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The EFL Pre-Service Teachers' Experiences and Challenges in Designing Teaching Materials Using TPACK Framework

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Abstract

This study aimed to explore the EFL (English as a Foreign Language) pre-service teachers' experiences in designing and implementing teaching materials by using the Technological Pedagogical Content Knowledge (TPACK) framework through the Learning by Design (LBD) approach. It also identified the challenges faced by the pre-service teachers in designing and implementing the teaching materials. This study involved EFL pre-service teachers in the Province of East Kalimantan, Indonesia. Semi-structured interviews and document analysis were used to gather data needed to accomplish the research objectives. The results of the study showed that the LBD approach was found to be beneficial for the pre-service teachers in designing and implementing teaching materials by using the TPACK framework. The LBD approach helped the pre-service teachers in combining the technological tools and applications with teaching. The EFL pre-service teachers believed that the process that they experienced, enabled them to have a positive change in designing the teaching materials. However, some challenges were still faced by the EFL pre-service teachers in designing and implementing the teaching materials. These included the EFL pre-service teachers' low level of computer skill, their lack of proficiency in content knowledge, and the

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availability of media. Moreover, the challenges they faced did not make them afraid of having more experience in LBD activities to promote their abilities in designing teaching materials and in teaching using the materials.

Keywords: Challenges, EFL pre-service teachers, experiences, LBD approach, TPACK.

1. INTRODUCTION

Current demands for teachers' knowledge are not only focused on the knowledge of the field of science they teach and the pedagogical knowledge related to principles and strategies in the classroom, but the teachers are also supposed to manage useful teaching by using technology (Asad et al., 2020; Ghavifekr & Rosdy, 2015). However, not all teachers can manage and integrate technology into the teaching-learning process. Looking at this fact, requiring teachers to experience technology courses in their education program would be beneficial (Polly et al., 2020). As the formal institution that prepares future English teachers, the English Department of the Teacher Training and Education Faculty of Mulawarman University, Indonesia, considers that it is essential for the pre-service teachers to learn innovative lesson plans and update their knowledge of technology so that later on, the programs lead them to adopt and adapt educational technology in their teaching. The department's lecturers apply a framework for integrating technology into teaching, namely the Technological, Pedagogical, and Content Knowledge (TPACK) framework.

A number of studies have been conducted to demonstrate the evolution of the Technological Pedagogical Content Knowledge (TPACK) framework (Allan et al., 2010; Angeli & Valanides, 2009; Harris & Hofer, 2011; Jang & Tsai, 2013; Jimoyiannis, 2010; Koehler & Mishra, 2005; Koehler et al., 2007; Kohen & Kramarski, 2012) and TPACK instruments (Archambault & Crippen, 2009; Baser et al., 2015; Chai et al., 2010; Shin et al., 2009). These studies suggested that it would be unwise for the teachers to ignore technology or to leave it out of the classroom. Technology has become a crucial means in many aspects of life and various fields of study, including education. It is a common phenomenon that students nowadays cannot separate from their mobile phones. Therefore, the integration of technology into a lesson plan that can be applied in the classroom provides students with a learning process that is close to their daily life experiences. One of the ways to integrate technology into the teaching and learning process in the classroom is by using the TPACK framework.

Mishra and Koehler (2006) explained that there are seven constructs in the TPACK framework, i.e., Content Knowledge (CK), Technological Knowledge (TK), Pedagogical Knowledge (PK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPACK). The fundamental elements of TPACK are the CK, which is known as knowledge of the subject matter; TK, which is known as knowledge of various technologies; and PK, which is known as knowledge of the processes or methods of teaching. The others are

combinations of two of three fundamental elements (TCK, TPK, and PCK) or all of the fundamental elements (i.e., TPACK).

