	3,94	3,95
Identifying accounting scientists	4,79	4,82	4,68
Getting along with the latest development on accounting	3,13	3,27	3,50

	Class A	Class B	Class IUP
Attending seminars or similar activities on accounting themes	2,35	2,12	2,23
Total average	3,51	3,71	3,75

Source: Processed research data, 2020

Content Knowledge (CK) means the ability or competence of the teachers to understand the learning materials, or in this case, knowledge of accounting. Based on the analysis in Table 3, the CK ability of pre-service accounting teachers from the IUP class is higher than that of class A and class B. The average difference between class A and class IUP is 0.23, while the difference between class IUP and class B is 0, 04. All classes have a 'good' average score.

Next, knowledge about Technological Knowledge (TK) as the third TPACK component is presented in Table 4.

Table 4. Technological Knowledge (TK)

Statement	Class A	Class B	Class IUP
Identifying how to solve technical problems that occur on computer/laptop	4,94	4,96	4,95
Learning various new technologies easily	4,63	4,10	3,91
Following the development of important new technologies	4,96	4,98	4,55
Frequently tinkering with electronic devices to find out more information about the technology	2,96	2,98	3,05
Identifying different types of computer/ laptop	2,96	2,92	3,00
Identifying computer/ laptop hardware (example: motherboard, RAM) and its functions	2,08	2,12	2,14

Identifying computer/ laptop software (eg Windows, Media Player) and its functions	2,19	2,20	2,23
Identifying how to use a word processing program (example: Ms. Word)	4,92	4,92	4,91
Identifying how to use a column processing program (example: Ms. Excel)	4,94	4,98	5,00
Identifying how to use a presentation program (example: Ms. Powerpoint)	4,96	4,96	5,00
Identifying how to use an image processing program	1,96	2,10	2,14
Identifying how to use communication applications on the Internet	4,94	4,96	4,95
Identifying how to use social media applications on the Internet	4,96	4,98	4,95
Being able to store data in digital form	4,98	4,98	5,00
Being able to save and modify data in different formats	4,94	4,96	4,95
Being able to use printers, projectors, scanners, and digital cameras	4,92	4,92	4,91
Total average	4,14	4,13	4,10

Source: processed research data, 2020

Technological Knowledge (TK) is the knowledge and mastery of prospective teachers regarding technology to support the learning process (Furqon Arbianto, Widiyanti, & Nurhadi, 2019). Based on the analysis of Table 4, the average score for class A is higher than class B and class IUP, with a very narrow difference (0.01 between class A and B, and 0.04 between class A and class IUP). Each of

the three classes has a good category average score.

The next TPACK component is Pedagogical Content Knowledge which is presented in detail in the following Table 5.

Table 5. Pedagogical Content Knowledge (PCK)

Statement	Class A	Class B	Class IUP
Making lesson plans for Accounting subject	3,88	3,94	3,86
Selecting models, approaches, strategies, methods, media, techniques, and learning tactics according to accounting materials	3,10	3,14	3,27
Making difficult accounting materials easy for students to understand	3,25	3,27	3,36
Making links between one topic and another in accounting subjects	3,21	3,31	3,41
Making links between accounting and with other subjects	3,17	3,29	3,55
Using various learning resources to teach accounting materials	4,08	4,24	4,36
Making test hints and questions on accounting subject	4,23	4,33	4,50
Total average	3,56	3,65	3,76

Source: Processed research data 2020

Pedagogical Content Knowledge (PCK) is effective teaching that requires more than just a separation of content understanding and pedagogy (Sholihah, Yuliati, & Wartono, 2016). Based on the analysis of Table 5, the highest average PCK score for accounting pre-service teachers comes from the IUP class. The difference between class IUP and class A

is 0.20 and the difference between class IUP and class B is 0.11, and the average score of the three classes is in a Good category.

The fifth TPACK component is Technological Content Knowledge (TCK). The following is a summary of the accounting pre-service teachers' TCK mastery.

