School of Education

The Influence of Self-Efficacy and Attitude Towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge

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Abstract

The massive development of digital technologies has impacted education, providing many benefits to classroom activities, meaning a teacher's knowledge and skills are critical in digital technology integration. In addition, teacher self-efficacy and attitudes towards digital technologies have also been identified as important variables in this scenario. This research aims to investigate Indonesian teachers' perceptions of self-efficacy and attitudes towards digital technologies, as well as their technological, pedagogical, and content knowledge (TPACK) in teaching. It also intends to investigate factors that positively or negatively affect digital technology integration into the Indonesian classroom setting.

Developed by Mishra and Koehler (2006), TPACK works as technology integration framework in the classroom which explores seven components required to succeed in the integration of technology. The complex interaction of the components generates the types of flexible knowledge needed for integrating the classroom technology (Koehler, Misra, & Cain, 2013). Understanding this complex relationship may help teachers to produce effective learning (Spector et al., 2014).

A mixed-methods approach with an explanatory sequential design was employed. 518 teachers participated in the surveys, and 12 teachers were chosen to take part in the interview, classroom observation, and document analysis. This research focused on teachers across the subjects at 18 senior high schools in Pekanbaru, Indonesia.

Quantitative findings indicated that teachers' self-efficacy and attitudes towards digital technology integration, as well as their TPACK, were good. Teachers' self-efficacy and attitudes towards digital technology integration positively influenced their TPACK. In addition, factors such as lack of ICT training, lack of ICT skills, lack of technical support, scarcity of time, and a poor internet connection were considered to be factors that prohibit digital technology integration in the classroom.

Qualitative data found that the global COVID-19 pandemic pushed teachers and educational sectors to use digital technology in their activities, including the teaching and learning process. The school also provided a lot of training in digital technology use in the classroom in order to adapt to the situation. In addition, teachers also showed good TPACK understanding, which was mainly influenced by the COVID-19 outbreak. Findings also revealed that self-efficacy and attitudes toward using digital technology affected teachers'

TPACK in the classroom. With their good self-efficacy and attitudes toward digital technology use, teachers believed that they could use any kind of digital technology useful for teaching. Findings suggested that students' access to ICT facilities was the most preventive factor for employing digital tools in the classroom.

In addition, tools such as smartphone, tablet, learning apps, and other relevant programs and software have been proven to help teachers in the classroom. Thus, digital technology brings a fundamental change into today's education, causing a quick acceleration in the adoption of educational technology at schools to empower and foster the teaching and learning process regardless of distance restriction. This research has also contributed to increasing the reliability and validity of the TPACK instrument. Finally, a new TPACK instrument has been developed to understand the use of digital technology to provide pedagogy with accurate subject-matter knowledge in the classroom, especially in the context of Indonesia.

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Table of Contents

List of Tables

List of Figures

Chapter 1

INTRODUCTION

1.1 Chapter Outline

This chapter outlines the discussion of self-efficacy and attitude towards digital technologies, as well as teachers' technological, pedagogical, and content knowledge (TPACK) in teaching. This chapter starts with the discussion of the nature of digital education in todays education, followed by the rationale for study. Subsequently, either the objectives or the researh questions of the study are well presented to guide this study. It also will structure the study into logical order which helps to understand the research well. In addition, the chapter also provide the significance section of this research in order to see the contribution it has to the body of current knowledge and to the Indonesian context as well. Following that, a section on the key terminologies is provided, defining the terms used in this research. A section on the limitations of this study is presented to explain the characteristics of the design and methodology that impacted the application and interpretation of this research. Finally, the chapter summary is discussed in the last part of this chapter.

1.2 Introduction

Today, the development of digital technologies has significantly changed our education. Digital technologies have become very important in education as a component of curriculum design, classroom instructional strategies, and as instruments used to create rich educational experiences (Raja & Nagasubramani, 2018). Technology becomes an important tool in today's education, where the use of appropriate digital technology in the classroom may enhance students' curiosity to learn in interesting ways (Carstens, Mallon, Bataineh, & Al-Bataineh, 2021).

Intended to improve student engagement and developing students' natural potentials (Mahdum, Hadriana, & Safriyanti, 2019), digital technology integration provides opportunities for schools to integrate digital technologies into teaching and learning in exciting and meaningful ways (Cha, Park, & Seo, 2020; Ghavifekr & Rosdy, 2015). Studies show that the integration of digital technology into the classroom effectively motivates students to get involved in learning activities (AL-Ammary, 2012; Lin, Chen, & Liu, 2017);

significantly improves students' academic achievement at school (Harris, Al-Bataineh, & Al-Bataineh, 2016); and positively enhances learning activities (Gorra & Bhati, 2016).

Digital technology use in schools becomes important not only to develop students' potential but also to support their future (Eady & Lockyer, 2013), and in turn, it improves the success of education in general (Ozerbas & Erdogan, 2016). For this reason, technologies based approaches would be preferred to replace the conventional teaching methods (Lin, Chen, & Liu, 2017); (Ghavifekr & Rosdy, 2015).

Furthermore, digital education is possible due to the development of digital technology such as the internet, which has created a new learning system in today's era (Mahdum, Hadriana, & Safriyanti, 2019). Internet access provides huge of information, entertainment, and socialization, which may change the way knowledge is possessed by students, and benefits teachers with thousands of teaching sources and information. Thus, digital technology, with its transformation, changes the way students learn and how teachers deal with the issues.

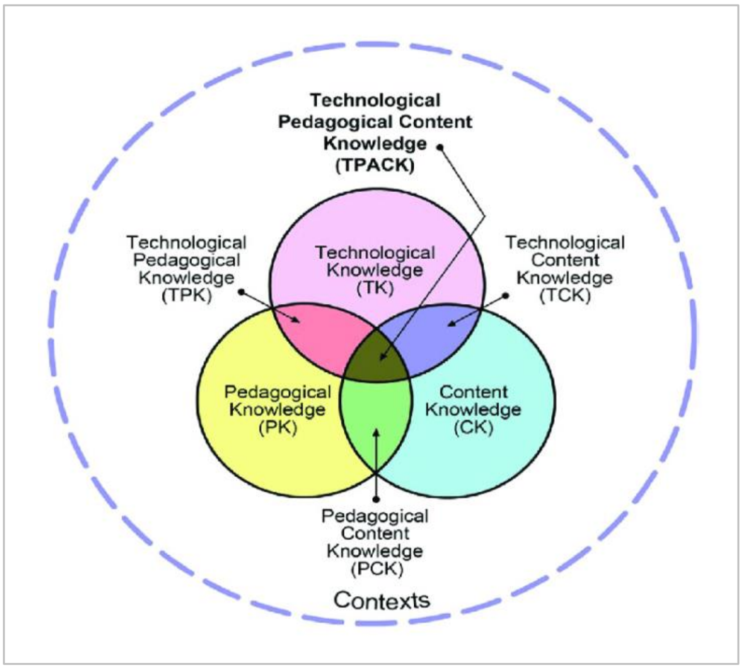
The COVID-19 global pandemic which is becoming a cross-border global health threat, has also brought about fundamental societal changes, including in the sector of education. The critical global pandemic incident forced schools to be closed and has resulted in significant changes in education with profound implications, where teachers were forced to use digital technologies, sometimes for the first time, to make it easier for their students to learn (Pozo, Echeverria, Cebellos, & Sanchez, 2021). In dealing with the situation, many institutions transformed the teaching and learning approaches through online learning. According to Rahiem (2020), there are some platforms mostly used during online learning, such as e-books, pdf documents, YouTube videos, video conferences (Zoom Meet, Google Meet, Microsoft Teams), WhatsApp, social media (Facebook and Instagram), Google Classroom, email, internet search engines, power point presentations, podcasts, and educational websites.

This pandemic situation is a challenge for each individual's creativity in using technology to develop the world of education. However, integrating digital technology in a classroom is not an easy task. Classroom digital technology integration is a complex process requiring teachers' focus, commitment, effort, and expertise. In Indonesia, the lack of digital technology infrastructure and the lack of digital technology training are found to prevent teachers from successfully doing their jobs, particularly those who are in suburban areas (Noviana & Akbar, 2019; Taopan, Drajati, & Sumardi, 2019).

TPACK (technological, pedagogical, and content knowledge) is a common framework that is used by many researchers to examine the integration of technology in the classroom. It was introduced by Mishra and Koehler (2005) in exploring the close relationship between technology, pedagogy, and content knowledge in teaching. The framework is developed from Shulman's pedagogical content knowledge (PCK). Shulman (1987) explained that PCK refers to the recognition of appropriate classroom strategies to teach specific topics or lessons in order to make them understandable for students. It depicts the combination of content knowledge and pedagogical knowledge necessary to achieve that goal (Shulman, 1987). The PCK framework has been enlarged by adding another essential domain, namely technology (Koehler & Mishra, 2005). It includes digital, analogue, new, or old technologies (Mishra & Koehler, 2009).

Figure 1.1

The components of the TPACK framework



Note: From *The Seven Components of TPACK*, by Koehler, M. J., 2012. (http://matt-koehler.com/tpack2/tpack-explained/). Copyright 2012 by tpack.org.

Mishra and Koehler (2006) established the TPACK framework by investigating a complex process in teaching that involved the domains of knowledge of content (CK), knowledge of pedagogy (PK), knowledge of technology (TK), knowledge of pedagogical content (PCK), knowledge of technological content (TCK), knowledge of technological pedagogy (TPK), and technological and pedagogical content knowledge (TPCK). The first three domains are regarded as the core of good teaching practices (Mishra & Koehler, 2006). These three core dimensions are interconnected, which then form other interrelated knowledge. Details will be explored in Chapter 2 of this thesis.

The TPACK framework has received a lot of attention from researchers and has been well explored, meaning it is still a useful framework. The TPACK framework is a generational framework that is applicable in the future (Chai, Koh, & Tsai, 2013). Though it still faces some challenges especially with regard to the instruments currently used to investigate the frameworks, TPACK provides a theoretical template to study teacher's ways of using digital technology in the classroom. (Valtonen, Sointu, Kukkonen, Kontkanen, Lambert, & Makitalo, 2017). Thus, the researcher believes that this TPACK scheme is a benefecial approach to analyze teachers' digital technology use in teaching.

In the context of digital technology integration, self-efficacy is considered important. Self-efficacy influences people's feelings, thinking, motivation, and behaviour (Bandura, 1994). People with high self-efficacy tend to take on any challenges they face and are not afraid to fail (Bandura, 1994). Teacher's belief with regard to their digital technology skills and ability to integrate digital technology into the learning environment is a key success of digital technology integration. Studies have shown that there has been a close relationship between teachers' self-efficacy and teaching effectiveness (Sehgal, Nambudiri, & Mishra, 2017; Zee & Koomen, 2016). As teaching involves a complex and dynamic process, a teacher's effectiveness will depend on his personal agency, such as his ability to be self-organizing, self-reflective, and self-regulating. This personal agency is a key point in enhancing teachers' self-efficacy in teaching (Bray-Clark & Bates, 2003).

In many cases, many teachers come into the classroom with certain technological skills for personal use, but they lack a complete understanding of how technology is applied for educational purposes (Mikusa, 2015). Theoretically, teachers with low self-efficacy can lead to avoidance behaviours, or, in other words, they may avoid the integration of technology into their teaching (Killi, Kauppinen, Coiro, & Utrainen, 2016). In contrast to low self-efficacy teachers, positive self-efficacy will result in teachers having a higher level of confidence and being more focused when faced with a barrier in integrating technology into the classroom (Yau, Cheng, & Ho, 2015). Negative emotional responses such as anxiety and stress can reduce one’s self-efficacy, while positive responses such as good humour may stimulate self-efficacy (Killi, Kauppinen, Coiro, & Utrainen, 2016).

Another important issue in digital technology integration is the teachers’ attitude towards technology integration. The teachers' ICT attitudes, pedagogical beliefs, ICT skills, and training have gained in relevance and been given careful consideration in the current educational context (Aydin, Ali, & Gurol, 2016). Ajzen (1993) defined attitudes as the way people react to an object, issue, or event. Their reaction can be favourable or unfavourable to a certain degree. Teachers’ attitudes indicate to what extent they agree or disagree with digital technology integration in the classroom and what they think and feel with regard to classroom digital technology integration.

Having a clear picture of teachers’ attitudes and beliefs towards ICT is very important in designing an ICT development program for teachers (Banas, 2010) since teacher’s attitude is one of the significant factors to ensure the success of technology integration in education programs (Rana, 2012). Experts believe that teachers’ attitudes play an important role in ICT integration in teaching and learning. Mustafina (2016) found that most teachers have positive attitudes toward ICT use in the classroom. Factors such as a teacher’s ICT experience (Shirvani, 2014), teacher’s confidence and knowledge, and gender (Mustafina, 2016) all potentially influence teachers’ attitudes towards ICT. In addition, teachers with good ICT skills tend to use ICT more often in teaching (Rastogi & Malhotra, 2013). Overall, teacher’s self-efficacy, teacher’s attitude, teacher’s psychological well-being, and students’ academic achievement are all interrelated in teaching and learning (Zee & Koomen, 2016; Sharma & Nasa, 2014).

However, the triumph of digital technology integration is affected by several factors. Barriers from teachers' extrinsic factors and teachers’ intrinsic factors (Bingimals, 2009; Ertmer, 1999) often limit the integration of digital technology in the classroom. Studies demonstared a lack of usage of digital technology in the classroom was due to factors such as insufficient of digital technology skills, support, and facilities, inadequate of time, and tight school’s budgeting (Astuti, Arifin, Mutohhari, & Nurtanto, 2022; Soepriyanti, Waluyo, Sujana, & Fitriana, 2022; Azzahra & Nadia, 2020; Pratolo & Solikhati, 2021; Payal & Vinod, 2018; Tedla, 2012; Goktas, Yildrim, & Yildrim, 2009). Identifying and overcoming such barriers is important. Only if those barriers are addressed well, digital technologies would benefit teacher and student to create positive learning outcomes.

Teaching in the classroom is ultimately a complex task which needs sufficient skills and knowledge. With TPACK main components and its intersections (technological knowledge, pedagogical knowledge, and content knowledge), teachers can easily improve their understanding to adopt new digital technologies in teaching, and know how to use the technology with appropriate pedagogy and subject-matter. The success of digital technology integration in education requires lot of works and supports from all interested parties. Preparing teachers with requisite skills and setting up adequate digital technology facilities and technical support are important to ensure that the use of digital technology can be integrated well.

1.3 Problem Statement

The need to incorporate technology in teaching and learning activities has been a huge demand since technology provides a meaningful learning experience. Technologies integration show to be effective to motivate students to get involved in classroom activities (Lin, Chen, & Liu, 2017); (AL-Ammary, 2012) as well as to be a significant factor in students' academic achievement at school (Harris, Al-Bataineh, & Al-Bataineh, 2016); (Lin, Chen, & Liu, 2017). Gorra & Bhati (2016) mentioned that the use of technology in the classroom is likely to have positive consequences for enhancing learning activities. In the students' points of view, technology helps them to have better and faster access to information, which they believe will be important for their lifelong journey (Andrew, Jennifer, Langille, Aimee, & Norman, 2018). Moreover, teachers believe that technological adaptation in the classroom can build up their communication skills with students and help them prepare course material well (AL-Ammary, 2012), as well as promote better teaching activities in the classroom (Aminu & Samah, 2019).

Classroom-based technology Instruction requires not only teachers' technological competences but also their ability to harmonize all necessary skills to enhance a fruitful learning environment. There has been a complicated process of effectively integrating technology into the classroom (Lim, Zhao, Tondeur, Chai, & Tsai, 2013). Teachers should take their proficiency and experience into account while teaching students, as well as to make use of technology and to consider factors that may influence students' learning activities and performance in the classroom (Eady & Lockyer, 2013). Nevertheless, teachers' decision to integrate technology relied very much on the factors such as school's culture, teachers' self-confidence to use technology, and teachers' perception on the use of technology in the classroom (Howard & Mozejko, 2015).

In the context of Indonesia, the integration of digital technologies has been introduced through the 2004 National Based Competence Curriculum. This curriculum was developed by considering the 2003 National Education Act, which explicitly mentions that digital technology should be used in classroom activities. In 2004, a subject called Information and Communication Technology was put into the curriculum to enhance students' ICT skills (Mahdum, Hadriana, & Safriyanti, 2019). Today, in the Indonesian curriculum, digital technology has been recognized as an important tool supporting meaningful classroom activities for all subjects.

Studies conducted in Indonesia found that many teachers were still not competent to use ICT in the classroom (Mailizar & Fan, 2019). In addition, Suryanto, Sartika, and Nashrullah (2022) also mentioned that teachers are skilled in non-technology skills but not in ICT skills. This study confirmed the studies of Wulansari, Adlim, and Syukri (2020), Mahdum (2015), Suryawati, Firdaus, and Hernandez (2014), who found that pre-service teachers seem to have insufficient technological knowledge (TK) compared to their ability in other domains.

To understand the complex relationship of how digital technology is integrated in the classroom, TPACK framework is used in this study. In addition, teacher self-efficacy and attitudes towards digital technologies have also been identified as important variables in this scenario. Thus, this research investigated Indonesian teachers' perceptions of self-efficacy and attitudes towards digital technologies, as well as the ways in which self-efficacy and attitudes towards digital technologies are reflected in the application of a teacher's technological, pedagogical, and content knowledge (TPACK) in teaching.

Besides, this research also explored the factors that positively or negatively affect the use of digital technology in the Indonesian setting and the factors that impinge on teachers' capacities to use digital technologies in their daily classroom practice. Therefore, it is crucial to reveal what factors that confine teachers' decision to use digital technology in teaching as well as what digital technology they prefer to implement in the classroom. Investigating such issues may provide a comprehensive understanding on the éclat of digital technology in the classroom.

1.4 Researcher’s Background

The researcher started his carrier as an analyst officer in the curriculum department, directorate general of primary and secondary education, the ministry of education, culture, research, and technology of Republic of Indonesia since 2014. Working as a curriculum analyst, the researcher had a variety of responsibilities to curriculum development process, which included the planning, compiling, implementing, and evaluating. In addition, the researcher gained many opportunities to visit schools and to discuss with many teachers related to the issues of curriculum at schools, including the integration of digital technology the classroom.

The integration of digital technology in the classroom was not an issue yet, only after the spread of Covid-19 global pandemic, it became a great concern. The global pandemic forced all educational institutions to close and shift teaching and learning process into online mode. During the early stage of the pandemic, many teachers were not ready to integrate the digital technology into classroom, though the curriculum required teachers to employ digital technology in their teaching. In addition, government educational agency, directorate general of teachers and educational personnel, has been conducting a teacher’s professional program called “profesi pendidikan guru” since 2017 to increase teachers’ content knowledge and pedagogy as well as to enhance their digital technology skills in teaching. However, the program seems need to be improved since teachers were not capable enough to use the technology into teaching.

Dealing with this difficult situation, government and other related agencies intensively provided trainings on digital technology use in the classroom, including introducing useful apps and programs needed for distance learning (Pusat Standar dan Kebijakan Pendidikan, 2022). Therefore, when the researcher got the opportunity to advance his study, he was interested to explore the complex knowledge that teachers should possess in integrating the technology in teaching, where TPACK was adopted as the framework for its usefulness and effectiveness to examine the relationship among technology, pedagogy, and content knowledge (Hill & uribe-Florez, 2020; Dalal, Archambault, & Shelton, 2017), and finally the research may provide useful information for the ministry of education, culture, research, and technology to evaluate the current programs and trainings in order to increase teachers’ teaching competence in accordance with digital technology use in the classroom.

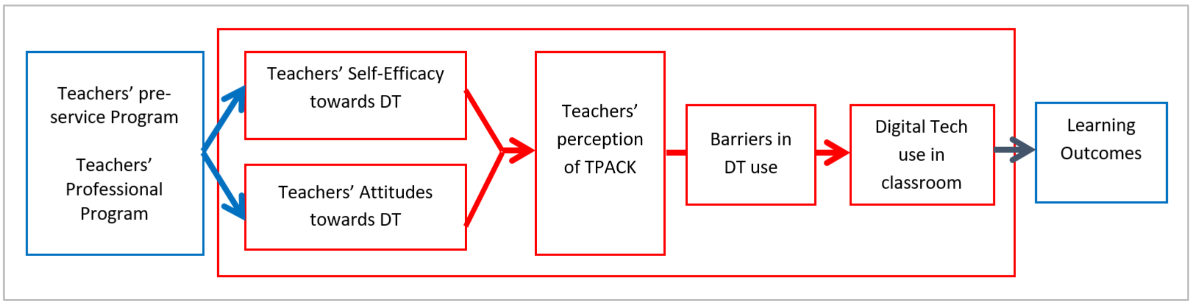
1.5 Conceptual Framework

Largely used in understanding the technology integration, TPACK shows to be a feasible framework to explore a complicated relationship among the components. TPACK can be positively associated with other factors such as self-efficacy towards digital technology (Lopez-Vargas, Duarte-Suarez, & Ibanez-Ibanez, 2017), and attitudes towards digital technology (Yulisman, Widodo, & Evtia Nurina, 2019). In addition, factors such as ICT access, resources, and time (Dalal, Archambault, & Shelton, 2017; Hill & Uribe-Florez, 2020) can be classified as the constraints which prohibit the use of digital technology in the classroom.

In this research, a conceptual framework is designed to show the relationship among the self-efficacy towards digital technology, the attitude towards digital technology, teachers' TPACK, and barriers in digital technology use which affect the selection of digital technology in the classroom, as well as how they are relate in this research. Figure 1.2 shows the conceptual framework that represents this research. It is believed that a four-year teachers' pre-service program as well as a two-semester teachers' professional program play a significant role in preparing skilful teachers who know what to do in the classroom as students of teaching in Indonesia, including to develop their positive perception on self-efficacy and attitudes towards digital technology use in the classroom. In addition, Teachers' perception of TPACK is affected both by their self-efficacy towards digital technology and their attitudes towards digital technology use in the classroom. Factors such as ICT facilities, internet connection, teacher's ICT skill and training, and ICT technical support have a major impact to support the classroom use of ICT, or they may also hinder the success of classroom ICT integration at the same time.

Figure 1.2

Research conceptual framework (the red boxes indicated the focus of this research, while the blue boxes were not included in this research).



1.6 Objectives of the Study

This research aims at understanding the teachers' self-efficacy and attitudes towards digital technology integration on their technological, pedagogical, and content knowledge (TPACK) use in the classroom, and investigating the barriers to digital technology integration, as well as exploring the current practice of classroom digital technology integration. To guide this study, the following research questions were formulated:

Q1. What are teachers' perceptions of their self-efficacy and attitudes towards the use of digital technologies?