TPACK studies have been conducted in various countries. In Asia, the results of TPACK studies have been from a number of countries such as Vietnam, Singapore, China, Turkey, and Malaysia. Many of the studies involved pre-service teachers (e.g., [Graham et al., 2012](#); [Pamuk, 2011](#)), followed by in-service teachers (e.g., [Chai et al., 2013](#); [Guerrero, 2010](#)), and the less frequent is the study combining pre- and in-service teachers. More studies of teachers' use of the TPACK framework are still needed in order to gain the possibility of cultural differences in teachers' TPACK perceptions ([Chai et al., 2010](#)).

A study on TPACK done by [Niess \(2013\)](#) is an important one. It is an interpretive case study and it was conducted for over three years of summer periods. It clearly outlined the steps of implementation. [Niess \(2013\)](#) used five steps of the developmental process to describe teachers' TPACK in a mathematics course. The technological tool used in [Niess's \(2013\)](#) study was a spreadsheet. The five steps included recognizing, accepting, adapting, exploring, and advancing. The result showed that in the first (recognizing) step, the teachers recognized that they had the ability in using the spreadsheet to teach mathematics. In the accepting step, the teachers accepted the function of the spreadsheet as a tool in teaching mathematical problem-solving. In the adapting step, the teachers engaged students to use the spreadsheet as an additional tool to understand more about mathematics. The teachers were in the exploring step as they infused and integrated the spreadsheet in teaching and learning mathematics. In the advancing step, the teachers translated the concept of mathematics using the spreadsheet in the form of learning activities so that students understand mathematics better.

Thus, TPACK as a framework has been developed rigorously. It has also been implemented as a research framework as well as for teaching practices. Many studies using the TPACK framework were conducted in mathematics and science; however, the TPACK framework has been rarely undertaken in EFL contexts, whereas the study of TPACK in the EFL context is also prominent because it provides the same challenges as those in mathematics and science. Out of the limited number of studies on the use of the TPACK framework in the EFL context, some studies focused on TPACK instruments. For example, in their study, [Baser et al. \(2015\)](#) developed and validated a subject-specific survey to assess pre-service teachers' perceptions of their TPACK within the context of teaching EFL. In the process, they created the TPACK-EFL survey to collect data on pre-service teachers' self-assessment of the seven types of knowledge represented within TPACK. Two phases were done, i.e., development phase (including qualitative data collection, qualitative data analysis, item pool generation, expert review, and cognitive interviewing) and two rounds of validation phase which include revision step in between (i.e., quantitative data collection, quantitative data analysis, revision, quantitative data collection, and quantitative data analysis). The results of the study offer a TPACK survey to foreign language teachers. Moreover, [Tseng's \(2014\)](#) study developed an instrument for assessing EFL teachers' TPACK as perceived by 257 EFL students of a junior high school in Taiwan. The application of the instruments in these studies revealed that the students perceived that their teachers demonstrated content knowledge more adequately than their integrated TPACK. The resulting perceptions of the students could be used to help teachers enhance their teaching practices associated with technology.

In Indonesia, a study on TPACK was conducted by [Mahdum \(2015\)](#), who investigated the use of TPACK among senior high school EFL teachers in Pekanbaru, Riau Province, by using a self-assess questionnaire. [Mahdum's \(2015\)](#) study showed that the teachers' scores for each component of TPACK as well as the integration of the components of TPACK were in a good category. Another study focusing on EFL professional development within the TPACK framework was reported by [Cahyono et al. \(2016\)](#). In their study, 20 teachers attended an in-service teacher training program as part of their master's education. In the teaching practice course, they were introduced to the TPACK framework in the hope that they could apply it in their instructional designs. It was found that there was an increase in the use of the TPACK framework integrating all components from their preliminary instructional design (two teachers), the first teaching practice (six teachers), to the second teaching practice (seven teachers).