Table 6. Technological Content Knowledge (TCK)

Statement	Class A	Class B	Class IUP
Identifying various media that can be used to learning accounting materials	4,19	4,29	4,41
Using certain computer/laptop applications to support materials understanding	4,94	4,96	4,91
Using computer/laptop to develop (writing papers and making presentation slides) on accounting materials	4,94	4,98	4,95
Using the internet as a learning resource for accounting materials	4,90	4,92	4,91
Using communication technology such as WhatsApp, Line, telegram, and other media to discuss accounting materials with colleagues	4,92	4,96	4,91
Using social media such as Facebook, Instagram, Twitter, blogs, and others to post and express the understanding of accounting materials with other subject matter	3,04	3,12	3,14
Use social media such as Facebook, Twitter, Linked-in, and others to connect with leading accounting scientists	2,15	2,04	1,91
Total average	4,15	4,18	4,16

Source: Processed research data, 2020

Technological Content Knowledge (TCK) is knowledge about how technology can create a new picture in certain materials. Based on Table 6, it can be seen that the highest average TCK score for accounting pre-service teachers is from class B. The difference in the average score between class B and class A is 0.03, while the averages score difference between class B and class IUP is 0.02. Each of the three has an insignificant score difference and all of them are in a Good category.

The sixth component of TPACK is Technological Pedagogical Knowledge (TPK). TPK means an understanding of how learning can change when certain technologies are applied using specific procedures in the learning process. Following are the details of the TPK for accounting pre-service teachers presented in Table 7.

Table 7. Technological Pedagogical Knowledge (TPK)

Statement	Class A	Class B	Class IUP
Choosing technology that can improve learning strategies in the classroom	4,08	4,12	4,36
Thinking deeply about how technology can affect the learning strategies in the classroom	3,21	3,29	3,36
Choosing technology that can increase students' interest during the learning process in the classroom	4,10	4,18	4,36

Thinking critically about how to use technology in classroom learning	2,35	2,33	2,32
Adjusting the use of technology in various learning activities in the classroom	4,04	4,08	4,27
Choosing technology that can be used to improve learning outcomes in the classroom	4,13	4,18	4,23
Helping other teachers to use technology in classroom learning	4,02	4,10	4,36
Total average	3,70	3,75	3,89

Source: Processed research data 2020

Technological Pedagogical Knowledge (TPK) identifies the interrelationships between technology and pedagogy. This knowledge supports the teachers to understand what kind of technology is appropriate to achieve pedagogical goals, as well as enables them to select what are the best learning media that can be applied based on their suitability for a particular pedagogical approach. Based on Table 7, the highest average TPK score is obtained by the IUP class. The difference between the average score for class A and IUP is 0.19, while the difference between the average score for class A and class B is 0.14. The three classes are included in the Good category.

The last component is Technological Pedagogical Content Knowledge (TPACK). The mastery of TPACK accounting pre-service teachers in more detail is presented in Table 8.

The last component is Technological Pedagogical and Content Knowledge (TPCK). It describes the knowledge that is synthesized from each of the fields of knowledge that has been previously described (Technological Knowledge, Content Knowledge, Pedagogical Knowledge, Pedagogical Content Knowledge, Technological Content Knowledge, and Technological Pedagogical Knowledge), with a focus on how technology can be made dis-

tinctively to be presented on the pedagogical need to teach appropriate contents in specific contexts.

Based on Table 8, the highest score for the mastery of TPCK comes from class B, with an insignificant average score difference. The difference between the average score for class B and class A is 0.07, while the difference between class B and class IUP is 0.06. Each of the three classes has a good average score category.

Table 8. Technological Pedagogical Content Knowledge (TPCK)

Statement	Class A	Class B	Class IUP
Using appropriate technology for learning strategies to deliver accounting materials properly in the classroom	4,13	4,24	4,05
Choosing appropriate technology to improve students' understanding of accounting material and using certain learning strategies in the classroom	4,04	4,29	4,14
Choosing appropriate technology for assessing students' learning outcomes in accounting materials using certain learning strategies in the classroom	4,15	4,20	3,91
Implementing good learning by combining the use of appropriate technology and learning strategies for accounting subjects in the classroom	3,27	3,10	3,5

Helping other teachers to use appropriate technology in learning strategies based on specific accounting materials in the classroom	4,08	4,16	4,09
Total average	3,93	4,00	3,94

Source: Processed research data 2020

Comparison of the Analytical Ability of Technological Pedagogical and Content Knowledge (TPACK)