Q2. What are teachers' perceptions of their technological, pedagogical, and content knowledge (TPACK) in teaching?

Q3. In what ways do teachers' self-efficacy and attitudes towards the use of digital technologies affect their use of technological, pedagogical, and content knowledge (TPACK)?

Q4. What are the factors that promote or inhibit digital technology use in the classroom?

Q5. What are the digital technology used by teachers, and how are they being used in the classroom?

1.7 Significance of the Study

Considering the importance use of classroom digital technology for both teachers and students, the integration of digital technology has become a major agenda at schools. In addition, during the COVID-19 global pandemic, there was a significant increase in the use of digital technology in education. This situation accelerated teachers to learn using the digital devices in teaching in order to keep in touch with their students due to the global health threat. The use of several platforms for online learning, such as video conferencing, social media platforms, online video platforms, and e-learning, has gained considerable attention from teachers. Good competence and attitudes toward utilizing those digital technologies ensure the effectiveness of classroom activities in today's digital era and promote students' digital skills. Moreover, it is also urgent to understand the factors that have impact on the classroom digital technology integration so that necessary actions can be followed up to settle the problems.

This study included all teachers from public schools that accredited by government accrediting agency and fulfil the eight standards of national education which are content standard (related to curriculum development and implementation), process standard (related to teaching and learning process), educational assessment standard (related to analyses and evaluation of students' learning), graduate competence standard (related to achievement of standard and learning outcomes), educators standard (related to qualification of teaching staffs), management standard (related to managing the educational institution), education financing standard (related to school's budget), and facilities and infrastructure standard (related to teaching facilities). In addition, qualitative research also included teachers with high perception of self-efficacy and attitude in integrating digital technology in teaching, and teachers with high perception of TPACK. They were selected because they had passed the teacher's professional program to ensure that they gained adequate training in teaching.

These criteria are important to make sure that the selected teachers are the one who used digital technologies since the research was aimed to investigate teachers' self-efficacy, teachers' attitude, and teachers' TPACK in digital technology use in the classroom as well as its barriers in the classroom. Thus, the conclusion drawn from the qualitative data represents the cutting edge in Indonesian schools as a result of the strategy used to choose participants for the qualitative phase. This study was intended to:

Firstly, it was expected that the result of this research may enrich the current body of knowledge related to teachers' self-perceptions of self-efficacy and attitude towards digital technologies and their relationship to teachers' self-perceptions of TPACK, particularly in the Indonesian context, which has not been thoroughly explored.

Secondly, the modification of research instruments from this research provided the most suitable questionnaire, TPACK, which meets the context of Indonesia.

Thirdly, the result of this research provided meaningful information useful in enhancing the professional development program for teachers through a program called "*Profesi Pendidikan Guru."* Improving the program may significantly increase teachers' understanding and practices of digital technology integration.

Fourthly, this research provided meaningful information for Indonesian government agencies on education financing services and curriculum development about factors that influence digital technology integration in teaching.

Fifthly, this research could potentially inform The Higher Education Institute for *Teacher Training in Indonesia on the importance of* teachers' self-perceptions of self-efficacy and attitudes towards digital technologies and teachers' self-perceptions of TPACK knowledge.

1.8 Key Terminologies

The definitions of importance terminologies used in this study are outlined as follows:

Self-Efficacy: Self-efficacy is the capacity of an individual to produce desired effects. It is the beliefs about what means lead to what goals and about possessing the personal capacity to use these means (Flammer, 2001). In the context of teaching, self-efficacy is considered important. Therefore, with this research, it refers to the teachers believe that they are able to deliver the subject content confidently and able to instruct their students to achieve the learning objectives.

Attitudes: Ajzen (1993) defined attitude as the way people react to an object, issue, or event. Their reaction can be favourable or unfavourable to a certain degree. In this context of study, attitude indicates to what extent teachers agree or disagree with digital technology integration in the classroom and what they think and feel with regard to classroom digital technology integration.

Digital Technology*:* Digital technology is usually interchangeable with general terms such as information technology (IT), information and communication technology (ICT), or educational technology (Salvati, 2016); (Eryansyah, Erlina, Fiftinova, Nurweni, 2019). Thus, the terms of Information and Communication Technology and digital technology are used more or less interchangeably in this research. It is the set of diverse technological tools (hardware) and resources (applications and software) intended to communicate, create, distribute, store, and manage information (UNESCO, 2023). The technological tools include computer, laptop, smartphone, internet, live broadcasting technologies, and recorded broadcasting technologies. In this study, digital technology is defined as any digital devices used by teachers in the classroom including hard ware or software, offline or online tools which are used to help them managing the classroom activities.

Digital Technology Integration: In this study, digital technology integration is the application of digital devices to enhance meaningful learning environment and activities in the classroom such as laptop, smartphone, tablet, and other related digital devices for teaching and learning. The focus not only on what digital technologies are used by teachers, but also on how often they are used in the classroom.

Digital Technology Barriers – Ertmer (1999) identified two forms of barriers in the classroom technology integration which are first-order barriers (teachers' extrinsic factors) and second-order barriers (teachers' intrinsic barriers). In this context of research, "barriers to digital technology" refers to factors that promote the application of digital tools, as well as the factors that inhibit the digital technology integration.

Teachers**—** Teachers specified in this research refers to all teachers across the subjects taught in eighten schools at Pekanbaru, the capital city of Riau Province, Indonesia.

1.9 Limitation of the Study

This study was carried out in eighteen senior high schools in Pekanbaru, the capital city of Riau, Indonesia. All selected schools are located in the urban area, all of them have good access to ICT facilities and professional teaching staffs. The study dealt with teachers with better digital technology literacy, exploring their self-perception of self-efficacy and attitudes to integrate digital technology in the classroom, as well as their TPACK level and teachers' current practice to make use of digital tools. Thus, this study did not describe the whole community, since there are still many schools in the remote with limited ICT supports and staff. The results from this study are not generalizeable to different setting with less ICT equipments and professional respondents or it needs to be very cautious to consider the generalizability of the findings.

1.10 Organization of the Thesis

The writing of the thesis is organized into eight chapters. Each chapters is outlined as in the following:

Chapter 1

Chapter one consists of several sections that focuses on the background of the study, problem of the study, conceptual frameworks of the study, objectives of the study, significant of the study, key terminologies of the study, limitation of the study, as well as the organization of the study.

Chapter 2

Chapter two consists of a brief discussion of the relevant literature review. The discussion started with a section on self-efficacy, a section on attitudes, and a section on the TPACK framework, followed by a brief discussion of the factors that promote or hinder the use of classroom digital technology.

Chapter 3

Chapter three focuses on the research methodology employed in this study. It begins with a clear discussion on the research design, the trustworthyness of the study, the design of the research instrument, the pilot study, data collection process, and sampling of the study. A description of data screening and analyses was presented at the end of the chapter, and followed by the description of the ethical issues.

Chapter 4

Chapter four discusses the first three research questions, which are (1) what are teachers' perception of their self-efficacy and attitudes towards the use of digital technologies?, (2) what are teachers' perceptions of their technological, pedagogical, and content knowledge (TPACK) in teaching?, (3) in what ways do teachers' self-efficacy and attitudes towards the use of digital technology affect their use of technological, pedagogical, and content knowledge (TPACK)?

Chapter 5

Chapter five focuses on the las two research questions, which are (4) what are the factors that promote or inhibit digital technologies use in the classroom?, (5) what are the digital technology used by teachers, and how are they being used in the classroom?. Responses of these two research questions are presented in the chapter 7.

Chapter 6

Chapter six of this thesis discusses the findings of the first three research questions, which are (1) what are teachers' perception of their self-efficacy and attitudes towards the use of digital technology?, (2) what are teachers' perception of their technological, pedagogical, and content knowledge (TPACK) in teaching, (3) in what ways do teachers' self-efficacy and attitudes towards the use of digital technologies affect their use of technological, pedagogical, and content knowledge (TPACK)?

Chapter 7

Chapter seven focuses on the findings of the last two research questions, which are (4) what are the facors that promote or inhibit digital technology use in the classroom?, and (5) what are the digital technology used by teachers and how are they being used in the classroom?

Chapter 8

Chapter eight, the concluding chapter, presents the originality of the research as well as the contribution it has to the body of knowledge and the community in particular. A section on recommendations and limitations on the research is discussed. It presents recommendations for future researchers in the field, teachers, and schools, including the Higher *Education Institute* for *Teacher Training and the Ministry of Education and Culture.*

1.11 Chapter Summary

This chapter has elaborated the introduction section of the research which may provide a brief description of the nature of the research in a general way. In details, the chapter discusses issues related to the problem statement of the research, objectives of research, significance of the research, and limitation of the research. The next chapter of this research discusses the review of literature that forms the basis for this research.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

Chapter two presents a discussion of the literature review of the research related to this study. The discussion begins with a section on teachers' self-efficacy towards the integration of digital technology in the classroom and followed by a section on attitudes towards digital technology use in teaching. The chapter further converses a section on the need of integrating digital technology in the classroom, particulalrly due to the COVID-19 global pandemic situation which affected all sectors, including the education sector. In addition, the chapter also outlines the discussion on technological, pedagogical, and content knowlede (TPACK) framework as the tool to understand the complex process of digital technology integration in the classroom which include the discussion on TPACK framework development, and how the framework can measure techers' perception of their technology use in the classroom. Finally, the chapter provides literature review on the barriers of digital technology use in the classroom as well as the factors that impinge on teachers' capacity to use digital technology in their daily teaching activities.

2.2 Self-Efficacy

Sef-efficacy is a social cognitive theory which has gain a lot of attention from researchers. It is becoming clear that a person's cognitions influence the motivation, direction, and endurance of actions (Schunk, 1989). The term "self-efficacy" was introduced by Bandura in 1977, when he discussed a theoretical framework of integration for explaining and predicting psychological changes using different methods of treatment. Self-efficacy is conceptualized as beliefs on the capability that a person may possess to achieve a goal influencing events and affecting their lives, which include the processes of cognition, motivation, affectivity, and screening (Bandura, 2006). It influences people's feelings, thinking, motivation, and behaviour (Bandura, 1994). Self-efficacy concerns the self and identity, where people believe that they are capable of doing something and how their beliefs affect what they want to achieve, how they achieve it, and their reactions to success and failure as they progress (Maddux & Gosselin, 2012).

According to Maddux (1995), the most important point of self-efficacy is that the factors such as judgment and expectation regarding behavioural competencies and the ability of likelihood of successfully addressing environmental demands and challenges are very important in determine the commencement of and endurance into performance and action plans. As important as the objectives one wants to achieve, self-efficacy is also the strongest predictors of a motivating a person's behaviour at almost any effort. It is a determining factor in one's efforts, perseverance, strategy, training, and work performance that can be developed to capitalize on its advantages to improve performance (Heslin & Klehe, 2006).

Bandura (1994) stated that high self-efficacy is important to improve personal accomplishment and well-being, and he conceptualized self-efficacy as "perceived operative capability" (Bandura, 1997, p. 646). People with high self-efficacy tend to take on any challenges they face and are not afraid to fail (Bandura, 1994). High self-efficacy would direct an individual to continue working even though he finds it difficult to attain the given goals. Rather than looking for excuses when dealing with problems, he would strive to improve his strategy in approaching his actions (Heslin & Klehe, 2006; Feltz, Short, & Sullivan, 2008). Efficacious individuals take more effort and endure more extensively compared to individuals with less efficacy, who keep questioning their abilities (Tenenbaum & Hutchinson, 2007; Schunk, 1989). Thus, self-efficacy is very important because without it, people will make no effort to achieve their goal and perceive that their efforts will be in vain (Tschannen-Moran & McMaster, 2009). Besides, studies have identified that self-efficacy is closely related to task performance (Carter, Nesbit, Badham, Parker, & Sung, 2018; Manasseh, 2015), task motivation (Bryant, 2017; Pajares, 2003; Schunk, 1995), and task persistence as well (Borbon, 2014; Milner, 2002).

However, self-efficacy is not only about believing in what people can do; it also should include capability, flexibility, creativity, and the power to execute the set goals (Locke & Latham, 1990). According to Locke and Latham (1990), personal goals have an effect on performance, and in this way, goals and self-efficacy have explicit and independent consequences on performance. Further, they argued that self-efficacy affects performance by indirectly influencing the preferred personal goals and the engagement to achieve the goals. Goal-setting affects an individual's self-efficacy in completing their goals. Those who are assigned difficult goals will have higher self-efficacy than those who are assigned low goals (Salancik, 1977).

Self-efficacy should be understood clearly as being different from other constructs such as self-confidence (a general personality trait dealing with the confidence people have and act with) and self-esteem (the degree to which someone likes himself) (Heslin & Klehe, 2006). Furthermore, self-efficacy also should be distinguished from self-concept, locus of control, and outcome expectations, which are totally distinct. Self-concept is defined as the beliefs people have about themselves, which include self-efficacy as an important part of it (Gosselin & Maddux, 2003). Locus of control is the individual's belief on outcome contingencies caused either by his own power or forces beyond his control, while outcome expectation concerns the judgment on the results that can be derived from the performance and consists of both positive and negative physical, social, and self-assessment results (Bandura, 2006). Thus, the discussion of self-efficacy mostly dealt with people's beliefs about their capability and strategy for attaining a goal, which drives them to be focused and persistent.

2.2.1 How Is Self-Efficacy Created?

Self-efficacy is believed to develop when people occupy themselves with actions. People with high self-efficacy will have different thinking patterns and emotions that enable them to achieve goals where they can exert some control (Tschannen-Moran & McMaster, 2009). In addition, Tschannen and McMaster (2009, p. 229) stated that self-efficacy is "a future-oriented belief" in what level of proficiency an individual is expected to demonstrate in a specific context. For example, a student who believes that he can learn well on his own, despite the fact that he is not gifted in a particular subject, can be observed. At the centre of this process lies the understanding that individuals are able to control their thinking, emotions, and conduct (Anstiss, Meijen, & Marcora, 2018).

According to Bandura (1995, 1994, & 1977), self-efficacy can be formed from four main sources which are mastery experience, vicarious experience, social persuasion, and physiological and affective states. Each are discussed in the following:

2.2.1.1 Mastery Experience

Mastery experience plays a significant role in forming and increasing the self-efficacy. It deals with one's experience in facing a specific task, which includes success in achieving the goals. It is so powerful to "produce a transformational restructuring of efficacy beliefs that is manifested across diverse realms of functioning" (Bandura, 2006, p. 308). According to Bandura (1994), a solid belief in individuals' self-efficacy is built by successes and ruined by failures, which particularly happen before there is a strong feeling of efficacy. Hemmings (2015) stated that success in completing a task builds one's personal efficacy, while failure to complete a task weakens his self-efficacy. Thus, mastery experience is an individual's reflexive evaluation of a task's previous success or failure, in which he will interpret and evaluate the results and judge the task's competency based on these reflections (Major, 2016).

People who are able to complete a task with the desired result possess mastery experience. This experience enhances his belief that he is able to cope with those specific activities. These past achievements can create a great sense of efficacy for such tasks every time they are faced (Mohamadi, Asadzadeh, Ahadi, & Jomehri, 2011). Self-efficacy would reinforce when a person carried out a task positively, and self-efficacy could demoralize and fade away if a person failed to perform the task (Hussain & Khan, 2020). A feeling of resilient efficacy demands experience in overcoming obstacles with constant effort. Likewise, certain failures and obstacles in human activities serve beneficial goals by teaching that success demands a continuous endeavour (Bandura, 1994). In the context of teaching, mastery experience is defined as authentic and successful teaching activities that preserve teacher performance (Bautista, 2011).

2.2.1.2 Vicarious Experience

Self-efficacy can be developed and strengthened by the vicarious experiences provided by the social model (Bandura, 1994). Observing similar people succeed through persistence leads the observer to believe that they also have the ability to control similar activities (Bandura, 1995). Vicarious experience is simply understood as taking advantage of others by learning from their experience, which has similar characteristics. It is a way of learning by observing and interpreting models. In the context of teaching, for instance, one individual teacher can build his self-efficacy through the vicarious experience of observing his colleagues teach. According to Major (2016), modelling influences self-efficacy development and is very powerful when an individual is not sure of their own capacities and has limited work experience.

As self-efficacy can be acquired from the knowledge of others, an observer would believe that he is also capable of doing the same task. However, vicarious information is not as strong as mastery information since it is very easy to be denied by later failures (Schunk, 2001). It deals with "effective actual modelling, symbolic modelling, self-modelling, cognitive self-modelling, and simulated modelling" (Bautista, 2011, p. 336). Observation-based learning using modelling calls for caring, retaining, producing, and motivating where specific actions learned by observing need practice as well as feedback to improve the skills (White, 2017). Further, White (2017) suggested that models who are showing specific behaviour but with no verbalization are not as effective as models who are explaining their judgments. Then, the extent to which this individual models a new strategy may determine the extent to which observers are able to implement it.

2.2.1.3 Social persuasion

Self-efficacy can be developed through social or verbal persuasion, empowering an individual who believes they can achieve a goal. It involves positive verbal comments from colleagues and others that strengthen and encourage an individual that, with his capabilities, he could gain the desired level of performance (Tschannen-Moran & McMaster, 2009). According to Bandura (1995, 1994), people who are verbally convinced that they have the ability to control specific activities work harder and longer. Persuasive boots lead people with high self-efficacy to strive more in order to succeed, thus promoting skill development and a feeling of personal efficacy.

Hendricks (2015) stated that efficacy perceptions will be so powerful if they are boosted by others' realistic affirmation, where compliments are given with substantiation. Compliments are meaningful and useful if they are given in a balanced, authentic manner and follow a very commendable performance (Pitts, Davidson, & McPherson, 2000). It is very easy to disprove impractical increases in efficacy once a person's effort has failed. Individuals who believe they lack capacity, on the other hand, are unlikely to take on challenges and will give up quickly in times of adversity (Bandura, 1994). In other words, social persuasion is when others state that an individual is capable of performing a task, such as "you can do this." This positive feedback may increase the self-efficacy, but if the subsequent efforts are not effective, it will be useless (Schunk, 2002).

2.2.1.4 Physiological and Affective States

Physiological and affective states are the last sources of self-efficacy beliefs, which include factors such as arousal levels, fatigue, anxiety, and stress (Major, 2016). It is defined as how much emotional arousal an individual experience while carrying out the given tasks (Frawley, Ober, Olcay, & Smith, 2017). According to Bandura (1994), to judge their ability to perform a task, people rely to a certain extent on their physiological and emotional states. They perceive the feeling of stress and tension as an indication of vulnerability to underperformance.

Stronger emotional arousal may actually change the person's beliefs in what they can do, and they may consider a state of arousal as a power input assisting the success of performance, or they may regard it as totally debilitating (Mohamadi, Asadzadeh, Ahadi, & Jomehri, 2011).

Emotional and physiological arousal are important for developing self-efficacy. If someone is uncertain of his abilities and tends to have negative thoughts and fears, these emotional responses may reduce his self-efficacy and create further stress and disturbance, which make them perform poorly (Frawley, Ober, Olcay, & Smith, 2017). It can be easily observed when a person gives a presentation. His positive emotional states increase his self-efficacy, and he is more capable of dealing with the task; his fears and negative thoughts can lower his self-efficacy.

2.2.2 The Teacher's Self-Efficacy

Teaching is a challenging activity that involves many skills and competencies. Therefore, a successful teacher depends greatly on how he is defining the tasks, using strategies, looking at the potential for success, and solving any obstacles found (Bray-Clark & Bates, 2003). In the context of teaching, self-efficacy is considered important. Self-efficacy impacts attitudes towards the educational process and teaching practice that affect teaching and learning outcomes (Achurra & Villardón, 2012).

Techers' self-efficacy is important in the classroom. It is their belief that they can teach well and help studentd to achieve their learning outcomes (Ma & C1avanagh, 2018). Tschannen-Moran, Woolfolk Hoy, and Hoy (1998) defined that self-efficacy of teachers is connected with teachers' belief on the power that they possess in accomplishing a particular classroom activities. Furtado Nina, Ramos, Holanda Ramos, Silva, De Oliveira Fernandez, & Ramos Pontes (2016) stated that the teachers' judgment on their own teaching abilities and competencies to teach the classroom at any circumstances is characterized as teahers' self-efficacy. Another definition provided by Barni, Danioni, and Benevene (2019) stated that teacher's self-efficacy is the belief in how well teachers manage their tasks, responsibilities, and challenges in the classroom, which significantly affect educational achievement and wellness in the school. It is a reflection of teachers' beliefs in terms of the perceived capacity to carry out certain teaching tasks and therefore affects their thoughts and emotions, which allow for class actions (Pendergast, Garvis, & Keogh, 2011). These definitions imply that self-efficacy has a pivotal role for a teacher in teaching, where his beliefs positively impact his ability to educate the students well.

Understanding teacher self-efficacy can have significant implications for the well-being of teachers and the effectiveness and improvement of the school (Barni, Danioni, & Benevene, 2019). It is because self-efficacy affects a person's emotional reactions and ways of thinking (Cherian & Jacob, 2013). A person who believes that he could succeed in performing a task will be more inclined, and he will engage in the task, trying to complete it and overcome the difficulties (Khurshid, Qasmi, & Ashraf, 2012). In teaching, a teacher’s self-efficacy significantly impacts the extent to which he is able to implement teaching strategies, manage classrooms, and engage students (Sarfo, Amankwah, Sam, & Konin, 2015).

2.2.2.1 Teachers’ Self-Efficacy and Teaching Performance

Teachers’ self-efficacy in teaching consists of two important related aspects, which are their beliefs about their capacity for teaching and their ability to affect students’ positive learning outcomes. According to Achurra and Villardon (2012), teachers’ self-efficacy is closely related to their behaviour when teaching the class. This behaviour can be identified through the teaching approaches selected by teachers. Mitchell (2019) revealed that teachers’ self-efficacy significantly related to teachers’ classroom performances. Furthermore, teachers’ higher level of self-efficacy affects teachers to have greater involvement and persistence to deal with students obstacles in learning. They tend to think that by using adequate support, activities, and evaluation methodologies, those obstacles can be solved. On the contrary, with low self-efficacy, teachers will show less involvement, which reduces the likelihood of successful outcomes, and they may think that their influence on students is low (Mitchell, 2019).