There is a promising approach to understand the TPACK framework more deeply as well as to develop TPACK, and it is called as Learning by Design (LBD) approach ([Koehler & Mishra, 2005](#)). In this approach, the learners have been involved in designing an artifact for a real-world context whereby their understanding and meaning toward a topic or concept are developed by them ([Han & Bhattacharya, 2001](#)). LBD is an approach that emerged from the constructionist theory that underlines the value of learning through creating, programming, or participating in other forms of designing. Based on [Kolodner et al.'s \(2003\)](#) model, some steps are included in the LBD approach, namely, understand challenges, plan the design, construct/design, test, and analyze/explain.

LBD for pre-service teacher technology preparation requires discussing the affordances of the model for this context. Pre-service teachers (PTs), however, have limited or no teaching experience; thus, they may construct TPACK which is different from in-service teachers' TPACK. When teaching TPACK to PTs, first of all, their technological understanding must be built along with content and pedagogy. Then, because the pre-service teachers are digital natives who use technology in a way different from previous generations, the technology integration instruction for digital native pre-service teachers needs to bridge the gap between their own levels of fluency and their ability to think like teachers ([Clifford et al., 2004](#)).

A research study conducted by [Lu et al. \(2011\)](#) can be an example as it was managed in an LBD environment for pre-service teacher technology preparation in their educational settings. They listed the LBD steps, provided sample instructional activities in each step, and applied the steps and the instructional activities in the pre-service teacher technology preparation context used in the courses. The results suggested that LBD was effective in helping PTs develop TPACK. However, not all components of TPACK increased significantly. PTs' content knowledge did not grow in both studies. This may indicate that the development of each TPACK component may evolve differently.

Reflecting upon the background, the present study explored the process and challenges experienced by EFL PTs in designing and implementing teaching materials using TPACK through the LBD approach in the Indonesian context. Two research questions are formulated in this study:

1. How is the EFL pre-service teachers' process in designing and implementing teaching materials using the TPACK framework through the LBD approach?

2. What challenges do the EFL pre-service teachers face in designing and implementing teaching materials using the TPACK framework through the LBD approach?

2. LITERATURE REVIEW

2.1 The Integration of Technology in the Teaching-Learning Process

It is widely known that teaching and learning activities are considered complex processes. The focus is not only on what knowledge learners should know or acquire but also on how the teacher will transmit that knowledge. Besides, the teaching-learning process will involve the teacher's decisions about what to do in order to achieve the desired learning goals. Teachers nowadays are expected to carry out effective teaching with technology. Therefore, many educators feel that knowing integrating technology into the teaching-learning process becomes essential from time to time. Moreover, the integration of technology in the teaching-learning process can increase students' motivation and students' engagement in the classroom (Costley, 2014). Students nowadays love to learn by interacting and discovering (Baytak et al., 2011), and these can be done by integrating technology into classroom activities.

Technology integration is not limited to having physical equipment in the classroom (Rice et al., 2008). Owning the equipment but not knowing how to use it productively does not qualify for technology integration. This means that technology integration depends on teachers' ability to use various technology tools, including software for teaching. For technology-based courses, Morrison and Lowther (2010) stated that five software categories must be integrated. First, productivity software (word processing, spread-sheets, software for presentations, databases, graphic organizers, graphic software, digital audio editing, digital video editing, and multimedia creation software); second, software for research (browsers, search engines, and plug-ins); third, asynchronous digital communication software (email, lists, discussion boards, blogs, Wiki, and podcasts) and synchronous digital communication software (chat, instant messaging); fourth, problem-solving software (games, simulations); and fifth, educational software (drill and practice, tutorials, integrated learning systems or ILS, process tools). For teachers and pre-service teachers, knowledge of the five categories of software and the ability to integrate the software into the teaching-learning process is crucial.