The students' TPACK ability in class A, B, and IUP is classified as good with a narrow average score difference that. The comparison can be seen in the following image of the scheme for Technological Pedagogical Content Knowledge (TPACK).
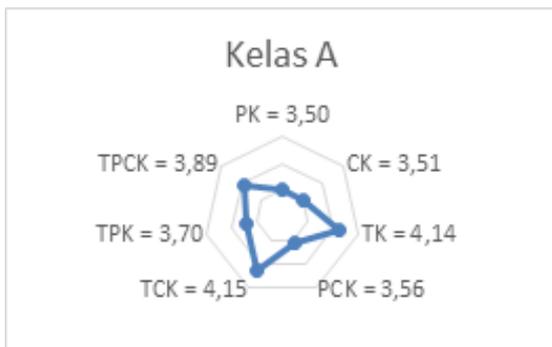
Figure 2. Resume of Analytical Ability of TPACK Class A

The Technological Pedagogical and Content Knowledge (TPACK) ability in class A with all of its components (CK, TK, PCK, TCK, TPK, and TPCK) is in a good category, except for the PK which only scores 3.50 and is included in the fair category.
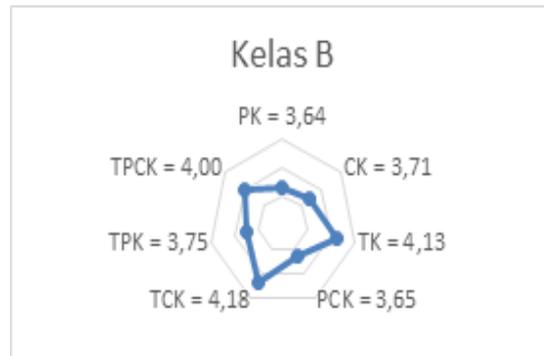

Figure 3. Resume of Analytical Ability of TPACK Class B

The analytical ability of Technological Pedagogical and Content Knowledge (TPACK) in class B with all of its components (PK, CK, TK, PCK, TCK, TPK, and TPCK) is in a good category with the highest average score found in the TK and the lowest one is PCK.
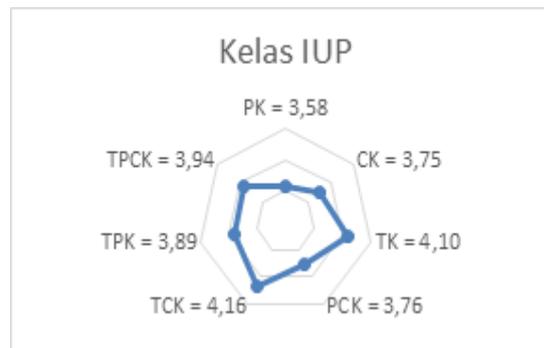

Figure 3. Resume of Analytical Ability of TPACK Class IUP

The analytical ability of Technological Pedagogical and Content Knowledge (TPACK) in the IUP class with all of its components (PK, CK, TK, PCK, TCK, TPK, and TPCK) is in a good category with the highest average score found in the TCK and the lowest one is the PK.

CONCLUSIONS

Based on the research findings, it can be concluded that the pedagogical knowledge (PK) ability of class B and class IUP is in a Good category, while class A obtains fair category. The Content Knowledge (CK) ability of the three classes is in a good category, with the highest average score is the IUP class of 3.75. Each Technological Knowledge (TK) ability has a small average score difference, namely class A = 4.14, class B = 4.13, and class C = 4.10. The three Pedagogical Content Knowledge (PCK) abilities are in a good category, with the highest average score obtained from the IUP class. The Technological Content Knowledge (TCK) ability of the three classes has a similar average difference, where the difference between class A and class B is 0.03, and the difference between class B and class IUP is 0.02. The Technological Pedagogical Knowledge (TPK) ability has got an average score for class A of 3.70, class B of 3.75, and IUP class of 3.89, and all three are in a good category. The Technological Pedagogical and Content Knowledge (TPCK) ability for class A has an average score of 3.93, class B is 4.00, and class IUP is 3.94 and the three classes are included in the category which means the students have good TPCK ability.

The Content Knowledge component is only measured using a questionnaire so that further research can add other components such as the learning outcomes of prospective teacher students by viewing their cumulative grade point index.

This research is limited to one study program in one educational institution (LPTK). Each LPTK needs to carry out a TPACK analysis to find out whether prospective teachers already have various types of knowledge needed to be able to teach according to the demands and characteristics of 21st-century learning. Besides analyzing the mastery of TPACK of the prospective teachers, LPTK needs to review the educational curriculum to see whether it has been under the demands and characteristics of 21st-century learning. If

it is not, the TPACK framework can be used for developing the latest and more relevant teacher education curriculum according to the demands and characteristics of 21st-century learning.

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