Studies of Pendergast, Garvis, and Keogh (2011); Clark and Bates (2003) showed that teachers’ self-efficacy and teaching effectiveness are closely related. In addition, Zee and Koomen (2016) in their study which integrated 40 years of teacher’s self-efficacy (TSE) research exploring the effect of teacher self-efficacy to classroom performances, students’ learning outcomes, and teachers’ psychological well-being over 165 eligible papers, found that teacher self-efficacy positively links with students’ achievement, practices of classroom quality, and teachers’ psychological well-being. Thus, teacher’s self-efficacy plays a vital role in the teaching and learning process.

According to Clark and Bates (2003), teaching is a complex and dynamic process where the effectiveness of teaching in the classroom depend on teacher’s personal ability to self-organize, to self-regulate, and to be self-reflective. Those ability are the key characteristics to enhance teacher's self-efficacy in teaching. This also confirms the study by Sehgal, Nambudiri, and Mishra (2017), that showed a good relationship between teacher effectiveness in teaching and teacher' self-efficay.

In contrast, studies conducted by Nurindah, Akil, and Jafar (2019) identified that teachers' self-efficacy has not been found to have a significant effect on their teaching performance, even though they believe that they are able to teach the subject well. They found that teachers ability to manage the classroom during the teaching and learning proess were not excellent. Similarly, a study conducted by Poulou, Reddy, and Dudek (2019) found that teachers' self-reported efficacy was not consistent with what they do when it comes to classroom management practices, which their survey responses may be a matter of preferences and may not be put into their daily teaching practice.

Though these studies showed a negative correlation between self-efficacy and teaching performance, lots of other studies confirmed the importance of self-efficacy in teaching. According to Benitez (2020), self-efficacy and teaching effectiveness are inversely related. Teachers who possess higher sense of self-efficacy tend to positively influence their instructional behaviour and encourage them to be risk-taker in teaching. In addition, higher level of self-efficacy also increases teachers' positive engagement with their school's community (Lacks & Watson, 2018), have a positive relationship with classroom management (Buric & Lim, 2020; Lazardies, Watt, & Richardson, 2020), and put in more effort, persistence, and take more responsibility for their students' success (Nurlu, 2017).

2.2.2.2 Teachers' Self-Efficacy and Students' Achievement

Teachers are considered effective in teaching if they can help their students achieve good outcomes in their classroom. Meaning that a good teacher must understand students's learning styles and characteristics and be able to assist them in achieving their learning objectives by using all necessary approaches. Thus, teachers' self-efficacy plays an important role not only for teachers but also for students, and their effectiveness is key to the students' success. Recent studies found that teachers' self-efficacy is an important factor in determining student achievement and motivation as well (Sabet, Dehghannezhad, & Tahriri, 2018; Shahzad & Naureen, 2017; Achurra & Villardon, 2013). Sabet, Deghannezhad, and Tahriri (2018) revealed that 25 teachers teaching English and 75 students learning English from several Iranian language institutes showed to have a significant positive correlation between teachers' self-efficacy and students' motivation.

This finding provides insight that teachers' self-efficacy may influence their teaching performance and students' motivation in learning.

According to Thompson (2015), teachers' self-efficacy significantly impacts teachers' decision in the classroom on their instructional approach. Their study revealed that teachers with higher perception of self-efficcy have a positive relationship with instructional decisions and positive students' learning outcomes. Similarly, Gulistan, Athar, and Mushtaq (2017) found that teachers' self-efficacy and students' academic achievement are strongly connected. Fox (2014) revealed that, though teacher self-efficacy did not seem to have a significant relationship with student achievement, their higher level of self-efficacy encourages them to behave in ways that inspire students' positive learning outcomes.

A qualitative research conducted by Benitez (2020) on three elementary teachers in California to understand teachers' perception of their self-efficacy and how this could affect their classroom effectiveness revealed that a teacher's self-efficacy closely related to teacher's effectiveness and students' success. Their increase of self-efficacy was empowered by mastery experiences and vicarious experiences. Thus, it is important to increase teachers' level of self- efficacy in teaching. Teachers with higher level of self-efficacy can create a positive learning environment as their positive beliefs in teaching my have a positive correlation to students perceived learning outcomes (Achurra & Villardon, 2012). Therefore, teachers who make a significant contribution to students' learning outcomes are those who possess high self-efficacy in teaching.

2.2.2.3 Teachers' Self-Efficacy Towards Digital Technology Integration

Being a teacher in the era of digital technology requires many skills, including knowledge of digital technology. Digital technology has developed immensely and has provided a lot of benefits for teachers and students alike. Nevertheless, teachers should possess adequate digital technology skills and the belief that they can teach their students by utilizing appropriate digital technology. According to Bakar, Maat, and Rosli (2018), teachers' self-efficacy is crucial in the classroom digital technology integration. After reviewing many studies on self-efficacy and technology integration, they concluded that the teachers' higher level of self-efficacy influenced the success of classroom digital integration.

Thus, self-efficacy could enhance ICT usage in classroom activities (Hatlevik and Hatlevik, 2018). Hatlevik and Hatlevik (2018) examined 1.158 teachers acrross the

Norwegian schools to explore teachers' ICT self-efficacy for educational purposes. Results indicated that teacher's self-efficacy towards ICT is closely related to their classroom use of ICT. The more they use the ICT in teaching, the higher is their self-efficacy towards ICT in the classroom. Similarly, Barton and Dexter (2020) revealed in their study that the teachers' level of self-efficacy positively affects technology integration, and advancing their self-efficacy may improve the quality of technology integration.

Sundqvist, Korhonen, and Eklund (2020) suggested that teachers' self-efficacy is one of the importance factors required to integrate digital technology in teaching and learning activities. Teachers' belief on their capacity to employ ICT in teaching effectively is caracterized as teachers' ICT self-efficacy (Skoretz, 2011). Based on the theory of self-efficacy, teachers' beliefs about their ICT skills may highlight the process of integrating technology into education (Brisci & Kul, 2019). Teachers' digital technology knowledge should be supported by their teaching confidence in the classroom since self-efficacy is an important variable and is more important in teaching. (Ertmer & Ottenbreit-Leftwich, 2010). For this reason, teachers should develop their self-efficacy level in order to succeed the integration of digital technology for classroom purposes. In addition, teachers' digital technology self-efficacy is important to enhance attarctive digital classroom learning experience for students to increase their academic performance.

Lailiyah and Cahyono (2017) stated that teachers' self-efficacy and classroom ICT integration positively related. Furthermore, self-efficacy would determine teachers' effort in employing classroom digital technology use as well as in achieving teaching objectives. Hatlevik and Hatlevik (2018) suggested that teachers' self-efficacy is important to develop their belief on ICT use in the classroom and the ability to integrate the ICT as well. The ICT integration in the classroom also promotes teachers' confidence to get new and better teaching resources in the classroom (Yamamoto & Yamaguci, 2016).

Thus, self-efficacy is important in the classroom, particulalrly in integrating the classroom digital technologies in today's digital era. Developing self-efficacy is critical either to help teachers manage the classroom, or to help students achieve their learning outcomes with the help of technology. Teachers' with higher level of self-efficacy are expected to have positive teaching performance and are able to integrate the digital technology effectively.

2.3 Attitudes

Another important issue in digital technology integration that is explored in this research is the teachers' attitude towards technology integration. According to Thurstone (1928), attitude is made up of one's own trends and feelings, assumptions and biases, thinking, believing, being fearful and anxious about anything. Simply put, he (1931) stated that whether or not an attitude is affected by a mental object determines its nature. More recently, Culbertson (1968) stated that social psychologists describe attitudes in three dimensions. They are an object of an attitude, which is often not a physical object; people's beliefs about an object, which can be positive or negative; and a tendency to react to an object in order to keep or get rid of it. In a brief way, Ajzen (1993) defined attitude as the way people react to an object, issue, or event. Their reaction can be favourable or unfavourable to a certain degree. Ajzen (2005, p. 3) stated that "attitude is a hypothetical construct that, being inaccessible to direct observation, must be inferred from measurable responses." Further, he (2005) explained that the responses can be cognitive, affective, or conative responses in the forms of verbal and non-verbal responses. Cognitive responses are responses that reflect both the beliefs about attitude objects and the perceptual reactions to them, while affective responses refer to the responses that reflect feelings towards the attitude object and a physiological reaction to the attitude object. In addition, conation responses are responses that reflect the behavioral intentions and overt behaviours with respect to the attitude object.

Similarly, Eagly and Chaiken (1993) define an attitude as a mental tendency that is expressed to some degree of favour or disapproval by measuring one specific entity. It has the meaning of evaluative judgment, which is a matter of making a decision between liking or disliking, approving or disapproving, or showing favour or disfavour toward an object (Haddock & Maio, 2008). For many years, attitudes in the social sciences were assumed to significantly influence behaviour, decisions, and judgments and were measured in an attempt to predict behaviour as well as the focus of persuasive calls with the goal of shaping behaviour (Guyer & Fabrigar, 2015).

In the sense of evaluating judgment, an attitude may have different directions, such as positive, negative, or neutral, and may have different strengths, such as stronger or less strong (Haddock & Maio, 2008). Furthermore, Petty Wegner and Fabrigar (1997) explained that the main idea in the discussion of attitude is the evaluation of its objects, ranging from positive to negative. An evaluation approach then becomes the central point of attitude studies and has been used by many researchers (Bohner & Dickel, 2011). The evaluation approach views attitude as being important to determining how people perceive an object they have in mind. Their feelings about the object of their attitude can be positive or negative (Bohner & Dickel, 2011).

The evaluation approach has been criticized by social psychologists Harreveld, Nohlen, and Schneider (2015) because it views people as having only one preference, positive or negative. It fails to recognize people who may have both positive and negative feelings about an attitude object at the same time. In this ambivalent perspective, attitude is frequently defined as a situation in which people have both positive and negative associations with an attitude object (Harreveld, Nohlen, & Schneider, 2015). According to Hoffarth and Hodson (2016), the presence of positive and negative feelings could be caused by the conflict of affection, behaviour, and cognition of an attitude or object.

2.3.1 Teacher's Attitudes

Recently, attitude has become a great concern for researchers in the field of education, and many studies have been coducted to measure teachers' attitude as well as its effect on teachers' teaching performance (Harthy, Jamaluddin, & Abedalaziz, 2013) and student achievement (Ekperi, Madukwe, Onwuka, & Nyejirime, 2019; James, 2018; Mariana Ngeche, 2017). In teaching, a teacher will always have a positive or negative feeling when delivering the subject content. The feeling can be about an idea or situation. Thus, a teacher's attitude can be defined as a teacher's psychological tendency toward a certain object related to teaching activities, which can be measured at either a certain level of favour or disfavour.

According to Nel et al. (2011), earlier experiences and views are strongly linked to attitudes, which in some way relate to the interaction with others. "Creating a link between attitudes and teaching allows for consideration of issues such as identity, feelings, and classroom settings, among others."(Morales Cortes, 2016, p. 49) Teachers develop their attitudes toward teaching based on their experiences in educational institutions and in the classroom. Hence, the teachers' attitude can be observed through their interactions and behaviour with the students during classroom activities (Jane & Judith, 2005).

Positive attitudes in teaching are important to determine a teacher's behaviour. Teachers are supposed to be successful role models for their students, either inside or outside the classroom (Ahmad & Sahak, 2009). Ahmad and Sahak (2009) stated that attitudes shape the way a person views, thinks, and acts upon something. Thus, a teacher who is positive about something is ready to conduct himself as required for this purpose (Omer Kutlu, Yildirim, & Bilican, 2010).

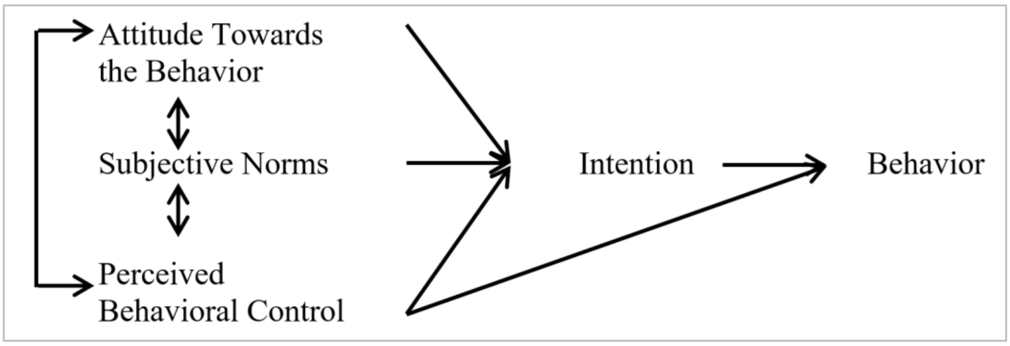
A quantitative study conducted by Ulug, Ozden, and Eryilmaz (2011) on 353 students from different departments at Istanbul Kultur University and Maltepe University asked them how their school teachers' and university teachers' positive and negative attitudes and behaviours affected their personality development and performance. The result indicated that their personalities and performances have been largely influenced by their teachers' positive attitudes. Another survey study conducted by Kurgat and Gordon (2014) in a Kenyan province involved 187 students, 32 teachers, and 4 inspectors. According to the findings, teachers have positive attitudes toward teaching, and thus students' poor negative academic performance was attributed to other factors.

2.3.2 Teachers' Attitudes Towards Digital Technology Integration

As it has been discussed earlier, a teacher's attitude toward teaching in the classroom by using digital technology is important. Any successful effort to integrate technology as part of an educational program is heavily dependent on the teachers' support and attitudes (Teo, 2008). Intentions to execute a specific behaviour are the core idea of the theory of planned behaviour (Ajzen, 1991), which identifies some factors influencing behavioural patterns. These intentions will then indicate the individual's readiness as well as the extent of his anticipated efforts to perform the given behaviour. In the context of digital technology integration, teachers with a positive attitude toward computer sciences are essential to effectively integrating ICT into the school's curriculum (Rana, 2012). Their attitude influences both teaching and learning in the classroom positively, as shown in Figure 2.1 (Ajzen, 1988, p. 133).

Figure 2.1

Theory of Planned Behavior



Note: This model was produced by Ajzen, from "The Theory of Planned Behavior", 1988, p. 133. Copyright 1991 by Academic Press Inc.

The planned behaviour theory explained that there are three factors affecting intention, which is very important in influencing behaviour. These factors are behavioural attitude, subjective norms, and perceived behavioural control. According to Cox (2003), the decision to use ICT in the classroom would depend on teacher's intention. Their intention would be affected by their ICT attitudes in the classroom. Furthermore, he pointed out that the attitudes may constitute perceptions about how their role as teachers is affected and how they impact positively on other teachers, students, and the school as well.

Teachers' positive attitudes towards classroom digital technology use plays a significant role at schools. Establishing innovative ways in classroom digital technology integration which combining teaching methods and technology require teachers' positive attitudes and belief to use the technology. Onalan and Kurt (2020) explored 70 Turkish English as foreign language teachers focused on the factors affecting teachers' technology integration practices showed that teachers' positive attitudes towards using technology in the classroom was among the importance factors of the classroom technology integration. A study conducted by Mwla (2018) revealed that positive teacher's and students's attitudes towards ICT would determine the success of ICT classroom integration. Teachers who have positive attitudes and beliefs to employ ICT into teaching are seen as critical determinants and predictors for ICT classroom integration (Erickelmann &Vennemann, 2017; Suraweera, Wickramasena, Jayalath, & Ariyadasa, 2017).

However, positive attitudes towards digital technology do not mean that it will be well integrated in the classroom, particularly in developing countries such as Indonesia. There will be a lot of challenges, mostly related to teacher readiness and technology access. Rastogi and Malhotra (2013) mentioned that the use of technology may be challenged by teachers' behaviour who are reluctant in employing the tools into teaching. Teachers would think that the use of technology is an extra burden which annoying them un the classroom. "The mismatch between the teachers' culture of techno-centric mindedness and their pedagogic culture would often result in their alienation from the use of technology" (Rastogi and Malhotra, p. 304, 2013).

Wanjiku-Omollo, Wanami, and Kandagor (2017) and Ndibalema (2014) discovered positive attitudes towards ICT integration in the classroom among teachers. Yet they did not integrate the ICT in the classroom, though they were thrilled with the new technology. Similarly, Liton (2014) examined the attitudes of English for Specific Purposes (EFP) and English for Foreign Languages (EFL) teachers towards ICT through a survey and observation, which revealed that young teachers were so enthusiastic about the technology and had no experience and knowledge to employ the tools in teaching. In contrast, senior teachers demonstrated a strong technology integration when they teach the students. Long before, Sanchez, et al. (2012) revealed that teachers showed to have good ICT attitudes required for classroom activities, but in fact they rarely used the technology in the classroom.

Undoubtedly, teachers' positive attitude in teaching is critical, including in incorporating digital technology in teaching. Besides, studies also indicated a positive correlation between attitudes and ICT integration (Makhlouf & Bensaf, 2021; Huynh & Nguyen, 2021). Teachers' with positive attitudes to use digital technology in the classroom are expected to be able creating a meaningful learning experiences to students. In addition, the integration of digital devices into classroom activities may equip students with necessary skills required to face the challenges of digital era.

2.4 Digital Technology

Today's education has been significantly changed by the development of technology. Technology necessitates curriculum reform to face the changes in many aspects of life due to the technological advances. For many years, numerous technologies have been introduced into education. According to Howard and Mozejko (2015), the integration of digital technology is documented in three different periods. The first period is the pre-digital era which included the technology such as film, radio, and television and was introduced during the 1890s-1970s. The next period is the digital technology era, which began in the 1970s and early 1980s and saw desktop computers become sufficiently affordable for purchase by schools. In addition, the internet was introduced in the 1990s, which signifies the era of connected digital technology where many schools used computers and other smart devices connected through the internet. By then, due to the importance of digital technology, the education sector had accepted the challenges of the digital era by integrating ICT into the curriculum.

Technology-based learning enables learners to take advantage of resources and expertise from around the world, beginning with their local environment (US Department of Education, 2017). Digital technology is useful for teachers to enhance their professional learning opportunities and for students to provide a personalized learning experience (Stork, 2018).

In recent decades, access to technology at school has continued to increase, which has led to an increasing demand for technology in the classroom (Martin, 2011). Supporting facilities for enhancing digital technology integration and designing programs for digital technology literacy are now provided at schools. With digital technology, teachers can easily design, prepare, and deliver the lesson much easier, and students can also enjoy the lesson without great effort, which provides unlimited learning as they wish. Thus, teachers must address the challenges of digital era by preparing students with the necessary skills needed to cope with the productive world posed by technology with necessary (Summaka, Samancioglu, Bagibel, 2010).

Digital technology, which takes over the globe, redesigns the way communication is conducted and makes geographical boundaries less important (Pullen, Baguley, & Marsden, 2009). Further, they argue that education sectors should see the changes not only to the extent they affect their local community, but they should also recognize that digital technology can be used to deepen and broaden the classroom activities in a global environment.

Pullen, Baguley, and Marsden (2009) define digital technology as tools that are based on the operation of microprocessors such as computers, applications that rely on the internet, and other devices such as mobile phones, personal digital asisstants, and video cameras. Similarly, Blundell, Lee, and Nykvist (2016, p. 536) define digital technology as "tools used to broadly describe various hardware and software tools, including information communication technologies (ICT), that can be used to collect, store, process, and act on data as well as facilitate creative and critical thinking, problem solving, collaboration, and communication." In the context of education, "digital technology" refers to any digital devices used to enhance classroom activities. It is a technology that, when designed carefully and applied thoughtfully, has a great potential for schools to maximize the impact of education (the US department of Education, 2017).

In order to provide interesting classroom activities, numerous digital technologies can be implemented to support and empower the classroom (Stork, 2018). Furthermore, Stork (2018, p. 37) stated that digital learning "emphasizes high-quality instruction and provides access to challenging content, feedback through formative assessment, opportunities for learning anytime and anywhere, collaboration with others, and individualized instruction to ensure all students reach their full potential to succeed in college and a career."

Current technology is essential in today's educational environment, where technology can potentially change the curriculum by allowing students to experience real-life context (Alfaleh, 2012; Vrasidas & McIsaac, 2010). Technology has been part of their lives since a very early age. They spend their time engaging with many kinds of digital technology, such as television, computers, tablets, smartphones, videos, or games. Furthermore, this generation, which was born in the digital era and is familiar with the updated technology, has caused schools to incorporate digital technology into their curriculum. Terms such as "cybercitizens," "netizens," "digital natives," "homo digitalis," "digital youth," and "generation Y" are used to describe those who spend a lot of time using digital tools (Hockly, 2011).

2.4.1 Benefits of Digital Technology to Learning

Are teachers ready to transform their classroom by incorporating digital technologies into classroom activities? Paradigm changes in the classroom request today’s teachers to serve as digital networks that provide creativity to their students as catalysts for transforming through intelligent tools (Jhanji, 2020). One of the most high-profile technologies in the epoch of today’s digital era is the application of the smart classroom with an internet connection. A teacher may use many digital devices in the classroom, such as social media platforms, a virtual classroom, podcasts, instructional videos, and learning apps that can be accessed via a laptop, computer, or smartphone. In educational setting, the use of digital technology progressively increases and changes the conventional classroom activities (Singh, 2021).

With the fast advance of digital technology, teachers have many alternatives to integrate digital technology into teaching to enhance classroom activities and students' performance. Classroom digital technology integration shows to have positive effects on students engagement and students' comfort with technology as well (Carstens et al., 2021). Yu, Yu, Xu, Xu, and Wu (2022) revealed that digital technology integration in the classroom such as mobile learning not only significantly increases students' engagements and learning outcomes but also improves their behavioural, social, and cognitive skills. Similarly, the use of other devices such as Google Classroom and Kahoot! Educational game learning was also found to showed a positive effect on students' achievement as well as students' learning activities to learn (Litualy, Serpara, & Wenno, 2022; Suparman et al., 2022).

Despite the fact that there's evidence that digital technologies have the potential to improve student outcomes, a number of experts support the idea that the same impact could be attained through the implementation of other well-managed non-technological interventions (Underwood, 2009). Digital technologies are thought to improve students' learning, but they are not yet fully integrated into teachers' classroom practices (Livingstones, 2012). However, with the fast changing of digital technology in today's era, educational sectors have gradually shifted their perspective in viewing the need to use digital devices for teaching and learning process. Some teachers still resist to change and continue to use traditional methods, keeping the education sector out of the technological age (Hicks, 2011). Therefore, shifting teachers' perspective on the use of digital technology as well as providing them with necessary technical skills are crucial. Certainly, classroom digital technology integration has a huge effetiveness either for teachers or for students (Ghavifekr & Rosdy, 2015).