2.2 Technology-Enhanced Language Learning and Teaching

The Internet and recent technological revelations have made technology tools a crucial part of our life. They have been used to both assist and enhance language learning. Technology-enhanced language learning refers to the use of the computer as technological innovation to display multimedia to complement language teachers' teaching methods, and it is used alongside the teaching method to help teachers in the teaching-learning process. Teachers have used kinds of technology to support their teaching, engage students in the learning process, set up authentic examples of the target culture, and connect their classrooms (Kranthi, 2017). Furthermore, teachers used some technology tools to differentiate instruction and adapt classroom activities

and home assignments, thus enhancing the language learning experience. Some studies believed the fact that language learning and teaching in an area where technology tools are used have made significant changes and helped language learners learn in a more efficient time (Bekleyen & Hayta, 2015; Smith et al., 2013; Yoon & Jo, 2014).

2.3 Technology Integration Models and TPACK Framework

One type of technology integration model is the Technology Acceptance Model (TAM) proposed by Davis (1989). This model is useful for explaining why someone is willing to adopt certain technologies in their work (Adam, 2017). There are two determining variables why someone wants to accept technology; namely, users see technology in terms of perceived benefits (Perceived Usefulness) and see technology in terms of ease of use (Perceived Ease of Use). Perceived Usefulness is defined as a level where someone believes that using a certain type of technology will improve work performance. Conversely, Perceived Ease of Use is defined as a level where a person believes that using a certain type of technology will prevent him from trying too hard in its use (Davis, 1989). This model's existence will also determine how teachers choose the software used to integrate technology into the learning process. Likewise, when teachers or pre-service teachers try to construct an understanding of the TPACK framework's knowledge in the learning process in college, the TAM technology integration model will be an essential consideration.

Another type of technology integration model that becomes one of the most effective ways to adopt teacher knowledge is the Technological, Pedagogical, and Content Knowledge (TPACK) framework (Mishra & Koehler, 2006). TPACK is an approach that knows where to place the right position to use technology in a curriculum, what specific technology is used, why the technology is used, and how that specific technology is used to teach learning content. The learning framework using this technology is built on the Pedagogical Content Knowledge (PCK), which connects knowledge about the teaching content of a field of science (Content Knowledge) with Pedagogical Knowledge (Pedagogical Knowledge) to create an integration which he calls Pedagogical Content Knowledge (PCK). Several studies have posited that TPACK represents knowledge in action and is best seen in the moments of teaching or from records of practice (Mishra & Koehler., 2006; Polly, 2014; Polly et al., 2020; Polly & Mims, 2009; Tai, 2015). Some positive responses towards the introduction of TPACK to the teaching practice in Indonesia have been reported in a number of studies (e.g., Cahyono et al., 2016; Sari & Sumardi, 2020).

2.4 Technology-Based Teaching Materials

Teachers are increasingly using multimedia-based technology in the current teaching-learning process because they feel it is more effective than not using it. Learning using multimedia is a process that combines words and images by assuming that people will learn more deeply from the presentation of words and pictures rather than using only words. Multimedia is defined as a medium for presenting words in verbal form (spoken text or printed text) and presenting moving images (illustrations, photos, animations, or videos) that are intended to support the improvement of the learning process (Mayer, 2014). Mayer (2014) argues that when learning, the human mind functions as a processing system using two channels, has a limited capacity, and

has an active processing system, in contrast to some other multimedia communication theories which claim that learning is using only one channel, has a capacity that is not limited, and is passive in a processing system. Understanding how the human mind's performance will significantly influence the way multimedia processors make multimedia convey the message in question. Seeing the advantages of multimedia in the learning process, teachers must have a way to facilitate and inspire students as pre-service teachers. In the learning process, it is needed to increase their creativity, as stated in one international society for technology education (Shamburg, 2008), where students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.

3. METHODS

This research was conducted at the English Department of Mulawarman University, a university in East Kalimantan, Indonesia, which has been accredited as an excellent university by the National Accreditation Agency for Higher Education in the country. The subjects of the research were EFL pre-service teachers in one compulsory course offered in the sixth semester called Microteaching. The Microteaching course was chosen because it is designed to provide a supportive environment for pre-service teachers to practice teaching skills. Pre-service teachers can get positive effects on teaching skills, self-efficacy, beliefs, anxiety management, critical thinking skills, and dispositions. Microteaching gives pre-service teachers opportunities to design their own teaching materials and to experience teaching as teachers in the classroom (Sahardin et al, 2020). Moreover, Saban and Çoklar (2013) also stated that the Microteaching class would give a chance to evaluate the pre-service teachers' strong and weak aspects in their teaching performances.