According to Costley (2014), technology contributes greatly to learning if it is used to enhance students' knowledge in an intellectually meaningful curriculum, which must be selected as the most suitable learning tools for students. However, the significant contribution of digital technologies in schools will be determined primarily by schools in determining the optimal balance of technology and traditional inputs (Bulman & Fairlie, 2016).Therefore, the teaching activities should improve students with knowledge and skills required in the digital era (Kmecova, 2020), rather than make the classroom activities slow down, the technology can boost the classroom activities by assissting teachers and students in many ways (Ranasinghe & Leisher, 2009).

2.4.2 Digital Technology Integration

Classroom-based digital technology provides many benefits for today’s classroom. With the ability of digital devices and internet access, technology may enhance students’ learning experiences, improve teachers and school administrators to manage their works (Tosun & Bari, 2011). However, technology itself cannot change the curriculum. There is a mutual relationship between curriculum reform and technology, and teachers should be prepared to understand how to deal with the various media in teaching (Vrasidas & McIsaac, 2010). Shifting from traditional teaching approaches to integrated technology teaching approaches requires sufficient teacher training and may take years to change (Nicole et al., 2018). In an integrated technology teaching setting, teachers’ roles will be significantly shifted from teacher-cantered to student-cantered. During this transition, there should be more support provided to teachers who are comfortable using traditional teaching methods (Hartman, Townsend, & Jackson, 2019).

When technology is integrated and used in conjunction with a thoughtful scientific approach in teaching, it can have a significant impact on the development of education (Aldoobie, 2015).The incorporation of ICT into curriculum allows teachers to design classroom activities in more effective, creative, and appealing ways to increase student engagement and benefit students by stimulating their understanding of subjects that are not limited to traditional curriculum and resources (Ghavifekr & Rosdy, 2015).Indeed, today's students are accustomed to being connected to the digital world and are prepared to deal with it.

The importance of ICT in education has contributed to the development of classroom approaches. The current teaching methods and approaches has been inspired by the critical advance of ICT, since the conventional methods cannot be successfully executed in the ICT classroom environment (Hadijah & Shalawati, 2017). Classroom ICT integration seems to be important to provide input into the development of curriculum particularly on vocational or social aspects, and to serve as a catalyst for curriculum change (Hammond, 2013). In addition, Hammond (2013) stated that the need to use ICT in the classroomis based on the argument that schools should have a higher level of matching where technology is omnipresent in a wider world.

Providing more attarctive ways of teaching which can effectively and effeciently deliver the content knowledge and focus on the cuurriculum outcomes, becomes the major concern of technology integration in education (Earle, 2002). A technology is chosen to be used in the classroom to support the learning objectives. Technology is a medium that allows for classroom activities to build knowledge and understanding, not just tools to deliver knowledge content. (Vrasidas & McIsaac, 2010). As a result, the major challenges of today's integrated ICT in schools are how to design classroom activities and how to apply flexible learning digital technology devices (Lin, Chen, & Liu, 2017). By integrating digital technology into the classroom, students are encouraged to explore their learning interest in their own ways, and to construct meaning and understanding through the 21st skills of problem solving, critical and creative thinking, communication and collaboration. In addition, teachers also gain more opportunities to increase their teaching capacity with the availability of digital technology.

Integrating ICT in the classroom means to make use of computer-based learning in daily classroom activities in order to prepare students with the skills of current digital era (Ghavifekr & Rosdy, 2015). Digital technology integration requires the application of devices which are connected into internet as well as the sufficient skills to operate the technology. Digital technology has allowed out-of-class practice environments to process unprecedented freedom of information and knowledge and access to devices, which suggests schools adopt new kinds of teaching and learning approaches (Matos, Pedro, & Piedade, 2019).

Digital technology integration in education has been a great concern for Indonesian governement. The need to use digital technology can be identified in the Long-Term National Development Plan (2005-2025), which is a government’s strategic planning for a 20-year span. One of the focuses of national development plan related to educational sector is to improve the educational quality and relevance in responding to the needs of national development and globalization. It entails developing educational curricula that empower learning types and diversity of learners while also meeting labour market and regional development needs; improving educators' and staff's professionalism; improving educational facilities; and improving research and community service.

In order to achieve this national development plan, the Ministry of Education and Culture designed a five-year strategic plan (Rencana Strategis). A 2020 Rencana Strategis introduced an educational policy called *Merdeka Belajar* (Freedom to Learn), which aims to provide high quality education for all people, characterized by high enrolment rates at all levels and good learning outcomes across the islands. To achieve these goals, schools were provided with adequate infrastructures such as building, computer, internet connection, free edutech platforms, and ICT tarinings for teachers. Moreover, government also distributed preloaded gadgets and tablets for schools located in remote areas with limited or no internet access (Rencana Strategis Kementerian Pendidikan dan Kebudayaan, 2020).

In the national policy of education, the need to integrate ICT into education became a focus of the 2003 National Educational Act. In article 35, number 1, it was clearly stated that the standards of educational facilities should include classroom, library, laboratory, and sport facilities. In addition, it was also stated that ICT can be used to enhance students' learning activities. In 2004 National Based Competence Curriculum, ICT then included into a subject taught which was called "Teknologi Informasi". Moreover, In 2013 national curriculum and its revisions, ICT was not taught as a special subject anymore, but it must be integrated in the classroom as a mean of delivering the subject content.

2.4.3 COVID-19 Outbreak and Digital Technology Integration

After China reported the first COVID-19 case in December 2019, the virus has spread to almost all parts of the world, including Indonesia. In an attempt to contain the spread of COVID-19, most governments around the world are temporarily shutting down educational institutions (Unisco, 2022). In Indonesia, the COVID-19 outbreak has impacted the education system to the point where schools and colleges will be completely shut down on March 1, 2020, for more than a year. Since then, the pandemic has transformed the education system to make digital technology as a major means of classroom activities at schools. The global outbreak of the pandemic required most teachers to utilize virtual education, in which they should use digital technologies, sometime for the first time, to assist their students in their learning (Pozo, Echeverria, Cebellos, & Sanchez 2021). Teachers were forced to implement emergency distance education, which is very different from planned practices such as distance learning or on-line learning, with very mixed results and exposure to system weaknesses such as the digital divide, inequality, or societal injustice (Valverde-Berrocoso et al., 2021).

In the context of the COVID-19 outbreak, the availability of digital technology and internet connection becomes the only possible means of teaching and learning at the school. According to Kang (2021), during the COVID-19 pandemic, there have been at least two recent trends of digital transformation in the education sector, driven by educational demands, which are an extension of distance learning, and increasingly innovative educational technologies. The emergence of internet-based distance learning allows teachers and students to interact through recorded online courses or interactive online sessions (Kang, 2021). In addition, the development of educational technologies has undergone rapid innovation in the use of new computer devices and the digitization of manuals and teaching materials such as Learning Management Systems, artificial intelligence-based education tools, and creating an OODA loop (Kang, 2021).

The quick transition from conventional classroom approaches into online mode during the COVID-19 global pandemic accelerated the penetration of an algorithm-based vision of the world in educational systems all over the world (Williamson, 2021). To achieve their educational objectives, educational settings used digital platforms. Livestreaming applications such as Zoom Meeting, Google Meeting, Microsoft Teams, and WebEx are among the best videoconference options. Such platforms, which employ algorithms to structure and monitor teaching and learning, are promoted as technical solutions to systemic issues, but they also create new issues and strengthen existing inequalities, generating negative reactions among the population and politicians (Williamson, 2021). In general, e-learning has been impeded by poor infrastructure, including network, power, inaccessibility, and unavailability, as well as poor digital skills (Onyema et al., 2021).

But there is no doubt that the pandemic has helped to raise ICT awareness among teachers (Pozo, Perez, Cebellos, & Sanchez, 2021). A study conducted by Yu, Liu, Huang, and Cao (2021) identified that online learning during the pandemic improved teachers' personal teaching efficacy and ICT efficacy, as well as facilitated their innovative teaching. A study by Vargo, Zhu, Banwell, and Yen (2021) also found that the majority of educators and students choose to use video devices and platforms to further their education, and they are now the second largest group of digital technology users in the pandemic. Thus, teachers should adjust the pace of online courses and devote more effort to the preparation of online courses, innovation, designing lessons, and patiently transforming students from passive recipients into committed learners (Sun, Tang, & Zuo, 2020). as pandemics transformed the educational system and there is a greater use of ICT in learning environments (Montiel & Gomez-Zermeno, 2022).

2.4.4 Teachers' Digital Literacy

As it has been discussed in the previous section, classroom integration of digital technology should be supported by teachers' confidence and skills to integrate the devices into the classroom while schools should have started to reform their curriculum by including digital technology literacy as one of their efforts to meet today's educational challenges. Though digital technology is used in the classroom, teachers' responsibility and role remains important. They should improve their existing understandings and skills or to develop their digital literacy as a result of curriculum changes (Vidosavljevic & Vidosavljevic, 2019). With digital technologies, information can be captured and presented easily through various media such as images and videos in interesting ways. Therefore, digital literacy is important to assist teachers teaching the classroom in more attractive approaches.

Due to the advancement of technology, digital literacy is used interchangeably with similar terms such as IT literacy, computer literacy, and media literacy (Gunes & Bahciven, 2018). In a pragmatic point of view, digital literacy includes the skills, knowledge, and attitudes necessary for accessing digital information effectively, efficiently, and ethically, and includes the evaluation and decision-making skills necessary in dealing with digital content (Julien, 2015). Similarly, Paul, Spires, and Kerkhoff (2017) stated that digital literacy is impacting contemporary education where teachers have to use the information in an efficient, ethical, and responsible manner, while teaching the students.

Digital literacy refers to the ability in reading and writing a number of digital resources, which include words, visual displays, animated graphics, audio, and video (Paul, Spires, & Kerkhoff, 2017). However, in today's digitalization era, it is insufficient to rely only on digital reading and writing competences. One needs the skills required to develop digital competence to use ICT with confidence and critical thinking for daily activities. Martin (2006, p. 19) defines digital literacy as:

> "Digital literacy is the awareness, attitude, and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse, and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process."

Hall, Atkins, and Fraser (2014, p. 5) define digital literacy from an educational perspective as:

> "The skills, attitudes, and knowledge required by educators to support learning in a digitally rich world to be digitally literate, educators must be able to utilize technology to enhance and transform classroom practices and to enrich their own professional development and identity. "The digitally

literate educator will be able to think critically about why, how, and when technology supplements learning and teaching."

According to Jenkins (2015), digital literacy consists of more than basic computer skills. It includes the skills to operate the technology, solve any existing problems, and communicate effectively. It is the knowledge of technology and skills required in productive life, personal development, and positive contribution to society (Cam & Kiyici, 2017). In an educational context, digital literacy covers aspects of technical, cognitive, and social-emotional learning where teaching approaches are carried out using digital technology either online or offline (Ng, 2012). Thus, digital literacy is a compulsory skill that teachers should possess while incorporating digital devices in the classroom. The skills will include knowledge about technology such as how to operate a particular digital technology into classroom activities, and the ethical understanding to use technology in a healthy and responsible way. A digitally illiterate teacher will find it easy to incorporate new emerging technology into his daily life, including teaching.

According to Batubara (2017), there were a huge number of Indonesian elementary teachers in the rural areas that need technical support in implementing the ICT for teaching. Internal factors such as the resistance to using ICT in teaching, insufficient ICT skills, and lower level of self-efficacy in using ICT, contribute to teachers' lower competence of using ICT in the classroom. Furthermre, external factors such as poor quality of ICT facilities at schools and poor training of ICT for teachers also affect teachers ICT competence in teaching (Batubara, 2017).

2.5 The TPACK Framework

Introduced in 2006 by Mishra and Koehler, TPACK frameworks is an interesting framework used to investigate the nature of technology integration in the classroom. TPACK framework identified the complex structure of technology integration by examining the three main of TPACK domains; (1) content knowledge (CK), (2) pedagogical knowledge (PK), (3) and technological knowledge (TK). The interconnection and intersection of these three domains result in four other domains; pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological, pedagogical, content knowledge (TPACK). Understanding these seven domains in digital technology integration is important to create meaningful classroom environment for both teachers and students.

The history of TPACK can be traced from Shulman (1986) who introduced the concept of pedagogical content knowledge (PCK). The concept included "the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, and the most powerful analogies, illustrations, examples, explanations, and demonstrations" (Shulman, 1986, p. 9). The blended of content knowledge and pedagogical knowledge resulted in pedagogical content knowledge (PCK) which presented for classroom instruction to meet the students' need for understanding particular topics (Shulman, 1987). In teaching specific subject content, teachers need to have both an understanding of the content itself and the appropriate teaching approaches and skills that meet students' needs (Spector et al., 2014). Therefore, in order to develop the most suitable pedagogical approaches that suit the identified subject content, teachers should have good understanding of content knowledge, pedagogical knowledge, and teaching experiences (Pamuk et al., 2015).

Working from this PCK framework, Mishra and Koehler (2006) developed a TPACK framework by adding other components of teaching to meet the challanges of technological development. It includes digital, analog, new, or old technologies (Mishra & Koehler, 2009). According to Mishra and Koehler (2009), the use of newer technology in teaching is more complicated and challenging for teachers. Unlike traditional technologies that are specific, stable, and transparent in function, modern technologies are changeable, unstable, and non-transparent (Mishra & Koehler, 2009). Teachers need to have adequate and appropriate skills in integrating digital technology into teaching. They are required to shift from conventional teaching into smart teaching (Kinshuk et al., 2016).

The additional of technological knowledge (TK) domain within the original concepts, provides new insights and domain to the current framework. It creates a new intersection and forms another concept of technological pedagogical content knowledge (TPACK) (Knolton, 2014). The intersections of TPACK components help teachers to understand the need of digital technology integration, where teachers are able to deliver a specific subject content by using suitable teaching methods and appropriate technology. The seven components of TPACK are defined in the following (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009):

1. Technological knowledge (TK) is defined as the understanding of integrated clasroom technology required for teaching and learning activities. It ranges from traditional tools to digital tools which are used to help classroom activities.
2. Content knowledge (CK) is defined as the understanding of subject content. It is a given topic, taught by teachers and learned by students in the classroom. In teaching process, teachers will always depend on other required knowledge of pedagogy and technology.
3. Pedagogical knowledge (PK) is defined as the knowledge of delivering a particular subject to students. It deals with how a subject topic is delivered to students during teaching and learning activities. It also delas with how the subject topic is assessed in measuring students' understanding, as wellas deals with how to manage the classroom activities in order the classroom run effectively.
4. Pedagogical content knowledge (PCK) is the knowledge of pedagogy and content which is blended together to enhance classroom activities. It is "the ways of representing and formulating the subject that make it comprehensible for others" (Shulman, 1986, p.9). Teachers need to have good understanding of pedagogical domains as well as content domain when applying the knowledge in the classroom. With a comprehensive understanding on the PCK, teachers will be able to deliver the subjcet matter effectively
5. Technological content knowledge (TCK) is defined as the blended knowledge of content and technology required for teachers in the classroom activities. understanding the correct technology in order to deliver a subject matter is important. The decision to choose a particular technology should be relied on the understanding that the topic would be effectively delivered and grabbed by students easily.
6. Technological pedagogical knowledge (TPK) is defined as the blended knowledge of technology and pedagogy required for teaching in the classroom. Good understanding of some particular digital technologies is not enaugh to teach the students, unless they also have adequate knowledge of certain pedagogies, and know how to combine them with the available digital technologies. The ability to choose the correct technology and the suitable pedagogy would help them very much in the classroom.
7. Technological pedagogical content knowledge (TPACK) is defined as the comprehensive understanding of all TPACK elements. Understanding the TPACK will help teachers to integrate the digital technology effectively as well as to create meaningful classroom experience for teachers and students as well.

Working as a framework in technology integration, TPACK describes certain knowledge that is required by teachers by emphasizing how the complex relationship among the elements are exist and connected. Understanding this complex relationship may help teachers to produce effective learning (Spector et al., 2014). Koehler (2006) believed that the TPACK approach was useful in helping teachers understand the complex processes involved in integrating technology so that they could deliver content knowledge effectively in the classroom. The complex interaction of the three main components of TPACK generates the types of flexible knowledge needed for integrating the classroom technology (Koehler, Misra, & Cain, 2013).

Koehler and Mishra introduced the TPACK framework in 2006, and its development and refinement has continued to this day. Understanding the clear concepts of TPACK framework is important. Researchers work extensively to comprehend TPACK's relationship to technology integration, as well as to develop the most suitable TPACK's measurements, and to refine its constructs and concepts. The focus on the TPACK framework extends to a wide range of content areas and mobilizes a wide range of scholars and researchers in an effort to get a clear view of its theoretical and real-world implications (Koehler, Mishra, & Cain, 2013). Cox (2008) stated that the TPACK constructs are not well defined and are still hard to understand; for example, the TCK and TPK constructs are not supported by empirical evidence that shows their existence. Angeli and Valanides (2009) argued that the TPACK conceptualization emphasized by Koehler et al. (2007) needs further clarification. They described that if TPACK works as a theoretical and analytical context to guides and helps teachers in integrating the technology in the classroom, TPACK's accuracy must be examined in order to develop and evaluate the measurement constructs. Angeli and Valanides (2009) also mentioned some other issues with TPACK, such as: (1) the lack of empirical findings regarding TPACK, whether it is a different form of knowledge or grows within the related constructs; (2) the limits between certain TPCK components are unclear, indicating a weakness in discriminating the knowledge and showing that the concepts needs further refinement; and (3) TPACK's current form appears too broad because it does not explicitly address the racial divide.

Cavanagh and Koehler (2013, p. 146) stated that TPACK theory is "still in its infancy, as is the measurement of TPACK." They highlighted the shortcomings of existing investigations and measurements in TPACK research and explained some points of the frameworks which conflicting the corrective push of the concepts, including the ambiguous definition of TPACK epistemology, ambiguous intention of TPACK evaluation, and unfitting selection for TPACK evaluation models.

Conducting a literature review of 55 articlaes, Voogt, Fisser, Pareja Roblin, Tondeur, and Van Braak (2013) to understand the TPACK concept and application, they found that researchers have different concepts regarding TPACK and technological knowledge, which had an effect on how TPACK was measured. The TPACK framework has been criticized "for not being practically useful" (Willermark, 2017, p. 315). Willermark (2018) discovered that self-reporting surveys are common in identifying teachers' TPACK in her review of 107 TPACK-related journals, and how they are operationalized is implicit and unclear. On the other hand, classroom teaching performances are rarely assessed.

According to Tseng, Chai, Tan, and Park (2022), over a reviev of 51 journal articles on TPACK from 2011 to 2019, there four major themes that draw researchers attention: (1) exploring self-perception of TPACK, (2) assessing TPACK measurement, (3) developing TPACK measurement, and (4) applying TPACK in the classroom setting. Furthermore, they found that teachers' TPACK competence was varied, however teachers perceived technological knowledge as the highest component within the constructs. Their study also revealed that the survey items used to assess TPACK have been contextualized to mitigate the challenge of separating the different components of TPACK. In fact, the challenge may still be that the seven sub-components do not seem feasible in practice. In developing TPACK, they revealed that the most effective ways to enhance teachers' understanding of the framework are through modelling from experienced teachers as well as teachers' engagement in designing lesson plan. Regarding the application of TPACK, they found that training courses and platforms adapted to it were seen as useful and effective.

Though TPACK received many critiques, a lot of researchers pay huge attention to it, and it has been well explored, meaning it is still a useful framework. The most encouraging is that TPACK is a dynamic research sector, which can be determined by the number of studies in this field and the range of methodological approaches used to study its development (Koehler, Shin, & Mishra, 2012). The TPACK framework is a "generational framework" that is applicable in the future (Chai, Koh, & Tsai, 2013, p. 45). Cavanagh and Koehler stated that efforts to develop the TPACK framework are still needed. They said (2013, p. 146): "Maturation of TPACK research and measurement requires nurture and external sustenance from well-established fields of research and methodologies." Therefore, the researcher believes that the integration of digital technology in the classroom can be measured by using the TPACK approach despite its identified weaknesses. The use of an instrument to measure a teacher's TPACK, along with each of its components, will be developed and used in this study, which will address to some degree the need identified by Cavanagh and Koehler.

2.5.1 Developing TPACK's Measurement

Since it was introduced by Mishra and Koehler (2006), the TPACK framework has gained a lot of attention from many researchers. Working as technology integration framework in the classroom, TPACK explores all components required to succeed in the integration of technology: the three main components and the sub-components. The seven components of the TPACK framework need to be clearly defined and an instrument enabling researchers to explore teachers' understanding of the TPACK components needs to be designed (Maor, 2013).

In measuring teachers' TPACK, a lot of studies used a combination of a self-assessment questionnaire, classroom observation, and product assessments or performance, where the choice on which instruments were required depended on the researchers' perspective on the TPACK framework (Fisser, Voogt, Braak, & Tondeur, 2015). As a theoretical framework, TPACK is largely used in technological integration in education, but the instruments being used to measure it proved to be difficult (Valtoneen, Sointu, Mäkitalo-Siegl, & Kukkonen, 2015). Wei (2016) identified five types of TPACK measurement developed by researchers: (1) self-report measurement focusing on survey development; (2) performance assessment rubrics investigating teachers' lesson plans; (3) open-ended questionnaires collecting written responses from teachers to predetermined survey questions; (4) interviews focusing on data collection using listed questions; and (5) observations investigating teachers' performance in classroom teaching.

Self-report measurement was the most common instrument used by researchers. In fact, there are a lot of TPACK self-report measurements developed by researchers to explore TPACK frameworks. A TPACK measurement was developed by Schmidt, Bran, Thompson, Mishra, Koehler, and Shin (2009) on a five-level Likert scale measuring the seven TPACK domains. The measurement was tested on 124 teacher candidates. They used quantitative research approach to investigate surveys validity and reliability as well as the factor analyses. Findings showed that their measurement was promising.

Chai, Koh, Tsai, and Tan (2011) developed a TPACK measurement which was based on the study of Schmidt et al. (2009). 834 candidate of teachers participated in the study. To evaluate the validity and reliability of the measurement, they employed the explatory factor analses (EFA) as well as the confirmatory factor analyses (CFA). Findings revealed that the measurement was applicable and the TPACK is a generative framework in the classroom digital technology integration. Furthermore, Valtonen, Sointu, Kukkonen, Kontkanen, Lambert, and Makitalo (2017) developed a 21st century TPACK measurement. Their instrument was used to measure 94 pre-service teachers in the first phase, and 267 pre-service teachers in the second phase. Findings enabled a better understanding of TPACK theoretical concept in digital technology integration and showed a practical TPACK measurement. Similarly, Kadioglu-Akbulut et al. (2020) developed a TPACK measurement which focused more on the development of ICT in the teaching of science. Findings identified that the measurement was doable. The summary of TPACK measurement development are presented in the Table 2.1:

Table 2.1

TPACK Measurement Development

Authors	Methods	Respondents	Types of Assessment	Results
Scmidt, et al (2009)	Quantitative analyses (EFA)	Pre-service Teachers	survey	The measurement was applicable
Chai, et al (2010)	Regression analyses (EFA)	Pre-service Teachers	survey	Pre-service teachers’ TPACK positively predicted by pedagogical element, content element, and technological element
Sahin, I (2011)	Quantitative analyses (EFA, Pearson Correlation)	Pre-service teachers	survey	The TPACK survey was valid and reliable measurement.
Chai, et al (2011)	Quantitative analyses (CFA, EFA)	Primary School Teachers	Survey	The measurement was applicable to measure digital technology integration in the classroom and the TPACK framework was a generative concept
Lux, et al, (2012)	Quantitative analyses (EFA)	Pre-service teachers	survey	The measurement was promissing and applicable

Authors	Methods	Respondents	Types of Assessment	Results
Jang, S.J., & Tsai, M.F. (2012)	Quantitative analyses (CFA)	Elementary mathematics and science teachers	survey	The measurement was promissing and applicable
Jamieson-Proctor, et al (2013)	Quantitative analyses (CFA, EFA)	Pre-service teachers	Survey	TPCAK instrument considered valid and reliable
Saengbanchong, et al (2014)	Quantitative analyses (CFA, EFA)	Pre-service teachers	survey	The measurement was valid and applicable
Nordin, H (2014)	Quantitative analyses (CFA)	Pre-service teachers	survey	TPCAK instrument considered valid and reliable
Valtonen, et al (2015)	Quantitative analyses (EFA)	Pre-service teachers	Survey	The quantitative analyses improve the understanding of TPACK framework. The measurement was promissing
Kartal, et al (2016)	Quantitative analyses (EFA, t-test)	Pre-service teachers	survey	TPCAK instrument considered valid and reliable
Kiray, S.A (2016)	Quantitative analyses (CFA, t-test)	Pre-service teachers	survey	The measurement was promissing and applicable
Valtonen, et al (2017)	Quantitative analyses (CFA)	Pre-service teachers	survey	The six factors of confirmatory factor analyses fit the TPACK theoritical concept. The measurement was valid and applicable
Yeh, et al (2017)	Quantitative analyses (EFA)	Science teachers	Survey	The measurement was promissing and applicable
Akyuz (2018)	Qualitative analyses (lesson-plans, activity sheets)	Pre-service mathematics teachers	Performance assessment	Four knowledge domains within the TPACK framework could be distinguished which are denoted as core, techTPACK-P, and TPACK-C
Cetin, I, & Erdogan, A. (2018)	Quantitative analyses (CFA, EFA)	Pre-service teachers	Survey	The measurement was proved to be valid and applicable
Schmid, et al (2020)	Quantitative analyses (CFA, SEM)	Pre-service teachers	Survey	The measurement was proved to be valid and applicable
Kadioglu, et al (2020)	Quantitative analyses (CFA, EFA)	Pre-service teachers	survey	The measurement was proved to be valid and applicable
Jung ku, et al (2020)	Quantitative analyses (CFA)	Pre-service teachers	Survey	The measurement was proved to be valid and applicable

Since the number of TPACK measurements developed by researchers increased significantly, ensuring the validity and reliability of the measurements is important (Koehler, Shin, & Mishra, 2011). Cavanagh and Koehler (2013) provided a good guideline in order to produce a valid and reliable TPACK measurement. They developed a seven-criterion lens to outline the principles of measurement and techniques. These seven lense would help researchers to confirm the validity and realibility of the measurment in critical and responsible ways. The proposed lense are presented in the following Table 2.2:

Table 2.2

TPACK Validity Eidence Criteria

Types of Evidence	Description	Example of Applications
Content evidence	Content evidence The relationship between the instrument's content and what the instrument seeks to measure	Specification of research questions, development of a construct model, writing of items, selection of a scaling model
Substantive evidence	Explanation of observed consistencies in the data by reference to a priori theory or hypotheses	Comparing TPACK scores of teachers who have completed TPACK training with those who have not
Structural evidence	Confirmation of sub-constructs or components in the construct model	Conducting Confirmatory Factor Analysis
Generalizability evidence	Individual items are not biased towards particular groups or situations	Testing that each item in a test of TPACK elicits similar responses from males and females with the same overall TPACK level
External evidence	Similar results are obtained when different tests are applied to measure the same construct	Comparing findings from observational schedules and document analysis
Consequential evidence	evidence Consideration of how results could impact on persons and organizations	Discussing findings with stakeholders
Interpretability evidence	Communication of the qualitative meaning of scores	Providing a construct map that explains key points on the scale

Note. From "A Turn toward Specifying Validity Criteria in the Measurement of Technological Pedagogical Content Knowledge (TPACK)" by R.F. Cavanagh and M.J. Koehler, Journal of Research on Technology in Education, 46:2, p.131 (https://www.tandfonline.com/doi/abs/10.1080/15391523.2013.10782616). Copyright 2013 by ISTE (the International Society for Technology in Education).

In conducting this research, a 21st century TPACK modification survey was developed to capture Indonesian teachers' TPACK competence. The measurement employed was adopted from previous study (details are discussed in chapters 3 and 4).The survey could probably be the first TPACK survey developed in Indonesian that measures the teachers' 21^{st} century TPACK skills as required by the curriculum. The findings from the survey could help stakeholders evaluate teachers' 21^{st} century digital technology teaching skills and take the necessary measures to improve the situation in Indonesia.

2.6 Barriers to Digital Technology Integration

Digital technology integration is a complex process. It embraces teachers' digital literacy, skills, and technical supports such as the availability of digital technology infrastructure, digital technology trainings, and internet connection. Researchers have identified several influencing factors that significantly affect the digital technology inegration in the classroom. Ertmer (1999) mentioned first-order barriers (teachers' extrinsic factors) and second-order barriers (teachers' intrinsic factors), which teachers should be able to deal with. According to Ertmer (1999), first-order barriers are challenges that come from outside of teachers, such as equipment, time, training, and support. In addition, second-order barriers are challanges which may appear from teachers' perspective are embeded. It includes the teacher's lack of confidence, the teacher's resistance to change, the teacher's negative attitudes, and the teacher's perception of seeing no benefits. Another identification proposed by the British Educational Communications and Technology Agency (2004) which grouped the barriers of ICT integration into teacher' level and school's level. School's level barriers are impediments which come from schools-level such as limited access to ICT facilitiies and resources, poor ICT training, and poor ICT technical support. On the other hand, teachers' level barriers are the hurdle factors that come from teacher's level such as limited time for ICT classroom preparation, limited ICT skills, lower level of ICT efficacy, lower level of ICT attitudes, and unwillingness to adapt to ICT classroom integration.

In Indonesia, digital technology integration into the classroom poses major challenges. The challenges mainly dealt with teachers' qualifications, the school's infrastructure, and teachers' readiness in employing the devices into classroom activities. In addition, results of the PISA (Program for International Student Assessment) which assessing students' reading, mathematics, and science, showed that Indonesian achievement was in the low position. One of the reasons of this low achievement was mainly caused by the lack of teacher qualifications and educational facilities, mostly in rural and remote areas.

According to the Indonesian Educational Policy Research Center (2020), there are still 10,84% of Indonesia's teachers who hold a diploma degree or lower, whereas according to the National Education System Act 2005, a teacher should at least graduate from educational undergraduate programs, or possess a teaching certificate from accredited agencies. In addition, the 2019 national teacher competency test results released by the Ministry of Education and Culture found that teachers showed low competence in teaching. The highest score achieved by teachers from a maximum of 100 is only 62, and the majority of teachers scored low achievement (Neraca Pendidikan Daerah, 2021).

In addition, as an archipelago country with 17,491 islands, the government faces many obstacles to building the islands and providing sufficient infrastructure for all communities. Indonesian Educational Policy Research Centre (2019) found that almost all schools located in remote areas have poor school facilities, such as a lack of classrooms, an unavailability of libraries, and laboratories for teachers and students. Furthermore, data from Neraca Pendidikan Daerah, Ministry of Education and Culture (2021), showed that more than 50% of schools' classrooms in Indonesia are categorized as damaged, more than 35% of schools do not have libraries, and more than 62% of schools do not have laboratory facilities.

Besides, the country faces great potential for natural disasters due to its geographical conditions, which include being located in the ring of fire (the plates of Indo-Australia, Eurasia, and the Pacific) and being located in three mountainous systems (the Alpine Sunda, Pacific Circum, and Circum Australia). According to the National Board for Disaster Management (BNPB) (2021), during the years 2020 and 2021, there were more than 5000 national disasters, such as earthquakes, volcanic eruptions, fires and forest fires, floods, landslides, and tornadoes. Those disasters destroy a lot of public facilities, including schools.

Another critical issue that may prevent the classroom digital technology integration is the internet connection. In today's digital era, internet plays a significant role in educational sectors such as for communicating, accessing unlimited information, as well as gaining teaching resources. Digital technology which connected to the internet, assisst teachers and students to have meaningful classroom activities. The Indonesian Educational Policy Research Centre (2020) found that though the government keeps providing ICT facilities to schools, there is still a big gap between schools located in urban areas and rural areas. The Indonesian Central Bureau of Statistics (2020) stated that nationally, only 76.6% of schools across the country have access to internet facilities. Similarly, Neraca Pendidikan Daerah, Ministry of Education and Culture (2021), showed that 40% of schools had no access to the internet. It shows that there are still a large number of schools, mostly located in remote areas, that have no access to the internet at all. Furthermore, despite having a large number of users, Indonesia's internet connection is ranked among the slowest in many Asia Pacific countries (Ookla, 2021).

According to Atmadja (2014), in addition to infrastructure issues, another major impediment of digital technology integration in education in Indonesia is the culture and attitude of teachers, who tend to see the traditional approaches as better and easier ways to be implemented in the classroom. Teachers face many challanges to integrate digital technology in teaching, so that they are comfortable to use the conventional teaching methods. Nurhayati (2016) confirmed that there were several factors that prohibit teachers to integrate the devices in the classroom. Among the factors are teachers' preferences to apply traditional teaching methods and school's current practice that does not encourage the classroom digital technology integration.

In Indonesian setting, studies showed that inadequacy skills in using digital technology, time-consuming nature, lack of ICT facilities and internet connection, lack of professional training, limited budget, and students' backgrounds often limit teachers' ability to integrate digital technologies in teaching (Astuti, Arifin, Mutohhari, & Nurtanto, 2022; Soepriyanti, Waluyo, Sujana, & Fitriana, 2022; Pratolo & Solikhati, 2021; Azzahra & Nadia, 2020). Furthermore, Aditya (2021) and Kusuma (2022) identified that the digital learning problem was mostly coming from teachers who teach in rural areas due to several factors, such as internet connectivity and ICT facilities.

In the global context, a lot of studies have found some challenges in integrating digital technology in teaching, either school-level barriers or teacher-level barriers. Tarman, Kilinc, and Aydin (2019) found that most of the barriers to ICT integration were mostly not because of teacher-level barriers. Their findings indicated that the poor infrastructure, lack of technical and administrative support, and limited internet connection were the main obstacles to ICT integration. However, the study by Raman and Yamat (2014) revealed that schools with technology-rich learning environments do not guarantee that teachers will not find any challenges. In fact, some teachers often face difficulty incorporating ICT in the classroom due to hesitancy to use ICT, insufficient skills to use ICT, the amount of their daily workload, and their teaching experience. Other studies confirmed that factors such as poor ICT facilities and infrastructures, limited time for ICT classroom preparation, poor confidence to use ICT in the classroom, poor ICT technical support from school, poor teachers' ICT skills and competence are the major obstacles that teachers have when dealing with ICT classroom integration (Muslem, Yusuf, Juliana, 2018; Ozdemir, 2017; Bindu, 2016).

In general, barriers such as poor facilities and resources, poor technical support, and poor ICT skills and training were found to significantly influence the success of ICT integration (Payal & Kanvaria, 2018; Gokts, Yildirim, & Yildirim, 2014). Identifying and overcoming such barriers is important and requires a long process. Only by effectively addressing these barriers will digital technologies benefit teachers and students and result in positive learning outcomes. The literature review revealed a wealth of information about the barriers to digital technologies that teachers face. However, there has been insufficient information on what kinds of digital technologies are implemented and how they are used in the classroom. Besides identifying the barriers to classroom digital technology use, findings from this research are expected to enrich the literature review in reference to digital technology integration in the classroom, the types of digital devices employed in the classroom, and how the digital technologies are being utilized in teaching.

2.7 Literature Gaps

TPACK is considered as a new model in investigating the classroom digital technology integration in the science of education which gains its popularity recently. The model provides insight for teachers to effectively implementing digital technology in their teaching. In viewing the effectiveness of the model, researchers are devided into two large groups; a group that sees TPACK as an effective framework in digital technology integration (Hill & Uribe-Florez, 2020; Atun & Usta, 2019; Dalal, Archambault, & Shelton, 2017) and a group that argues it as a defective approach that requires lot of refinement (Cavanagh & Koehler, 2013; Brantley-Dias & Ertmer, 2013; Archambault & Barnett, 2010).

TPACK model can bridg the content knowledge, teaching pedagogy and the use of technologies for classroom effectivenes. However, the structure of the TPACK model has been becoming a critic for being inaccurate and unclear (Cox & Graham, 2009) and the validity of the TPACK's domains are complicated and convoluted (Archambault & Barnett, 2010). In order to improve the TPACK model, many researchers have been carrying out the studies in different settings to better understand the concept. A continuous imrpovement is crucial to clarify all issues and obscurities of the model. Thus, this study aims to fill the gaps which still exist by developing a TPACK instruments, particulalry in the context of Indonesia. Result of this study might provide some contribution on the discussion of the teacher's TPACK and their current practice of digital technology integration in the classroom.

2.8 Chapter Conclusion

In summary, the chapter two presents the discussion of literature review attributed to the research topic in this study. The chapter clearly discusses the review of self-efficacy and its importance to digital technology integration in the classroom as well as the discussion of attitudes towards the use of digital technology in teaching. In addition, the chapter also provides the discourse in regard to digital technology use in the classroom during the outbrak of COVID-19 global pandemic. Furthermore, a section on TPACK theoretical framework has been presented along with its measurement development and analyses. Finally, a section on the barriers of classroom digital technology integration is discussed to get a comprehensive understanding of the research context. The next chapter of this thesis would cope with the research methodology undertaken in this study.

Chapter 3

RESEARCH METHODOLOGY

3.1 Introduction

In explaining the research methodology undertaken in this study, the chapter introduces the discussion on research design. In addition, a section on research trustworthiness is presented which include the clear explanation of credibility, dependability, conformability, and transferability of the research. Following that, the chapter presents the disscussion on the design of research instrumentation, the pilot study, the sampling of the study, and the data collection process of the research. In addition, the chapter also includes the discussion on data screening and data analyses as well. Finally, ethical issues related to this study are also discussed, which include the Low-Risk Human Research Ethics Approval from Curtin University, research permissions and recommendations from Indonesian authorities, and a section on data management and storage.

3.2 Research Design

In designing the research, the conceptual framework of this study provides a useful guideline to conduct the study. Teachers' self-efficacy towards digital technology integration and teachers' attitudes towards digital technology integration are believed to affect teachers' self-perception of TPACK in the classroom. Their high self-perceotion on self-efficacy and attitudes might increase their TPACK use in teaching. Therefore, this study considers that these two factors are important to understand teachers' TPACK in the classroom. In addition, teachers' understanding on the concept of TPACK does not secure the digital technology integration in teaching. There several barriers identified by previous studies to prevent teachers from using technology in the classroom. Investigating all those elements can provide comprehensive understanding on Teachers' TPACK useful for teaching effectiveness.

With regard to its purpose, educational research is unique in its epistemological and methodological assumptions (Springer, 2010). There are three different research designs used in the field of education: quantitative approaches, qualitative approaches, and the approaches that incorporate both (Lodico, Spaulding, & Voegtle, 2010). In educational research, qualitative and quantitative approaches have different assumptions regarding the world and the procedures that should be considered when conducting the research, as well as the conclusions that might be drawn (Lochmiller & Lester, 2017). Both quantitative and qualitative approaches have different epistemological assumptions.

Quantitative research tends to be a reflection of positivism, while qualitative research tends to be a reflection of constructivism (Lodico, Spaulding, & Voegtle, 2010; Mackenzie & Knipe, 2006). Under a positivistic paradigm, a researcher assumes that the research can identify a unique truth about the studied phenomenon, and these assumptions make it possible to generalize the findings to a vastly wider population (Lochmiller & Lester, 2017). Quantitative researchers are interested in demonstrating that what they have found can be generalized away from their project site (Morrison, 2002). Quantitative research is a range of deductive approaches to the study of man's experience, usually shown as numeric data (Lochmiller & Lester, 2017), and uses scale as one of the data collection tools (Mackenzie & Knipe, 2006).

On the other hand, a constructivist paradigm implies that multiple realities may exist and can be investigated to let the researcher get his understanding of those realities while working through the perspective of those involved in a given phenomenon, and this comprehension of the given phenomenon would probably not be generalizable (Lochmiller & Lester, 2017). Qualitative researchers pay a lot of attention to detailed observation; indeed, the essence of their work is rich and deep description (Morrison, 2002). In qualitative research, the data obtained is in non-numerical form and is based on concepts of social science. It is a phenomenological study that focuses on subjective experience (Springer, 2010), where interviews, observations, document reviews, and visual data analyses are the tools used in data collection (Mackenzie & Knipe, 2006).

Another type of research approach is pragmatism. Aligned to mixed methods, pragmatism is an approach that focuses on what works and is not concerned with whether the research relates to a real or socially constructed world (Lodico, Spaulding, & Voegtle, 2010). In conducting the research, pragmatic researchers concentrate on the research problems of "what" and "how" (Crewell, 2003).

According to Bryman (2016), mixed methods are the combination of two research strategies, quantitative and qualitative, in one research project. It is a method that is "both feasible and desirable" (Bryman, 2016, p. 637). A mixed method design uses qualitative and quantitative approaches to measure different and overlapping aspects of a phenomenon, which yields more comprehensive findings (Greene, Caracelli, & Graham, 1989). This method aims to broaden understanding of various methods and strengthen the findings from various data collection methods (Creswell, 2003). The mixed methods allow researchers to generate a comprehensive understanding (Johnson and Onwueggbuzie, 2004), and it demands a higher competence level, results in less waste of potentially valuable data, allows researchers to make appropriate criticisms of all types of research, and is often of greater impact (Gorard, 2004).

The data for this research was collected by using a mixed-methods research design. The majority of TPACK studies used surveys to depict either in-service or pre-service teachers (Beri & Sharma, 2019; De Freitas & Spangenberg, 2019; Roussinos & Jimoyiannis, 2019; Sarçoban, Tosuncuolu, & Krmz, 2019; DeCoito & Richardson, 2018). There have not been many researchers who have investigated teachers' teaching performances (Willermark, 2018).

According to Bibi and Khan (2017), other data collection procedures such as classroom observation and document analysis are desirable to go with surveys since some items on TPACK's survey are not easily answered. From reviewing over 50 TPACK-related studies in the Indonesian context, the researcher found that the majority of the studies used surveys to measure teachers' self-perceptions of TPACK. There have been few studies that combine quantitative and qualitative methods in exploring teachers' self-efficacy and attitudes towards digital technologies as well as their relationship to TPACK. This mixed-methods were chosen because the researcher wanted to gain comprehensive understanding with respect to teachers' TPACK in the classroom. Data from different sources such as survey, class observation, and document analyses would provide meaningful interpretation of teachers understanding and their current practice of digital technology integration, as well as its constrains in the classroom.

An explanatory sequential design was employed in this study. The strategy used the combination of two different data collections techniques in collecting and analysing the research data set, which are quantitative andqualitative approaches (Cresswell, 2003). Results from quantitative analyses will be used to interpret and explain the findings from qualitative data

3.3 Design of the Research Instrument for This Study

This research applied two different data collection stages. The stages were quantitative data collection by using questionnaire and qualitative data collection by using interview, class observation, and document analyses. Details can be seen as follows (See Table 3.) and each of the stages are discussed in the following sub-sections:

Table 3.1

Methods Used to Address the Research Questions

Research Questions	Research Methods	
	Quantitative Stage	**Qualitative Stage**
What are teachers' perceptions of their self-efficacy and attitudes towards the use of digital technologies?	Survey	Interview, Class Observation, and Documents analyses
What are teachers' perceptions of their technological, pedagogical, and content knowledge (TPACK) in teaching?	Survey	Interview, Class Observation, and Documents analyses
In what ways do teachers' self-efficacy and attitudes towards the use of digital technologies affect their use of technological, pedagogical, and content knowledge (TPACK)?	Survey	Interview, Class Observation, and Documents analyses
What are the factors that promote or inhibit digital technology use in the classroom?	Survey	Interview, Class Observation, and Documents analyses
What are the digital technology used by teachers, and how are they being used in the classroom?	Survey	Interview, Class Observation, and Documents analyses

Note: Qualitative stage were conducted after the quantitative stage.

3.3.1 Quantitative Stage

In exploring teachers' understanding and perception towards self-efficacy in the use of digital technologies in the classroom, teachers' attitudes towards classroom digital technology integration, and teachers' TPACK competence in the classroom, the combination of three adopted instruments was administered; teachers' self-efficacy towards digital technologies (Kiili, Kauppinen, Coiro, & Utrainen, 2016); teachers' attitude towards digital technologies (Semerci, & Aydin, 2018); and TPACK 21st Century (Valtonen et al. , 2017).

These three instruments were used in this study based on their reliability and validity in the earlier studies. The TPACK 21st century was chosen in particular for this study due to its compatibility with the Indonesian curriculum, which emphasizes the incorporation of thinking skills into teaching and learning proces to meet the challanges of the 21st century.

Before collecting the quantitative data, the combined surveys were analyzed to meet the Indonesian context, especially the terms used in the Indonesian curriculum. In addition, the survey items were translated into Indonesian, and the translation draft was sent to a professional from the Department of Education Quality Assurance to be reviewed. The feedback suggested replacing the words and terms with those that were commonly familiar to teachers. After some revisions were made to the survey draft, the revised Indonesian draft was back-translated into English by a translator, and a comparison was made between the original English and the re-translated English versions to see how much the difference was. According to Sahin (2011), translation validation is done through translation and reverse translation. Comparison between the two versions showed that there were no significant differences; the differences mostly connected with the choice of the terminology. The final draft was then used to collect the data. Details of the instrument can be seen in the appendix I.