From their second until fourth semesters in the department, the EFL pre-service teachers have learned some courses about technology, i.e., Computer Literacy (CL), Computer Application (CA), and Computer Assisted Language Learning (CALL) which are offered either as compulsory or elective courses. In those subjects, the pre-service teachers learned how to operate some software. These helped them a lot in designing teaching materials.

From the number of the students in the Microteaching course, three research subjects were conveniently involved in the research study. Semi-structured interviews and document analysis were used to gather the data needed to answer the research questions. The interview guide was adapted from Schmidt et al. (2009). Fourteen questions were asked in the interview sessions. The documents, in the form of lesson plans, were used as the data triangulation. The results of the interview were synchronized later on with the lesson plans made by the pre-service teachers.

4. RESULTS

The two research questions are used as the basis to present the results of this study. The first research question concerns the EFL pre-service teachers' process in designing and implementing teaching materials using the TPACK framework through

the LBD approach. There are five steps used in one LBD cycle as presented in Table 1, which later on were asked to the subjects of this research in the interview session.

Table 1. An LBD model for pre-service teacher technology preparation (adapted from Lu et al., 2011).

No	LBD steps	Activities
1	Understand challenges	Framing the course goals.
2	Plan design	Discussing the subject matter with the instructor.
3	Construct/ design	Design, create and focus on the technology used for instructional purposes.
4	Test	Feedback from peers and instructor.
5	Analyze and explain	Written feedback from the instructor and PT's self-reflection.

4.1 Designing the Learning Task

In the Microteaching course, the pre-service teachers were asked to choose one of the topics offered in the curriculum and syllabus of junior high and senior high schools. After that, they were asked to plan and design the teaching materials and activities used in the teaching-learning process. The teaching materials are required to be developed by using technology to teach content in real-world contexts. When designing the teaching materials, they used software, among others PowerPoint, Internet, Comic Life, Canva, and Filmora as applications to design the teaching materials. Furthermore, the TPACK framework which includes three basic components (CK, PK, and TK) and four combinations of components (PCK, TCK, TPK, and TPACK) was integrated with the teaching materials and the aforementioned applications to ease them in the designing process. As the pre-service teachers have little experience in teaching with technology, the lecturer assisted the pre-service teachers who were less technologically literate than their peers.

After designing, the next step is the investigation. In this step, the pre-service teachers implemented their design through teaching practice in the classroom to investigate and explore whether their design was appropriate to teach the students. They had thirty to forty-five minutes to implement their teaching materials. After one of the pre-service teachers implemented teaching material, the other pre-service EFL teachers and the lecturer gave some feedback about the teaching performance. The purpose of having feedback is to know what issues were identified by the pre-service teachers when designing and implementing teaching materials.

4.2 Designing and Implementing Teaching Materials Using TPACK Framework through LBD Approach

In order to illustrate how the LBD model is applied in designing and implementing teaching materials using the TPACK framework in the Microteaching course, the process used by each of the pre-service teachers is presented in this section.

4.2.1 Pre-service teacher 1 (PT1)

PT 1 started using Content Knowledge (CK) in deciding the subject matter to be taught to the students; it is about 'offers and suggestions'. She also used Pedagogical Content Knowledge (PCK) when she derived information from the syllabus and

designed the lesson plan. Later on, she used Pedagogical Knowledge (PK) in selecting the teaching methods.

PT1 'I used Communicative Language Teaching because of 'offering and suggestions', so the output is more to students to be able to speak in the target language. Well, I don't just want my students to be more active, more active, but I also want them to understand more about what I say and how to use good language. That's both spoken and written, so I want to fully use CLT'.