3.3.1.1 Modification of TPACK Measurement

The discussion on the development of TPACK measurement was presented in the chapter 2, Section 2.5.1. The design of TPACK measurement becomes a great concern for some researchers. Its development and enhancement are still ongoing. Self-evaluation was the most common approach used by researchers. In fact, there are many self-reported TPACK measures that researchers have developed to explore the TPACK frames. Some researchers used the TPACK framework to explore students' teacher's self-perception such as Schmidt, et al (2009), Sahin, I (2011), Lux, Bangert, and Whittier, (2011), Jamieson-Proctor, et al (2013), Saengbanchong, Wiratchai, and Bowarnkitiwong (2014), Nordin, H (2014), Valtonen, et al (2015), Kartal, et al (2016), Kiray, S.A (2016), Valtonen, et al (2017), and Akyuz (2018). On the other hand, some researchers measure teachers' TPACK competence such as Chai, et al (2011), Jang and Tsai (2012), Yeh, et al. (2017), and Yanuarto, Mat, and Husnin (2020).

In the context of Indonesia, from 50 TPACK-related studies that have been reviewed by researcher, there have been no single study found to employ the TPACK for the 21st century which put the emphasis on thinking ability (eg. collaboration, communication, and creativity) as they are part of the Indonesian national curriculum. Reliability factors for TPACK survey elements reported in most studies have demonstrated consistent measurement of TPACK development, indicating good internal reliability. However, applying TPACK measurement in different settings is very important to see the validity and reliability of the scale (Nordin, 2014).

This research used a modification survey of TPACK 21st century developed by Valtoneen, et al (2015) and updated version (2017). The original survey has been developed in stages starting in 2013 and started with a review of existing TPACK instruments (Valtoneen et al, 2017). In the early development stage, Valtoneen et al. (2015) divided the survey into two phases (Studies 1 and 2) and used three starting points. Firstly, they used the measurement (Koh, & Chai, 2011) which guide them in improving the application of pedagogical knowledge into some well-studied learning theory. Secondly, the pedagogical goals were design based on the view of the importance of the 21st century skills. Therefore, the measurement was intended to explore and focus on collaborative learning practices with the emphasis on critical and creative thinking, self-regulated learning, and collaborative problem solving. Thirdly, they include the same statements in the domains of PCK and TPK as developed by Schmidt et al. (2009) in providing a relationship between the sub-scale output and an extra safety line if the output is poorly chracterized. On the basis of the results of these two studies, they deleted, added, or modified certain declarations.

The self-survey developed by Valtonen et al. (2015) consisted of all components of TPACK. The first domain, technological knowledge (TK), contains seven questions; the second domain, pedagogical knowledge (PK), involves seven questions; the third domain, content knowledge (CK), consists of four questions; the fourth domain, technological pedagogical knowledge (TPK), comprises six questions; the fifth domain, technology content knowledge (TCK), accommodates four questions; the sixth domain, pedagogical content knowledge (PCK), has four questions; and the last domain, technological pedagogical content knowledge (TPACK), comprises seven questions. In addition, the survey was developed within a six-point likert scale to rate teachers' self-perception of TPACK competence.

Valtoneen et al. (2017) proposed an updated measurement of TPACK. 267 teacher's candidates participated in the study. The reliability test of the measurement indicated that the survey possessed good internal consistency. In addition, findings from confirmatory factor analyses (CFA) showed that the measurement provided with a six-factor model of the

TPACK. Though the CFA result only indicated the six-factor model of the TPACK, the instrument provides a new educational tool to measure the knowledge (pre-service) of teachers about how to capitalize on different technologies in enhancing students' thinking skills in the classroom. In addition, empirical studies in the development and examination of the existing questionnaires are important to increase the understanding of the nature of the TPACK framework (Valtoneen et al., 2017).

A modification of the TPACK 21st century (Valtonen et al., 2017) was employed in this research. The modification was done to fit the survey with the Indonesian context, particularly with the national curriculum. Firstly, all seven items of pedagogical knowledge (PK) were adopted and reworded. For example, item "Supporting students' critical thinking" was modified into "I know the teaching methods to support students' critical thinking." Item "Supporting students' reflective thinking" was completely changed into "I know the teaching methods to encourage students to communicate effectively." Another two items of the PK, which were "guiding students' discussions during group work (2–5 students)" and "guiding students to make use of each other's thoughts and ideas during group work (2–5 students)," were changed into "I know the teaching methods to guide students working collaboratively." Secondly, all four items from Technological Knowledge (TK) were adopted, and only little changes have been made. For example, "I am familiar with new technologies and their features" was changed into "I am familiar with new digital technologies and their features that benefit teaching and learning."

Thirdly, since the TPACK 21st century survey originally examined the natural sciences pre-service teachers' TPACK, the features connected with the natural sciences in all domains should be changed. Thus, all four items from the Content Knowledge (CK) domain were changed from "I know the history and development of important theories in the natural sciences" to " I know the history and development of important theories in the subject I taught". Similarly, items in Pedagogical Content Knowledge (PCK) were also modified. For example, "In natural sciences, I know how to guide students' content-related problem solving in groups of 2–5 students" was then changed into "I know how to support students' problem-solving skills in the subject I teach." In addition, another item in PCK was completely changed from "In natural sciences, I know how to guide students' reflective thinking" to "I know how to encourage students to communicate effectively in my classroom." Another item was also modified from "In the natural sciences, I know how to guide students to make use of each other's thoughts and ideas in group work (2–5 students)" to "I know how to guide students to work collaboratively on the subject I teach."

Fifthly, items on Technological Pedagogical Knowledge (TPK) were all adopted with very few changes. For example, "I know how to use ICT in teaching as a tool for students' critical thinking" was changed into "I know how to use digital technology as a tool for students' critical thinking." Sixthly, items on Technology Content Knowledge (TCK) were all adopted and changed accordingly. For example, "I know technologies that I can use to illustrate difficult contents in natural sciences" was changed into "I know digital technologies that I can use to illustrate difficult contents in the subject I teach."

Lastly, related items on the TPACK have been changed necessarily. For example, "In teaching natural sciences, I know how to use ICT as a tool for students' creative thinking." was modified into "I know how to use digital technology to deliver specific subject content as a tool for students' creative thinking." In contrast, item "In teaching natural sciences, I know how to use ICT as a tool for students' reflective thinking" was completely changed into "I know how to use digital technology to deliver specific subject content as a tool for student communication." Furthermore, two items, "In teaching natural sciences, I know how to use ICT as a tool for sharing ideas and thinking together" and "In teaching natural sciences, I know how to use ICT as a tool in group work with 2–5 students," were changed into "I know how to use digital technology to deliver specific subject content as a tool for sharing ideas and working collaboratively."

The final version of the modified TPACK survey in this study is composed of 36 items. The survey aimed at measuring in-service teachers' TPACK with a five-point likert scale from strongly agree to strongly disagree.

3.3.1.2 Modification of Self-Efficacy Measurement

The self-efficacy instruments used in this study were adopted from Killi, Kauppinen, Coiro, & Utrainen (2016). They developed a measurement used to examine pre-service teachers' self-efficacy beliefs that are considered important in integrating the technologies in the teaching. They designed the measurement in alignment with three different constructs: teacher's self-efficacy (Bandura, 1997), teacher's computer self-efficacy (Compeau & Higgins, 1995), self-efficacy towards technology integration in the classroom (Wang, Ertmer, Newby, 2004). The measurement consisted of eleven items.

In this study, the researchers adopted the measurement developed by Killi, Kauppinen, Coiro, & Utrainen (2016) to measure teachers' self-efficacy towards digital integration in the classroom. A likert five-point scale was used which ranged from strongly disagree to strongly agree. Three more items were supplemented to the survey: (1) feeling confident to create meaningful learning experiences for students, (2) feeling confident to motivate students actively involved in learning, (3) and feeling confident to integrate digital technology in developing classroom activities.

3.3.1.3 Modification of Attitude Measurement

To measure teachers' attitudes toward integrating digital technologies in this study, an instrument developed by Semerci and Aydin (2018) was adopted. Semerci and Aydin (2018) developed the measurement to explore teachers' attitude self-perception with respect to the integration of ICT into teaching. They tested the measurement to 353 techers from different high schools in Ankara Province of Turkey during academic years 2016-2017 were participated in the study. The measurement called TICTAS (Teachers' ICT Attitudes Scale) was used and consisted of two parts. The first part was ICT willingness domain included 11 items and the second part was ICT Anxiety included 5 items. The survey was scored as follows: (1) "I completely do not agree." (2) "I do not agree." (3) "I am neutral." (4) "I agree," and (5) "I completely agree."

In conducting the current research, the researcher adopted the attitude measurement developed by Semerci and Aydin (2018). In order to meet the context of Indonesian settings, the instrument was modified as necessary. To modify the instruments, four steps were taken into consideration. Firstly, some items that were adopted remained the same, such as "Digital technology plays a critical role in contemporary education" and "Digital technology turns teaching into a monotonous and mechanical.

Secondly, some items were reworded, such as "Is a fruitful means of attaining the educational targets?" which was modified into "Digital technology is a useful means of attaining educational goals." "Increases my students' involvement in my class" was modified into "Digital technology enhances interaction and increases student engagement," and "Makes students' learning permanent" was modified into "Digital technology improves student knowledge retention."

Thirdly, some items were changed but the idea remained the same such as "Makes it easy for me to plan my teaching" was changed into "Digital technology helps teacher to create engaging, interesting and well-designed classroom activities", "Makes teaching easier for teachers" was changed into "Digital technology helps the teacher to manage his classroom efficiently", "Leads to an underestimation of teachers' role", and "Trivializes teachers were changed into "Digital technology causes a less respect of the teachers' role and responsibility in the classroom".

Fourthly, some of the items were deleted and new items were added. For example, “Increases the quality of teaching and learning process”, “Increases students' success in my class”, and “Offers alternative learning opportunities such as e-learning and mobile learning” were deleted. New items such as "Digital technology encourages student collaborations in the classroom", "Digital technology encourages students' different learning styles", "Teaching with digital technology is more complicated and takes more time", and "Digital technology increases the risk of cyber attacks and hacks". The final version of the adapted survey was composed of 14 items on a five-point Likert scale: (1) strongly disagree; (2) disagree; (3) neutral; (4) agree; and (5) strongly agree.

3.3.2 Qualitative Stage

In the qualitative stage, three different sources were used to gather the data in this study. They were a semi-structured interview, document analysis, and class observation.

3.3.2.1 The Interview

The interview questions were developed based on the research questions that guided this study. The interview is a flexible and helpful method of collecting data, and it is particularly suitable for collecting information about participants' experiences, beliefs, and behaviors (Rowley, 2012; Frances et al., 2009). It is "ways of listening to and gaining an understanding of people's stories" (Bolderston, 2012, p. 68), where the interviewer and participant get involved in a conversation to formulate reliable information (Aldhaen, 2020).

A semi-structured interview uses a combination of closed and open-ended questions with one person at a time, and follow-up questions such as "why" and "how" are often provided (Adams, 2015). In a semi-structured interview, numerous questions will be anticipated, but the lines of inquiry will be carried out during the interview to keep track of interesting and unexpected avenues (Blandford, 2013). The decision to use a semi-structured interview was made because a semi-structured interview is useful as an accessory for complementing and deepening other approaches and is perfectly adapted to a number of precious tasks, especially when there are some open-ended questions that require follow-up requests (Adams, 2015). Most of the time, a researcher can do additional follow-up, either verbal or nonverbal responses such as intuition, laughter, and silence, for revealing hidden information that is important for data analyses from various topics of conversation (Ritche & Lewis, 2003). Thus, it is very practical for engaging in a deep conversation (Kakilla, 2021).

The interview protocols in this study were developed on the basis of research and a review of the literature. The interview questions were subsequently field-tested with three teachers teaching in two different schools in Pekanbaru. In this pilot study, the researcher revised a number of items in the interview protocols for clarification and simplification based on the comments received from the respondents. For instance, instead of giving the TPACK queries directly to respondents, the researcher provided a brief explanation of TPACK theory prior asking the questions. This helped them to internalized the questions and to answer them well. In addition, questions such as “what softwares and hardwares do you use in the classroom” were changed into “what digital devices do you use in the classroom” because some respondents confused with the terms of softwares and hardwares.

Upon completion of the quantitative study, the researcher then conducted the interview by contacting the potential respondents that met the specified criteria mentioned in the previous section. There were twelve teachers who voluntarily participated in this interview session. The interview was started by introducing the purpose of this study as well as the research topics. The researcher then started the questions by asking about their background information, such as subjects taught, teaching experience, and ICT training. The interview was conducted in the Indonesian language, where they could describe the issues well and most of them could not speak English. The interviews lasted 35 to 50 minutes and were conducted at the respondents' convenience time and location, where they all preferred to be after the school session. With the knowledge of respondents, all interviews were recorded on two different voice recorders to protect the information required for this study.

3.3.2.2 The Classroom Observation

Another type of qualitative data source used in this study was classroom observation. It is a method of direct observation of educational practice in real time, with the observer making notes and coding teaching behaviors in the class or using video lessons (Hora & Ferrare, 2013). Classroom observation often plays a major role in teacher assessment and improvement systems, supplies instructional anchors essential for professional development (Martinez et al., 2016), and provides significant information on how teaching takes place in a realistic context (Putnam & Burko, 2000).

In this study, after the completion of the interview, the researcher requested the respondents be observed in classroom observation at their most convenient time. Initially, it was hard for classroom observation to be carried out due to the outbreak of COVID-19. As it was mentioned earlier, all schools in Pekanbaru were closed until August 2021. Some schools in Pekanbaru began reopening in September 2021, but 75% of teaching and learning took place online, while 25% took place offline. After some difficult negotiation with the respondents, the class observation was able to be conducted at a time that suited them. With respondents' consent, classroom observation was video recorded to be further studied. The classroom observation took place during the limited face-to-face classes (75% online teaching and 25% offline teaching) that were strictly enforced to prevent the spread of the COVID-19 pandemic.

3.3.2.3 Document Examinations

The last source of qualitative data collection in this study was document analysis. It is a systematic process to review or assess printed and electronic documentation material, which may contain words and images that have been recorded without the involvement of a researcher (Bowen, 2009). All respondents in the qualitative stage were requested to provide lesson plans and a syllabus for the purpose of this study.

3.4 Pilot Study

Running a pilot study is considered important in research. According to Arain, Campbell, Cooper, and Lancaster (2010), a pilot study, a minor feasibility study, is used to review certain aspects of the methods aimed at a broader purpose or a more thorough or confirming investigation. This is not about answering research questions from the study; instead, it is used to stop researchers from starting a large-scale study without having appropriate knowledge of the proposed methods; essentially, a pilot study is undertaken to prevent the occurrence of a fatal defect in an expensive and time-consuming study (Polit & Beck, 2014). A pilot study can also be used to revise the questionnaire regarding the word choices, design, layout, length, sequence, and schedule of the elements (Anthony, Artino, Jeffrey, Rochelle, Dezee, & Gehlbach, 2014).

A pilot study was conducted after all research recommendations and permissions from related agencies had been obtained, including from the principals. In distributing the survey, I explained to the teachers that the purpose of the survey was to test the questionnaire. Positive feedback from all participants was important to refine and improve the questionnaire. The pilot provided feedback regarding the internal consistency (Cronbach's alpha), where the alpha values of all TPACK's subscales indicated good reliability of the instrument (>.60; Hair et al., 2010).

Pilot testing was administered in April–May 2021 to examine the reliability of the instrument used in this study. The pilot study was conducted in two schools in Pekanbaru, Indonesia. A total of 44 teachers were selected to take part in the study. The group of teachers was selected because they shared similar criteria to the targeted group of teachers, which were teachers of senior high schools. Thus, information on the reliability and validity of the instrument for the survey could be gotten from this piloting. From sixty questionnaires distributed, only forty-four questionnaires (73%) were returned and analyzed.

3.4.1 TPACK Reliability and Validity

The results indicated that the alpha values of all TPACK scales indicated good reliability of the instrument (>.60; Hair et al., 2010). Details can be seen as follows (See Table 3.):

Table 3.2

Reliability of the TPACK Scales

Subscales	Reliability (α)
Pedagogical Knowledge (PK)	.95
Content Knowledge (CK)	.82
Technology Knowledge (TK)	.86
Pedagogical Content Knowledge (PCK)	.94
Technological Pedagogical Knowledge (TPK)	.82
Technological Content Knowledge (TCK)	.87
Technological Pedagogical Content Knowledge (TPACK)	.96

Note. N=44. A Cronbach's alpha score () > 0.60 is accepted as a good reliability score for the instrument (Hair et al., 2010). Thus, the seven TPACK scales showed good reliability.

In addition, due to the small number of respondents (N = 44), the sample of the covariance or correlation matrix may not be definitive as a result of a simple sampling fluctuation. However, analyses of factor loadings in TPACK domains revealed that the survey was quite promising, though the results showed that the TCK items and TPCK items loaded into the same factor. Thus, the researcher decided to proceed with the main data collection and would re-examine the reliability and validity later (see Section 4.3).

Based on the comments and feedback received from piloting, a revision was conducted to reword the TCK and TPCK items. In addition, the grammar, the spelling, the layout, and the design were also improved for the final survey. The factor loading estimates for all seven TPACK constructs are presented as follows (See Table 3.):

Table 3.3

Seven TPACK Subscales' Factor Loading

	Factors Loading						
	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	**Factor 7**
TK1						.671	
TK2						.735	
TK3						.720	
TK4						.616	
CK1					.790		
CK2					.591		
CK3					.847		
CK4					.694		
PK2		.781					
PK3		.866					
PK4		.829					
PK5		.774					
PK6		.818					
PCK1		.629		.528			
PCK2				.680			
PCK3				.664			
PCK4				.837			
PCK5				.886			
PCK6				.908			
TCK1	.717						
TCK2	.341		.398				.683
TCK3	.812						
TCK4	.831						
TPK1			.719				
TPK2			.887				
TPK3			.780				
TP4K			.573				
TPK5			.842				
TPK6			.744				
TPACK1	.854						
TPACK2	.896						
TPACK3	.918						
TPACK4	.828						
TPACK5	.771						
TPACK6	.797						

Note. All of TPACK's subscales were loaded properly into their factors, except for TCK and TPACK, which loaded into the same factor.

3.4.2 *Self-Efficacy Reliability and Validity*

The results indicated that the alpha values of self-efficacy indicated good reliability of the instrument (>.60; Hair et al., 2010). Details can be seen as follows (See Table 3.):

Table 3.4

Reliability of the Self-Efficacy

Subscales	Reliability (α)
Digital technology self-efficacy	0.79
Teachers' self-efficacy	0.71
Digital technology integration self-efficacy	0.92

Note. *N=44.* A Cronbach's alpha score () > 0.60 is accepted as a good reliability score for the instrument (Hair et al., 2010). Thus, the three self-efficacy scales showed good reliability.

Furthermore, since the number of participants in this pilot was small (N = 44), the sample of the covariance or correlation matrix may not be definitive as a result of a simple sampling fluctuation. Thus, the researcher decided to proceed with the main data collection and would re-examine the reliability and validity later (see Section 4.3).

3.4.3 *Attitudes, Reliability, and Validity*

The results indicated that the alpha values of attitudes indicated a good reliability of the instrument (>.60; Hair et al., 2010). Details can be seen as follows (See Table 3.):

Table 3.5

Reliability of the Attitude

Subscales	Reliability (α)
Willingness to use digital technology	0.76
Anxiety in digital technology use	0.67

Note. *N=44.* A Cronbach's alpha score () > 0.60 is accepted as a good reliability score for the instrument (Hair et al., 2010). Thus, the two attitude scales showed good reliability.

Furthermore, since the number of participants in this pilot was small (N = 44), the sample of the covariance or correlation matrix may not be definitive as a result of a simple sampling fluctuation. Thus, the researcher decided to proceed with the main data collection and would re-examine the reliability and validity later (see Section 4.3).

3.5 Data Collection Process

This research was conducted in compliance with the standards of the national statement on the ethical conduct of human research. Prior to conducting the proposed research, law-risk human research ethics approval and a fieldwork and work-integrated learning risk assessment from Curtin University had been obtained (see Appendix A and Appendix B). Furthermore, in order to collect the data in Indonesia, an application to conduct research was submitted to the One-stop Investment and Licensing Office, Ministry of Home Affairs. It is a government agency under the Ministry of Home Affairs that is responsible for approving any research conducted in Indonesia by any international institutions. The recommendation obtained from this agency would be very important for the researcher to get other research permission from the local authorities. The process was online and took three weeks to get approval. Once the research document was approved, another offline application was submitted to the office of the Provincial Department of Education and Culture of Riau Province, which took two weeks to process. The next step in data collection was obtaining permission from the principals of the senior high schools in Pekanbaru, which took approximately two weeks. After getting approval from the principals to collect the data, the researcher approached the vice principals for curriculum to discuss the research project and asked the teachers to participate in the research. A participation information form, a consent form, and a survey were distributed to each teacher.

3.6 Sampling

This research was undertaken in Pekanbaru, Indonesia, since the researcher knew the geographical conditions of pekanbaru as well as the social-psychological aspects of the community which made it easy to conduct the research. Schools included in the study were public schools accredited by national agency and located in the urban areas that were equipped with adequate digital technology facilities and were exposed to digital technology training. With the help of this strategy, the researcher was able to thoroughly investigate the phenomenon and add to the body of knowledge.

In conducting this research, a purposive sampling technique was utilized. This ensured that the critical participants were involved in the study (Maxwell, 1996). This was important because the population is of interest and could effectively allow the researcher to answer the research questions. This study concerned teachers' perceptions of self-efficacy and attitudes towards digital technologies, teachers' technological, pedagogical, and content knowledge (TPACK) in teaching, as well as what digital technologies were used in the classroom and how they were used in the classroom. Thus, teachers from those public schools were selected for two reasons: (1) public schools have adequate ICT infrastructure, and (2) public school teachers have a great opportunity to attend many ICT trainings from the government. The following sub-section explains the participant selection for this study.

3.6.1 Participant Selection

After all the documents required for collecting the data were obtained, a permission letter to collect the data was sent to eighteen principals of senior high schools in Pekanbaru, Indonesia. It took two weeks to get permission from schools. Since the researcher already had a recommendation letter from the Provincial Department of Education and Culture to conduct his research at the schools, all the principals allowed him to conduct his research in their schools, though they could refuse if they wished.

As a standard of the school's administrative system in Pekanbaru, after obtaining permission from the principal, the researcher met the vice principal for curriculum to discuss the technical issues in collecting the data. The researcher started conducting the research in a difficult pandemic COVID-19 situation in March 2021. Teaching and learning were conducted online until August 2021. All schools were closed, and students studied from home. It was not compulsory for teachers to come to school, and most of them did not go to school on a daily basis. However, some teachers decided to conduct online classes at school because of good internet access and good facilities for online teaching. Some schools set a policy where teachers were scheduled to be at school twice a week and encouraged senior teachers to teach from home.

On September 20, 2021, based on the decision of the Ministry of Education and Culture, some schools started to reopen as part of the implementation of Community Activities Restrictions Enforcement Level 4 in the Pekanbaru region. During this situation, online teaching and learning were still the primary concern, while face-to-face learning had just begun with strict regulation and restrictions. Offline, the teaching and learning process took only thirty minutes for each subject, occupying fifty percent of the classroom capacity. There were only two subjects a day, and students only went to school twice a week. The rest of the instruction and learning took place online. The respondents that participated in this study came from different age group and subjects taught. Details are presented as follows (See Table 3.):

Table 3.6

Profile of Participants Based on Gender, Age, and Subjects Taught

Profile		Respondents (N)
Gender	Female	420
	Male	142
Age	21-25	30
	26-30	69
	31-35	84
	36-40	65
	41-45	82
	46-50	71
	51-55	72
	56-60	35
Subject Taught	Math	60
	Sciences	101
	Social sciences	99
	Languages	86
	Health and sports	32
	Art, culture, and crafts	26
	Religious education	28
	Civic education	34
	Counseling	34
	Others	14

Note. There were more female participants than male participants, with an age range of 21 to 60 and various subjects taught.

3.6.1.1 Quantitative Data Collection

Due to this difficult situation, from the beginning, the researcher anticipated the data collection by recruiting schools' staff to assist in the quantitative phase of research, where they knew the situation at the school well. It was carried out from March to September 2021. The staffs were appointed by the schools and were briefed about the survey before the distribution. They were responsible for explaining to the teachers what the survey was about, as well as for distributing and collecting the completed survey and consent form. Once the survey was collected, the researcher came to collect it. Each school needed three to four weeks to complete the data collection because teachers were not available at the school every day. It was an offline data collection where the researcher used a printed survey with the rationales: (1) psychologically, teachers were more familiar and ready with a printed survey than an online form, and (2) it was meant to increase the number of participants in this research. All teachers across the subject at the schools were invited to participate in the study, and each of them got a participant information and consent form and a printed survey.

The survey was conducted between March and September 2021. A total of 750 surveys were distributed, but only 562 were returned; 20 surveys were incomplete. In July and August 2021, quantitative data collection was completely postponed due to Community Activities Restrictions Enforcement Level 1 in the Pekanbaru region, where schools were closed. Details are presented as follows (See Table 3.):

Table 3.7

Quantitative Data Collection Timeline

Month	Data Collection Activities	Participants	Locations
March 2021	Survey	Teachers	Senior high schools 12, 14, 19, and 17.
April2021	Survey	Teachers	Senior high schools 2, 5, 7, and 18.
May2021	Survey	Teachers	Senior high schools 3, 16, 10, and 13.
June2021	Survey, Community Activities Restrictions Enforcement level three interrupted the data collection activity due to the second wave of the COVID-19 outbreak.	Teachers	Senior high schools 15 and 9.
July2021	Survey, Community Activities Restrictions Enforcement Level One completely postponed the data collection activity due to the second wave of the COVID-19 outbreak.	-	-
August 2021	Survey, Community Activities Restrictions Enforcement level one completely the data collection activity due to the second wave of the COVID-19 outbreak.	-	-
September 2021	Survey, Community Activities Restrictions Enforcement level three interrupted the data collection activity due to the second wave of the COVID-19 outbreak.	teachers	Senior high school 6, 11 and 10

Note. The research was conducted from March to December 2021 during the COVID-19 global pandemic.

3.6.1.2 Qualitative Data Collection

In the qualitative phase (interview, classroom observation, and document analyses), twelve teachers were invited to participate in the qualitative study, which consisted of interview, classroom observation, and document analyses. These twelve teachers fulfilled the following criteria:

- Teachers who identified themselves as using digital technologies with high frequency in the classroom;
- Teachers who had participated in teachers' professional development conducted by the Ministry of Education and Culture;
- Teachers with a high level of self-efficacy and attitudes toward digital technologies, as well as teachers with a high level of TPACK self-perception

These criteria were important to make sure that the selected participants were the ones who used digital technologies since the research was aimed to investigate teachers' practice in digital technology use in the classroom as well as to explore the limitations from their view. It would provide the researcher with necessary information useful for data analyses and interpretation. In addition, ensuring that the participants had taken part in the teacher' professional development would be also crucial to provide feedback on the improvement of the program for the benefits of teachers in the future. Finally, choosing respondents with high level of self-efficacy and attitudes toward digital technologies, and high level of TPACK was also fundamental because those who have strong perception of self-efficacy, attitude, and TPACK seem to have more confidence to use digital technology in teaching. Consequently, the conclusion reached from the qualitative data represents the cutting edge in Indonesian schools as a result of the method employed to choose participants for the qualitative phase.

After getting the list of teachers who met the specified criteria, I contacted the vice principals for curriculum to allow the teachers to take part in the qualitative study. Soon after the teachers were allowed to join the second phase of the study, I invited them to participate in it and informed them that the study would consist of three parts: an interview, classroom observation, and document reviews. Once they agreed to take part in the study, I set the schedule for the interview at their convenience. I chose to interview them at schools for the sake of ease. Prior to the interview, each teacher was given the consent form for participating in the second stage of the research. The classroom observation came after the interview. It was finally conducted after many difficulties due to the COVID-19 outbreak. The interview and classroom observation were conducted with 12 teachers after the completion of the survey. It took place from September to December 2021. The class observation was carried out following the interviews with each participant. Details are presented as follows (See Table 3.):

Table 3.8

Qualitative Data Collection Timeline

Month	Data Collection Activities	Participants	Locations
September 2021	interview, followed by classroom observation.	Teachers (Selfi Rahmi, Adey Alihsan)	School
October 2021	interview, followed by classroom observation.	Teachers (Nurul Fitriana, Lamsaidah, Mimi Citra Sari, and Lolita Vianda)	School
November 2021	interview, followed by classroom observation.	Teachers (Syafrinetty, Rahmat Roihan, and Hadi Wijaya)	School
December 2021	interview, followed by classroom observation.	Teachers (Abdul Rahman, Ruli, Yulia, Sofia)	School

Note. The research was conducted from March to December 2021 during the COVID-19 global pandemic.

3.7 Data Screening

Data screening was used to ensure that the data was entered accurately. Furthermore, it was also used to check for missing values. The original questionnaires were sampled at random and cross-checked with database information item by item. Those data points that were found to be errors were immediately rectified.

3.8 Data Analyses

This study employed a mixed method in collecting the data. In order to answer the research questions that guided this study, the data was analyzed in three ways: (1) statistical data analyses; (2) unstructured data analyses; and (3) comparative analyses of the two approaches. Details are presented as follows (See Table 3.9):

Table 3.9

Data Analysis Approaches

Research Questions	**Data Anlyses**			
	Quantitative Stage		**Qualitative Stage**	
What are teachers' perceptions of their self-efficacy and attitudes towards the use of digital technologies?	Survey	Ddescriptive analyses	Interview, Class Observation, and Documents analyses	Narative analyses
What are teachers' perceptions of their technological, pedagogical, and content knowledge (TPACK) in teaching?	Survey	Descriptive analyses.	Interview, Class Observation, and Documents analyses	Narative analyses
In what ways do teachers' self-efficacy and attitudes towards the use of digital technologies affect their use of technological, pedagogical, and content knowledge (TPACK)?	Survey	Multiple regression analyses	Interview, Class Observation, and Documents analyses	Thematic analyses
What are the factors that promote or inhibit digital technology use in the classroom?	Survey	Descriptive analyses	Interview, Class Observation, and Documents analyses	Thematic analyses
What are the digital technology used by teachers, and how are they being used in the classroom?	Survey	Descriptive analyses	Interview, Class Observation, and Documents analyses	Thematic analyses

3.8.1 Quantitative Data Analyses

The research questions that guided this study are:

Q1. What are teachers' perceptions of their self-efficacy and attitudes towards the use of digital technologies?

Q2. What are teachers' perceptions of their technological, pedagogical, and content knowledge (TPACK) in teaching?

Q3. In what ways do teachers' self-efficacy and attitudes toward the use of digital technologies affect their use of technological, pedagogical, and content knowledge (TPACK)?

Q4. What are the factors that promote or inhibit digital technology use in the classroom?

Q5. What are the digital technologies used by teachers, and how are they being used in the classroom?

Firstly, the reliability and validity of each TPACK domain subscale were checked by using Cronbach's alpha reliability technique and confirmatory factor analysis (CFA) with SPSS. After that, the first and second research questions, which measured the perceptions of teachers' self-efficacy and attitude towards digital technology integration and teachers' perception of their TPACK level, were determined by descriptive analyses, which included the examination of the mean score of the items and standard deviation, rated on a five-point Likert scale. The third research question, which examined the influence of teachers' self-efficacy and attitudes in the use of digital technologies that affect their use of technological, pedagogical, and content knowledge (TPACK), was measured by using multiple regression analyses with SPSS version 26.0. The fourth research question, which examined the factors that promote or inhibit digital technology integration in teaching, was measured using descriptive analyses and the mode score of the items. Finally, the last research question, which measured what digital technology was employed by teachers in teaching as well as how the digital technology was used, was also examined using descriptive analyses and the mode score of the items. Details of the data analyses will be presented in Chapter 4.

3.8.2 Qualitative Data Analyses

In this study, qualitative data analyses involved the interview, classroom observation notes and a check list, and document analyses. In qualitative research, analysis refers to categorizing and sequencing information in order to understand the data and create a true and correct final report. Researchers are interested in people's beliefs, experiences, and meaning systems from the perspective of the people, where the methods used are more subjective (Brink, 1993). Qualitative data analysis refers to the process of description, classification, and interconnection of phenomena with the researcher's concepts that requires his ability to explain and interpret the data (Graue, 2015).

In qualitative research, experts come up with different stages to analyze the data. Miles and Huberman (1994) mentioned three simultaneous courses of action that were required while analyzing the dataset. They are reducing the data, displaying the data, and drawing conclusions about or verifying the data. Further, Miles and Huberman (1994) described these concurrent flows of activity as follows: (1) Reducing data as a process for selecting, developing, simplifying, abstracting, and transforming data in writing field notes or transcripts happens continuously throughout the lifetime of any qualitatively oriented project. It is part of the analytics that refine, sort, focus, reject, and organize the data in order to be able to draw a final conclusion and check it. (2) A data display, a set of arranged and compressed information that allows the researcher to reach conclusions and take action, includes matrices, graphs, charts, and networks. (3) The final draw can only be concluded at the end of the data collection, depending on the size of the body of field notes; the encoding, storage, and extraction methods used; the researcher's competence; and the funding organization's request, but they were frequently predicted early on. Verification can be as brief as a fleeting second idea passing through the analyst's mind while writing, in which case the analyst will not do much review of the field notes, or it can be more elaborated, with extensive argument and consideration among coworkers to develop an inter-subjective consensus, or by putting a lot of effort into reproducing a finding in another dataset.

In a way similar to Miles and Huberman (1994), Mezmir (2020) included familiarization as an additional stage in analyzing the qualitative data beside the existing stages, which are data reduction, data display, and report writing. Akinyode and Khan (2018) displayed five steps of analysis procedures in qualitative data analyses, which include data logging, anecdotes, vignettes, data coding, and a thematic network. It was meant to precisely interpret the analytical techniques and provide assistance to researchers who conducted qualitative research.

3.8.2.1 Data Reduction

Prior to starting the data filtering and sorting process, the researcher should familiarize himself with the variety and diversity of the documents collected in order to form an impression of the key issues and emerging themes in the data by bringing them into context (Mezmir, 2020). This familiarization requires the researcher to study all the data collected: interview transcriptions, observation notes, documents of lesson plans, and video of classroom observation. In data reduction, the data obtained was organized and arranged systematically in groups. Data from twelve participants was sorted into twelve cases (TA, TB, TC, TD, TE, TF, TG, TH, TI, TJ, TK, TL).

The initial stage was data logging. It was a process of transferring the raw data collected into data documentation to help the researcher prepare the anecdotes (Akinyode & Khan, 2018). In this stage, the researcher writes down all the data collected for this research such as interview, class observation, and document analyses into data documentation. After data logging, the next stage was preparing the anecdotes. The anecdotes were done after all responses from the respondents had been copied in the form of logs. Then the data was screened to remove the unnecessary information and rewritten to easier understand the information. Anecdotes were the refined version of the logs written clearly for the record, which involved a reorganization of the data log to improve the understanding of the data collected and allow the researcher to create a feeling and develop themes (Akinyode & Khan, 2018).

After creating the anecdotes, the researcher created the vignette in the form of narrative to gain in-depth description of the data. For instance, the researcher created a naration of a participant A in applying digital technology in the classroom to comprehend the whole story of digital technology integration in the classroom. This vignette was used to provide a detailed description of information gathered in narrative format with the purposes of establishing the credibility of the study and gaining a better understanding of the subject to give a higher degree of interpretation (Akinyode & Khan, 2018). A further step was data coding. Data coding was done in order to gather and tag the content of related data on the content of a given theme or idea (Attride-Stirling, 2001). Within qualitative research, a "code" is typically a short word or sentence that symbolically assigns the summative, silent, striking essence, and/or evocative properties of some language or visual data (Saldana, 2013). Coding is an important part of the process of switching from raw data to results, a way to ensure consistency between the goal and the outcomes, and a way of being certain that the questions being asked have been answered (Skjott & Korsgaard, 2019). In general, codes are created to represent identified topics and are then associated with raw data as summary markers for future analyses (Guest, MacQueen, & Namey, 2011). During the data coding exercise, the researcher verified the accuracy of the transcript and read the data back and forth to gain insight into the database interpretation (Akinyode & Khan, 2018). In the coding stage, the researcher used deductive coding to gather and tag the data into a given idea. For example, to understand the barriers of digital technology integration in the classroom, the researcher develped a code set that included codes such as “difficult to upload documents into google classroom”, “do not really understand to use canva in teaching” and “employing digital technology is complicated” to derive themes and patterns for qualitative analyses.

The last stage was the thematic network. It is meant to explore a subject’s understanding or denote an idea without solving conflicting explanations of a problem (Attride-Stirling, 2001). Thematic analyses require greater engagement and the researcher’s interpretation, which go further than counting explicit words or sentences and focus on the identification and description of implicit and explicit ideas in the data, which are themes (Guest, MacQueen, & Namey, 2014). The thematic network assists the researcher in exploring the connections that exist between explanatory statements and implied meanings in words or respondents, as well as providing tools for interpreting and organizing the themes (Akinyode & Khan, 2018). It consists of three stages: basic themes, organizing themes, and global themes.

During thematic analyses, the researcher examined the data to identify the common ideas that came up repeatedly. To identify barriers in digital technology integration for instance, the researcher looked over the codes that have been created and identfied the themes which were generally broader that codes. Some codes such as “difficult to upload documents into google classroom”, “do not really understand to use canva” and “employing digital technology is complicated” were combined into a theme of “lack of digital technology skills”

3.8.2.2 Data Display

Data display essentially involves the use of text representations of the data to select the segments that best represent the concept of interest (Hubemen & Miles, 1994). It aims to gradually transform the apparently disrupted primary data into an identifiable conceptual scheme (Mezmir, 2020). Several techniques can be adopted in displaying the data in order to assist in their analyses, such as tables, figures, and theme maps, which offer opportunities to better understand the data (Alhojailan, 2012). The researcher has chosen case studies as a form of data display. It tends to be either consolidated narratives in the voices of participants or author-voiced summaries of a typical or extreme situation or individual experiences (Grbich, 2013). The case stories presented would help the reader understand the setting as well as the participants’ perspectives. Thus, quotations from the participants are required to be presented (Nordin, 2014). In displaying the data, the researcher started by presenting the quantitative findings of the TPACK survey in Chapter 4, followed by a detailed discussion of the qualitative findings in Chapter 5.

3.8.2.3 Data Verification

Verification is the process of checking and confirming, which relates to the procedures used during the research process to gradually ensure the reliability and validity, and hence the rigor, of the study (Morse et al., 2002). The process of data analysis in qualitative research is an iterative process where a researcher should come and go through the data to cross-match the encryption for the purpose of improving the validity of the interpretation (Nordin, 2014). The iteration process is not an iterative mechanical task but a profoundly reflective process, which is the key to understanding and developing meaning and is the focus of visiting and revisiting the data and relating them to the new insights, gradually leading to greater focus and understanding (Srivastava & Hopwood, 2009). Discussions with good colleagues were conducted to ensure the reliability of the data analyses in this study. In addition, after the analyses of each participant's data were completed, it was sent to them for any appropriate comments, if necessary, to further validate the findings of the study.

3.9 Confidentiality and Anonymity

The participants' participation in this study was voluntary. Participants were allowed to opt out at any level and for whatever reason they considered important to them. The information collected in this research was identifiable. This means that all information was kept confidential, and no individual or school will be identifiable in the final report. Any collected and used information during this research was treated as confidential. Electronic data was password-protected, and hard copy data was in locked storage. The collected information in this study was kept under secure conditions at Curtin University for 7 years after the research has ended, and then it will be destroyed. The data was only discussed with supervisors. However, the following people have access to the collected information: the research team and the Curtin University Ethics Committee.

3.10 Minimization of Risk of Harm

Apart from giving up the participants' time to complete the survey and interview, there were no risks or inconveniences associated with taking part in this study. Participants volunteered to take part in the study.

However, because the quantitative and qualitative data for this study were collected during the COVID-19 pandemic in 2021, Indonesian COVID-19 health and safety protocols and regulations were followed at all times to limit potential exposures and virus spread during data collection. The preventing activities, such as wearing face covering, maintaining physical distance, practicing hand hygiene, accessing the authorized COVID-19 vaccines, and updating the most up-to-date version of those protocols at the time of data collection, were obeyed. There were few physical contacts made with teachers in obtaining the quantitative data; the contact was made only in the collection of qualitative data under strict health and safety protocols.

3.11 Trustworthiness of the Study

The trustworthiness of a research project indicates the level of confidence in the data, the interpretation, and the methods employed in order to ensure a good study (Pilot & Beck, 2014). The case study requires “construct validity, Internal validity, external validity, and realiability” (Wedwatta, Amaratunga, & Ingirige, p.8, 2011). The work of Lincoln and Guba (1985) was followed to make sure that this study is trsutworthy and addressed the following procedures: credibility, dependability, transferability, and conformability.

3.11.1 Credibility

Credibility or confidence in the qualitative study-oriented research is important (Polit & Beck, 2014). In the quantitative study-oriented, the concept of credibility is called as internal validity (Connelly, 2016) with a multitude of realities and truths; therefore, the evidence of the research is credible when it best represents the multiple realities revealed by the participants (Chilisa & Preece, 2005). The strategies, such as prolonged and substantial engagement, peer debriefing, member checks, and triangulation (Chilisa & Preece, 2005), used by the researcher for enhancing the credibility of the research.

3.11.1.1 Prolonged and Substantial Engagement

Extra time on the field and involvement with participants are important to improve the credibility of the study, as participants may share more sensitive information and thoughts than they did at the beginning of the research (Chilisa & Preece, 2005). In this study, besides conducting a survey, the researcher also carried out an interview with each participant, followed by a classroom observation at the schools. Furthermore, during school visits, the researcher was able to observe the schools' ICT facilities and speak with school staff about the ICT infrastructure. It allowed the researcher to get a better understanding of the context and to observe the salient issues related to the research.

3.11.1.2 Peer Debriefing

The findings of the study, as well as its interpretation, were discussed with academic colleagues. Peer debriefing works as a mean to avoid researcher' prejudicse and to ensure the objective of the data interpretation. In addition, the finding and the interpretation were also discussed with the researcher's supervisors in order to justify and verify the final conclusion objectively based on the dataset.

3.11.1.3 Member Checks

Member verification is performed for verification of the themes and patterns that are emerging as the data are gathered and examined with the participants in the research (Chilisa & Preece, 2005). Creswell (2005) elaborates on the member checking in the qualitative studies as follows:

> Member checking is the process in which the researcher asks one or more participants in the study to check the accuracy of the account. The check involves taking the findings back to the participants and asking them (in writing or in an interview) about the accuracy of the report. You ask participants about many aspects of the study, such as whether the description is complete and realistic, if the themes are accurate to include, and if the interpretations are fair and representative. (p, 252)

In this study, at the end of the interview, the researcher summarized the points discussed and asked the participants' feedback about whether the conclusion reached was accurate or not. In addition, the transcript and the conclusion were sent back to the participants, and they were asked to ponder them and give some comments if they appeared to be incorrect.

3.11.1.4 Triangulation

Triangulation of data sources combines data drawn from different sources and at different times, in different places, and from different people (Flick, 2004), which frequently used interviews, observation, and field notes in collecting the qualitative data (Carter et al., 2014). Triangulation ensured the agreement of the research findings from questionanire, interview, class observation, and document analyses (Nordin, 2014). Using different approaches (class observation, interviews, and recordings) results in a more valid, reliable, and diverse construction of reality (Bashir & Azheem, 2008). Thus, in supporting the findings of quantitative study, results from qualitative study which included the interview, class observation, as well as document analyses were taken into account to broaden the understanding of the study.

3.11.2 Dependability

Dependability refers to the data stability under the outlined circumtances and timing on the terms of the study (Polit & Beck, 2014), which is comparable to reliability in quantitative research, but the stability relies on the nature of the study (Connelly, 2016). According to Bitsch (2005, p. 86), dependability is "the stability of findings over time." If the research process is traceable, well documented, and makes sense, it is possible to establish dependability in qualitative research (Munn et al., 2014). The researcher compiled and stored all the dataset properly, including the voice recordings, video recordings, interview transcripts, class observation checklists, ICT facility notes, and lesson plan documents, in order to make it easier for the researcher to trace back the findings and see if there is a bias in the research.