PT 1 then used her Technological Knowledge (TK) in designing her teaching materials. She used several applications and made them as educational videos for her students. She said that she spent three weeks making the educational video. The video was used to teach her students using Technological Content Knowledge (TCK).

PT1 'Okay, for sure my first one would be to pick a topic. Then, I was looking for the exact source, Kemendikbud book, while also looking for some other references, e.g., from PDFs or books – anything relevant available on the web. Then, I summarized the points. After that, I was designing with the C- Map and putting the material that I have selected from the sources into the PowerPoint. The design was in accordance with the 2nd grade of high school. After putting the material into the PowerPoint, then I recorded the PowerPoint with Camtasia, and I also recorded my voice while Camtasia was recording. Finally, I edited with Camtasia, and done'.

PT1's Technological Pedagogical Knowledge (TPK) is seen in the dialogue as the mainly used activities in her design of the lesson plan.

4.2.2 Pre-service teacher 2 (PT2)

PT2 used CK when he decided to use News Items for the topic of his teaching materials because he is familiar with the topic. He used PCK when he brought the information from the syllabus and designed the lesson plan. In the 'design/redesign' step, PT2 used PK when selecting the Direct Method as his method in the teaching practice.

PT2 'I used Direct Method because its definition that I know is that during teaching, we always use English. Then I emphasized the students to increase their listening, speaking, and vocabulary. So, this method has five basic principles of learning English. In order to make the students have more experience in speaking English, the teacher must explain everything in full English'.

In designing teaching materials, PT 2 used his TK. He preferred not to use Audacity.

PT2 'First, I looked for supporting materials from the internet, found the content, called News Items. I tried to understand the materials and inserted the materials into the PowerPoint. In the PowerPoint, I needed to consider interesting materials. I tried to make a simple background, but still interesting, and added some animations to my PowerPoint. After the PowerPoint was completed, by using Camtasia, the PowerPoint then was recorded slide by slide, then I inserted the audio, and added the instruments. Actually, we can also use Audacity, but because my voice was clear enough, I did not need to use Audacity'.

PT2 had only two days to design his materials because he took more time in understanding the materials. After he had the materials, he used his TCK in doing peer teaching. PT2 also used his PCK in arranging the assignments in the teaching-learning process.

PT2 *'Oh I invited the students to analyze the video. I explained first what should be seen and identified in the video. For example, in the News Items, there are similar backgrounds as the event; I would ask, where is the event or other information stated in the video? If I stopped the video, the students should be able to mention the main event, background, and other information'*.

PT2 teaching-learning activities can be seen clearly in his lesson plan as described above.

4.2.3 Pre-service teacher 3 (PT3)

In the design step, PT3 used PK to select the Communicative Language Learning in this teaching practice as his method in the design/redesign steps. PT3 used CLT because he wanted the students to be more active in giving opinions in the teaching learning process. In the 'design; step, PT3 used TK to select the application for designing the subject matter and added an audio dictionary in the teaching process.

PT3 *'Oh, the application that I used in teaching was a lot. Among them was the audio dictionary, so that students could easier find meanings to words and their pronunciations. PowerPoint, Audacity, Camtasia, Filmora are the other applications that I used to help me make my design'*.

PT3 spent two weeks designing the teaching materials. He designed it by putting the Application Letter as a topic and combining it with some applications into an educational video.

PT3 *'I spent almost two weeks designing the teaching materials. The first step in making the educational video is inserting materials about the Application Letter into the PowerPoint. After that, I recorded the sound on Audacity. Then I inserted the recordings and the PowerPoint into Camtasia. After that, I inserted the subtitle, I used Filmora for this, and merged all of that in Camtasia. The last one was in Camtasia. All the applications between Filmora and Audacity were included in Camtasia, and there were also some videos from YouTube included along with the instruments'*.

In designing the teaching material, PT2 used CK when choosing an Application Letter from the topic as the teaching materials because the topic helped the 3rd grade senior high school students who want to find a job if they do not go to college. In the investigation step, PT3 used PCK to explain the Application Letter as the topic of teaching for his students. PT3 explained the main forms of the Application Letter to the students and also gave some examples of the topic in order to make his students understand the topic better.

4.3 The Challenges in Designing and Implementing Teaching Materials Using TPACK Framework through LBD Approach

Each of the PTs has her or his own challenges in designing and implementing teaching materials using the TPACK framework through the LBD approach.

4.3.1 Finding the best video to be added to the teaching materials

During the design step, PT1 had challenges in TCK when she designed the material. She found it difficult to get the best video that is suitable for her materials.

PT1 *'The most difficult thing is to find the best video suitable for my teaching-learning activities. I was looking for videos on YouTube, and it is hard for me to find the videos. That is why I had no example of videos in my teaching materials because I could not find it'.*

4.3.2 Lack of time to prepare the teaching materials

PT2 stated that he needed more time in understanding the materials before he designed the teaching materials. PT2 also had challenges in his CK and TCK when he designed the materials. It was difficult for him to be more creative to get the students more interested in the lesson.

PT2 *'The problem is not in the technology, like Camtasia or Filmora. Those are easy to learn. But the problem is with creativity. It is hard to be more creative. The intention is there, but it is hard to make the design interesting. If it is not interesting, the students will easily get bored. We need to be more creative in order to attract the students' attention in learning'.*

4.3.3 The trial version of the technology used

This challenge was stated by PT3 in designing his own material using TCK. He argued that the technology he used, namely Camtasia, was challenging because he used the trial version. When he was designing, it could stop suddenly, and the video resulted in very slow rendering, and sometimes the audio could be cut by Camtasia.

PT3 *'My problem was in Camtasia. There was a trial, a trial period. When I was editing the video, suddenly Camtasia could not be opened. I have to buy it. That was the first problem. Then, when Camtasia was able to reopen, it was rendered. That was the second problem. So, I remembered once when I rendered the video that had already been made, it was displayed very slow. The PowerPoint has already changed its slides, but not the audio. The audio is very slow or did not fits with the video. Sometimes the audio could be cut. That was my problem, and it made me very dizzy'.*

5. DISCUSSION

Koehler and Mishra (2005) stated that the first knowledge, Content Knowledge (CK), is knowledge of the subject matter that will be studied or covered including knowledge of a concept, theory, idea, framework, knowledge of proof, and practices and approaches to develop that knowledge. The three pre-service teachers had designed a subject matter to be taught because they believed that their students understood, and the subject was suitable to them. They used the syllabus which has been designed by the government in order to help them design the subject matter. In teaching practice, they taught using the lesson plans which they have developed based on the existing syllabus.

The second knowledge of TPACK is Pedagogical Knowledge (PK). According to Schmidt et al. (2009), pedagogical knowledge refers to the methods and processes of teaching and includes knowledge in classroom management, assessment, lesson plan development, and student learning. In this knowledge, the pre-service teachers selected the method which is appropriate for their topic. In the syllabus, there is no description regarding teaching methods, unlike in the lesson plan, because the syllabus contains a guideline of teaching material for one semester, while the lesson plan is a guideline of teaching material for one meeting.

The third knowledge of TPACK is Technological Knowledge (TK). [Mishra and Koehler \(2006\)](#) argued TK is the knowledge of standard technology (books, chalk, and whiteboard) and more advanced technology (the Internet and digital video) involving the skills required to operate certain technologies. Furthermore, all of the pre-service teachers designed their teaching material using PowerPoint, Comic Lite, Canva, Audacity, Camtasia, Internet, Filmora. This was evidenced by the 'investigate' and 'explore' steps in which they taught their students by not using conventional technology (books, chalk, and whiteboard) but by using more advanced technology (the Internet and digital video). All the pre-service teachers also designed their own educational videos, and the lecturers acted as their mentors in designing the videos and determined the process of designing videos on the basis of the creativity of each pre-service teacher.

The fourth knowledge of TPACK focused on Pedagogical Content Knowledge (PCK). According to [Koehler and Mishra \(2005\)](#), PCK is an in-depth knowledge of the process and practice or teaching methods in teaching and speech learning, which includes knowledge of classroom management, tasks, planning, and implementation of learning. In this knowledge, the pre-service teachers implemented their topic in the teaching-learning process. They followed the syllabus and lesson plans because there are steps of teaching which have been developed inside those sources.

Technological Content Knowledge (TCK), the fifth knowledge of TPACK, refers to knowledge of the interrelationships between technology and content ([Koehler et al., 2007](#)). This knowledge engages teachers to understand that the use of certain technologies can change the way they understand concepts in a particular content ([Schmidt et al., 2009](#)). In this knowledge, the explanation of the subject matter, the assignment or the activities, and the assessment use technology as part of the knowledge, but in this discussion, we focused on discussing the assignment or the activities of the students and the assessment of the students using technology. In the 'design/redesign' step, the pre-service teachers' designs were able to be learned by the students because the pre-service teachers have designed them creatively, and their designs contained the definition of subject matter up to the activities to assess students' abilities in the topic. However, in the 'investigate' and 'explore' steps, the pre-service teachers faced some difficulties when they conducted assignments and assessments.

The sixth knowledge of TPACK is Technological Pedagogical Knowledge (TPK). TPK is knowledge of how various technologies can be used in teaching, and using these technologies can change the way teachers teach ([Schmidt et al., 2009](#)). In this knowledge, we focused on the interaction of pre-service teachers' design with their students in the teaching-learning process. Based on the interview and the documents, we found that the pre-service teachers conducted interactions with their students using their designs.

The last knowledge is Technological Pedagogical and Content Knowledge (TPACK). TPACK refers to the knowledge of integrating technology by teachers into their teaching of specific materials, which becomes a complete package. Teachers must have an intuitive understanding of the complex interactions between the three basic components of knowledge, namely PK, CK, and TK, by teaching certain materials using pedagogic methods and appropriate technology ([Schmidt et al., 2009](#)). In this knowledge, the pre-service teachers combined the subject matters, the design, and the method to implement for teaching practice in the classroom. They had a willingness to apply TPACK in the teaching-learning process, although they found

some problems when implementing PCK, TCK, and TPK. Among them is the issue in designing the educational video. They also needed some creativity that was suitable between the subject matter and the video. They also had some technical issues when the Camtasia rendering was slow, and sometimes the audio could be cut by it. According to [Debreli \(2016\)](#), pre-service teachers have new experiences to be ‘real teachers’, and also facing difficulties teaching in the classroom. The lecturer in this study gave feedback based on their teaching in order to improve their teaching skills in the future. Accordingly, to apply TPACK, teachers must have facilities, for example, a laptop, a projector, and an electricity network because TPACK involves technology to implement the TPACK framework. Moreover, [Shadiev and Yang \(2020\)](#) encouraged the use of technology in the teaching and learning process, and teachers can adjust their teaching activities, as well as their teaching strategies, to make the most effective use of the existing resources.

6. CONCLUSION

The results of the study showed that the LBD approach was beneficial for the EFL PTs’ process in designing and implementing teaching materials using the TPACK framework. Applying the TPACK framework through LBD extends the understanding of the theoretical grounding for the design of teacher technology preparation in teaching-learning activities. However, some challenges (i.e., availability of media and the EFL PTs’ content knowledge and computer skills) are still faced by PTs in designing and implementing teaching materials using the TPACK framework through the LBD design.

Future researchers might have an in-depth insight into the theoretical grounding of teacher technology preparation and see the impact for the school system from a workforce of technologically competent teachers who can effectively use technology to enhance EFL students’ learning.

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