3.11.3 Conformability

Connelly (2016, p. 435) defines conformability as "the neutrality or degree to which findings are consistent and repeatable". Conformability indicates that the results of the research to some extent may be confirmed or supported by other studies (Baxter & Eyles, 1997). To obtain conformability, researchers should be able to demonstrate that the results are apparent from the data and do not have their own predispositions attached to them (Shenton, 2004). Thus, researchers should provide detailed notes of their decision-making and analysis as it moves forward, where these notes are examined by a colleague; or these can be discussed through peer debriefings with a highly regarded qualitative researcher to avoid bias in a single person's view of research (Connelly, 2016). In relation to this study, the researcher discussed the collected data and study findings with an academic colleague to ensure the research's conformability. Besides, along the data analysis process, the researcher kept looking at and reading all the collected data and notes to evaluate the conformability of the findings. According to Bowen (2009), maintaining a review of the investigative process and product for data validation to demonstrate how the data were collected, documented, and analyzed is important.

3.11.4 Transferability

According to Bitsch (2005), transferability is the extent to which the findings from qualitative studies may be transferred into another context. Transferability involves the readers' inference that the findings of the research would be similar in their own context (Lincoln & Guba, 1985). According to Connelly (2014), transferability is analogous to generalization in quantitative research due to its uniqueness in providing a brief researcch description. According to Nordin (2014), with transparency, communication, and consistency, the reader has the ability to evaluate what the investigator did and can apply it in other settings. Therefore, providing clear description of the research methodology including the research design of the study, design of the research instrument, data collection process, data screening, data analyses, as well as ethical consideration, were crucial to inform the research context and focus so that the readers may get some insights and are able to apply it in their own context

3.12 Chapter summary

This chapter described the research designs, the data collection procedure, the instrumentation development and piloting, the data analyses, as well as the ethical considerations for this study. A mixed-methods approach was used in the research design, which combined quantitative and qualitative data collection methods. A survey was used to gather the quantitative data, while an interview, class observation, and document review were used to collect the qualitative data. The researcher has also described the measures taken to ensure the reliability and validity of the research. The findings of this research's reliability and validity will be discussed in Chapter 4, and the qualitative findings will be presented in Chapter 5.

Chapter 4

METHODOLOGICAL FINDINGS OF THE SURVEY

4.1 Introduction

This chapter presents the methodological findings of the survey for measuring teachers' self-efficacy, teachers' attitude towards digital technology integration in the classroom, as well as teachers'TPACK levels across all subjects in Indonesia. The focus was more on TPACK, as one of the purposes of this study was to provide a more suitable Indonesian version of TPACK questionnaire. The survey was in Indonesian language and was modified in accordance with the current curriculum of K13, specifically related to the 21st century skills. This chapter discusses the findings of the study which begins with the data screening and followed by the description of its reliability and validity test. In addition, the reliability and validity tests of self-efficacy and attitudes toward digital integration are also discussed in this chapter.

4.2 Main Study of the Research

The main study of quantitative research was conducted from March 2021 to September 2021 in eighteen senior high schools in Pekanbaru, the capital city of Riau Province, Indonesia. A total of 583 teachers participated in the study. Quantitative data collection took a bit of time due to Community Activities Restrictions Enforcement Level One in the Pekanbaru region caused by the COVID-19 Pandemic, where schools were completely closed and then opened with strict regulations. Details can be seen in the previous chapter.

The level of response rate is an important issue in relation to the validity of the research's results (Baruch, 1999). The response rate determined by Hamilton (2009) is the proportion of respondents who participated in the survey using the sample size identified for the research. The return rate of this survey was 77% (583 participants). 30 surveys were eliminated. 10 surveys were eliminated due to incomplete answers, and 20 surveys were eliminated due to blank answers, leaving the final data set of 553 respondents (N = 553). The distribution of surveys for the main study, including returned, eliminated, and completed surveys, is described as follows (See Table 4.1):

Table 4.1

The distribution of the surveys

Distribution of Surveys	Distributed Surveys	Returned Surveys	Eliminated Surveys	Completed Surveys	Total
Main data collection	750	583	30	553	553

Note. From 750 copies of the survey, 583 were returned, 30 were eliminated, and 553 were considered complete.

4.2.1 Data Screening

Statistical data screening requires the computation of a statistical indicator of data quality (DeSimone, Harms, & Desimone, 2014). According to Stephen (2016), before conducting the actual statistical tests, the data set needs to be screened for any irregularities by checking (1) for the accuracy of the data input, (2) for other kinds of outliers, (3) for missing values, and (4) for checking assumptions (normality).

4.2.1.1 Accuracy Data

Accuracy data was obtained by examining the descriptive statistics analyses. The univariate descriptive statistics identified that there were two wrong data entries within the data set. From a score of 1 to 5 of likert-point scales, there were a score of "33" and a score of "44". Instead of "33" and "44", the scores should be "3" and "4" which were caused by misstype. The wrong data entry was then corrected. The results of means and standard deviations were then also plausible.

4.2.1.2 Dealing with Missing Values

A close examination of the data revealed that some values were missing, involving 14 of the 583 respondents. Of the cases with missing values, for example, there were some cases of missing values on self-efficacy items, TK items, PK items, PCK items, TCK items, TPK items, and TPACK items. In dealing with these missing values, the researcher has decided to use deleting listwise or checkboxes, which is the most common solution for missing values and the default value for standard statistical packages. According to Acock (2005), if the missing value model is totally random, the listwise solution is an optimal and sensible strategy with a sufficient sample size, and it will result in unbiased estimates.

4.2.1.3 Normality and Outliers

The measured variables were assessed for the normality of the data. One of the methods used to assess normality is using the skewness and kurtosis of the distribution, which can be fairly accurate in small and large samples (Kim, 2013). Tabachnick and Fidell (2007) identified that the measured data are considered to have normal distribution if the skewness and kurtosis are less than +/_ 2.

A histogram and boxplots were used to identify the univariate outliers. The histogram was used to determine the potential outliers because it provides a fast and simple way of identification. It is a graph view that is used to prove central trend distributions on the axes x and y (Field & Miles, 2010). In addition, a box plot was also used to identify the potential outliers. It is a convenient way to determine univariate outliers, where values outside the whiskers are considered outlier cases if the wrong data entry is excluded (Field & Miles, 2010).

Besides, the z-scores analysis is significant objectively to identify if a suspected univariate outlier is really an issue (Mowbrey, Fox-Wasylyshin, & El-Masri, 2018). According to Tabachnick and Fidell (2007), the absolute value of 3.29 is the default value used for the identification of outliers. It means any value with a z-score higher than +3.29 or smaller than -3.29 is regarded as an outlier case if the measured variables were calculated to observe the univariate outliers. Any values that were higher than 3.29 or smaller than 3.29 in this study were deleted. The elimination method is the most conservative and probably the safest way of dealing with outliers because, by definition, an outlier is not part of the population of interest or is an extreme case in the population (Mowbrey, Fox-Wasylyshin, & El-Masri, 2018).

Furthermore, in detecting the multivariate outliers, the computation of Mahalanobis distance at $p <.001$ was employed. According to Tabachnick and Fidell (2007), all cases with the Mahalanobis distance value above the upper critical value for a chi-square distribution with 36 degrees of freedom (in relation to the number of variables measured) (2 (36, 0,001) = 67,99) were found to be multivariate outliers. Result from the computation of Mahalanobis distance found that none of them have been identified as multivariate outliers. In addition, as suggested by Tabachnick and Fidell (2007), cases where the value is greater than 1 may become an issue. According to these data, the maximum Cook distance is 1.000, employing no major problems. Table 4.2 shows the values of skewness and kurtosis:

Table 4.2

The Values of Skewness and Kurtosis in This Study

Measured Variables	Skewness	Kurtosis
Self-Efficacy 1	-.254	-.267
Self-Efficacy 2	-.455	-.179
Self-Efficacy 3	-.145	-.278
Self-Efficacy 4	-.202	-.081
Self-Efficacy 5	-.452	.169
Self-Efficacy 6	-.543	.389
Self-Efficacy 7	-.027	.466
Self-Efficacy 8	.005	.722
Self-Efficacy 9	-.029	.774
Self-Efficacy 10	.115	-.450
Self-Efficacy 11	.115	-.450
Self-Efficacy 12	.040	-.658
Self-Efficacy 13	-.050	-.189
Self-Efficacy 14	.276	-.366
Attitudes 1	-.101	-.354
Attitudes 2	-.134	.572
Attitudes 3	-.318	.115
Attitudes 4	-.252	-.024
Attitudes 5	-.409	.731
Attitudes 6	-.341	.737
Attitudes 7	-.293	.142
Attitudes 8	-.244	.183
Attitudes 9	-.037	-.966
Attitudes 10	-.334	-.127
Attitudes 11	-.204	-.711
Attitudes 12	.054	-.842
Attitudes 13	-.522	.387
Attitudes 14	-.245	-.044
Technological Knowledge (TK)1	-.034	-.563
Technological Knowledge (TK)2	-.051	-.270
Technological Knowledge (TK)3	-.373	.082
Technological Knowledge (TK)4	-.191	-.154
Content Knowledge (CK) 1	-.361	.274
Content Knowledge (CK) 2	.013	.226

Measured Variables	Skewness	Kurtosis
Content Knowledge (CK) 3	-.114	.373
Content Knowledge (CK) 4	-.009	-.242
Pedagogical Knowledge (PK) 1	-.174	.024
Pedagogical Knowledge (PK) 2	-.105	-.029
Pedagogical Knowledge (PK) 3	-.572	.420
Pedagogical Knowledge (PK) 4	-.425	.297
Pedagogical Knowledge (PK) 5	-.515	-.329
Pedagogical Knowledge (PK) 6	-.375	.105
Pedagogical Content Knowledge (PCK) 1	-.245	.128
Pedagogical Content Knowledge (PCK) 2	-.331	1.080
Pedagogical Content Knowledge (PCK) 3	-.317	.655
Pedagogical Content Knowledge (PCK) 4	-.316	1.094
Pedagogical Content Knowledge (PCK) 5	-.312	.731
Pedagogical Content Knowledge (PCK) 6	-.243	.735
Technological Content Knowledge (TCK) 1	-.463	.322
Technological Content Knowledge (TCK) 2	-.335	.214
Technological Content Knowledge (TCK) 3	-.172	-.273
Technological Content Knowledge (TCK) 4	-.257	-.193
Technological Pedagogical Knowledge (TPK) 1	-.571	-.103
Technological Pedagogical Knowledge (TPK) 2	-.551	-.009
Technological Pedagogical Knowledge (TPK) 3	-.341	-.232
Technological Pedagogical Knowledge (TPK) 4	-.249	-.250
Technological Pedagogical Knowledge (TPK) 5	-.249	-.250
Technological Pedagogical Knowledge (TPK) 6	-.420	-.011
Technological Pedagogical Content Knowledge (TPCK) 1	-.039	-.368
Technological Pedagogical Content Knowledge (TPCK) 2	-.244	-.129
Technological Pedagogical Content Knowledge (TPCK) 3	-.235	-.158
Technological Pedagogical Content Knowledge (TPCK) 4	.018	-.459
Technological Pedagogical Content Knowledge (TPCK) 5	.029	-.246
Technological Pedagogical Content Knowledge (TPCK) 6	-.017	-.213

Note. The absolute value of 3.29 is the default value used for the identification of outliers (Tabachnick & Fidell, 2007). Thus, any values that were higher than 3.29 or smaller than 3.29 in this study were deleted.

4.2.2 Measuring TPACK, Self-Efficacy, and Attitudes: Reliability and Validity

The reliability and validity of the instruments used in this study were assessed. The assessments of reliability for internal consistency and validity of the seven domains of TPACK, namely: technological knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPCK), were conducted after the data screening process, as well as for self-efficacy and attitudes.

4.2.2.1 Reliability

Generally, the internal consistency is used to determine the consistent score of the subscale of a composite score from the same construct. It is a psychometric property of a test associated with the interim correlation degree and the saturation of the overall factor, and it is independent of test length (Tang, Cui, & Babenko, 2014). In assessing internal consistency, alpha is commonly used by researchers. Alpha was used as an indicator to see the reliability of interrater, the reliability of separation, internal reliability, internal consistency, congruence, unidimensionality, and coherence (Taber, 2018). In science education, it is common practice to consider alpha reaching the slightly arbitrary value of 0.70 as an adequate measure of the internal reliability or coherence of an instrument (Taber, 2018). According to Hair et al. (2010), the lowest acceptability of alpha values was from 0.60 to 0.70.

Reliability of TPACK Scales

Findings from the study suggested that the internal consistency (Cronbach's alpha) for the TPACK subscale was considered to be acceptable. The results showed that Cronbach's alpha values ranged from 0.77 to 0.95. Details can be seen in Table 4.3. It means that the instrument used in this study was reliable and consistent to measure teachers' TPACK in Indonesia.

Table 4.3

Reliability of the TPACK Scales

Subscales	Reliability (α)
Pedagogical Knowledge (PK)	.89
Content Knowledge (CK)	.77
Technology Knowledge (TK)	.79
Pedagogical Content Knowledge (PCK)	.90
Technological Pedagogical Knowledge (TPK)	.94
Technological Content Knowledge (TCK)	.90
Technological Pedagogical Content Knowledge (TPACK)	.95

Note. N=482. A Cronbach's alpha score () > 0.60 is accepted as a good reliability score for the instrument (Hair et al., 2010). Thus, the seven TPACK scales showed good reliability.

Reliability of Self-Efficacy Scales

Findings from the study suggested that the internal consistency (Cronbach's alpha) for the self-efficacy subscale was considered to be acceptable. The results showed that Cronbach's alpha values ranged from 0.80 to 0.88. Details can be seen in Table 4.4. It means that the instrument used in this study was reliable and consistent to measure teachers' self-efficacy in digital technology use in Indonesia.

Table 4.4

Reliability of the Self-Efficacy Scales

Subscales	Reliability (α)
Digital technology self-efficacy	0.80
Teachers' self-efficacy	0.82
Self-efficacy towards digital technology integration	0.88

Note. *N=482*. A Cronbach's alpha score () > 0.60 is accepted as a good reliability score for the instrument (Hair et al., 2010). Thus, the three self-efficacy scales showed good reliability.

Reliability of Attitude Scales

Findings from the study suggested that the internal consistency (Cronbach's alpha) for the attitudes subscale was considered to be acceptable. The results showed that Cronbach's alpha values ranged from 0.70 to 0.90. Details can be seen in Table 4.5. It means that the instrument used in this study was reliable and consistent in measuring teachers' attitudes toward digital technology use in Indonesia.

Table 4.5

Reliability of the Attitude Scales

Subscales	Reliability (α)
Willingness to use digital technology	0.90
Anxiety in digital technology use	0.71

Note. *N=482*. A Cronbach's alpha score () > 0.60 is accepted as a good reliability score for the instrument (Hair et al., 2010). Thus, the two attitude scales showed good reliability.

4.2.2.2 Validity

The factor validity of the TPACK's seven subscales (self-efficacy subscales and attitudes subscales) was examined using exploratory factor analysis (EFA). The EFA is used to test if the survey components for each subscale measure each variable satisfactorily (Sahin, 2011). The general objective of factorial analysis is to summarize the data so that relationships and trends are easily interpretable and understood (Yong & Pearce, 2013). Before running the EFA, the Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy and Bartlett’s Test of Sphericity (BTS) were applied to the data set.

Validity of TPACK Scales

The results of the KMO and BTS indicated that the characteristics of the data set satisfy the psychometric characteristics for performing factor analyses. KMO analyses for TPACK indicated higher indexes with statistically significant BTS scores (Kaiser-Mayer-Olkin Measure of Sampling Adequacy, 0.922 > 0.50, and Bartlett’s Test of Sphericity, sig, 0.000 0.05). The factor loadings for all seven TPACK constructs revealed that the indicators were closely linked to their so-called latent factors, which ranged from.435 to.864, significant at p. 50. According to Comrey and Lee (1992), any loading factors which greater than .70 is found to be excellent, .63 is considered to be very good, .55 is regarded as good, .45 is judged to be poor. Therefore, the researcher decided to remove three items with factor loadings smaller than .50 (PK1, PK2, and CK4) from further data analyses. It was observed that the indicators were found to be highly related to the alleged latent factors. Therefore, it was considered adequately qualified to be included as part of the scale. Table 4.6 presents the factor loading estimates for all seven TPACK constructs:

Table 4.6

Factor Loadings For 33 Items of TPACK Domains

	Factor Loadings						
	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	**Factor 7**
TPACK3	.816						
TPACK1	.806						
TPACK2	.805						
TPACK6	.793						
TPACK5	.791						
TPACK4	.740						
PCK4		.808					
PCK2		.800					
PCK5		.785					
PCK6		.755					
PCK3		.751					
PCK1		.742					
TPK3			.807				
TPK1			.804				
TPK2			.792				
TP4K			.732				
TPK5			.644				
TPK6			.578				
PK4				.864			
PK3				.817			
TK3				.813			
PK5				.749			
PK6				.645			
TCK2					.825		
TCK1					.778		
TCK4					.653		
TCK3					.651		
TK1						.793	
TK2						.716	
TK4						.588	
CK3							.825
CK2							.808

Note. Loading factors which greater than .70 is found to be excellent, .63 is considered to be very good, .55 is regarded as good, .45 is judged to be poor (Comrey & Lee, 1992). Three items with factor loadings smaller than .50 (PK1, PK2, and CK4) were decided to remove from further data analyses.

Furthermore, the correlations between the seven factors of TPACK are indicated in Table 4.7 Statistically significant correlations occur between the subscales for the TPACK survey, ranging from the lowest value, r =elations occur between the subscales for the TPACK survey, ranging from the lowest value, r =.24, between TK and PCK, to the highest, r = TPACK survey, ranging from the lowest value, r =.24, between TK and PCK, to the highest, r =.78, between TPK and TPCK. These findings show that knowledge about technology, pedagogy, content, and their intersections are linked. According to Paranhos et al. (2014), the r values between 0 and 0.25 show a very weak correlation, 0.26 to 0.49 show a weak correlation, 0.5 to 0.69 suggest a moderate correlation, 0.7 and 0.89 point to a high or strong correlation, and 0.90 and 1.0 show a very high or very strong correlation.

"In lay terms, we want our indicators (and often our constructs) to correlate, but not too much, with variables they are theoretically related to and not be meaningfully related to variables that are theoretically irrelevant" (Hudson, 2021, p. 577).

The findings showed that most of the subscales had moderate correlations. The correlations between the latent variables indicated to be less than .90 (Hair et. al., 2010), thus establishing the discriminant validity.

Table 4.7

Pearson Correlation Coefficients between TPACK Subscales

TPACK Subscales	TK	CK	PK	PCK	TCK	TPK	TPCK
TK	1.000	.468**	.449**	.242**	.617**	.630**	.642**
CK		1.000	.520**	.438**	.482**	.435**	.460**
PK			1.000	.627**	.388**	.464**	.472**
PCK				1.000	.270**	.360**	.342**
TCK					1.000	.676**	.668**
TPK						1.000	.786**
TPCK							1.000

Note: **. The correlation is significant at the 0.01 level (2-tailed). TK = technological knowledge; CK = content knowledge; PK = pedagogical knowledge; PCK = pedagogical content knowledge; TCK = technological content knowledge; TPK = technological pedagogical knowledge; TPCK = technological pedagogical content knowledge.

Validity of Self-Efficacy Scales

The results of the KMO and BTS indicated that the characteristics of the data set satisfy the psychometric characteristics for performing factor analyses. KMO analyses for self-efficacy indicated higher indices with statistically significant BTS scores (Kaiser-Mayer-Olkin Measure of Sampling Adequacy: 0.895 > 0.50 and Bartlett's Test of Sphericity: 0.000 0.05). The factor loadings for three self-efficacy constructs identified a close link among the indicators, which they refer to as the latent factors, ranging from =.583 to =.857, significant at p. 50. There was one item which decided to be deleted from the data set since its factor loadings was smaller than .50 (Efficacy13) and was considered to be poor. It was observed that the indicators were found to be highly related to the alleged latent factors. Therefore, it was considered adequately qualified to be included as part of the scale. Table 4.8 presents the factor loading estimates for all self-efficacy constructs:

Table 4.8

Factor Loadings For Self-Efficacy Constructs

	Factor Loadings		
	Factor 1	Factor 2	Factor 3
Efficacy12	.773		
Efficacy1	.763		
Efficacy2	.738		
Efficacy6	.713		
Efficacy10	.687		
Efficacy11	.624		
Efficacy8		.840	
Efficacy9		.836	
Efficacy7		.783	
Efficacy3			.857
Efficacy4			.630
Efficacy5			.585
Efficacy14			.583

Note. There was an item deleted from the data set since its factor loadings was smaller than .50 (Efficacy13) and was considered to be poor.

Thus, it was observed that factor 1 (digital technology self-efficacy) was composed by items 12-1-2-6-10 and 11; factor 2 (teacher self-efficacy) by items 8-9, and 7; and factor 3 (digital technology integration self-efficacy) by items 345 and 14. They were named according to the area they encompassed.

Validity of Attitude Scales

The results of the KMO and BTS indicated that the characteristics of the data set satisfy the psychometric characteristics for performing factor analyses. KMO analyses for Attitudes indicated higher indexes with statistically significant BTS scores (Kaiser-Mayer-Olkin Measure of Sampling Adequacy 0.845 > 0.50 and Bartlett's Test of Sphericity (sig) 0.000 < 0.05). The factor loadings for two attitude constructs revealed that the indicators were found to be highly related to the alleged latent factors, ranging from =.588 to =.815, significant at p. 50. There were two items which were judged to be poor because their loading factors were smaller than .50 (Anxiety 9 and Anxiety 10). These two items were then removed from the data set for further analysis. It was observed that the indicators were found to be highly related to the alleged latent factors. Therefore, it was considered adequately qualified to be included as part of the scale. Table 4.9 presents the factor loading estimates for all attitude constructs:

Table 4.9

Factor Loadings For Attitude Constructs

	Factor Loadings	
	Factor 1	**Factor 2**
Willingness 5	.815	
Willingness 3	.807	
Willingness 4	.800	
Willingness 6	.787	
Willingness 7	.787	
Willingness 2	.762	
Willingness 1	.731	
Willingness 8	.725	
Anxiety 13		.768
Anxiety 12		.758
Anxiety 14		.717
Anxiety 11		.588

Note. There were two poor items identified because the loading factors were smaller than .50 (Anxiety 9 and Anxiety 10).

4.3 Chapter Summary

This chapter provides a detailed report on the instrument design used in this study as well as the reliability and validity of the instrument. Results suggested that the internal consistency (Cronbach's alpha) of all the scales was considered reliable. In addition, the results of the exploratory factor analysis (EFA) of the overall measurement were valid. These results particularly serve to provide a more relevant TPACK questionnaire for the Indonesian as one of its demanded research purposes and represent an original contribution to the research literature. The TPACK survey designed in this study could be used to increase teachers' understanding of their TPACK self-perception and provide information on technology integration as well as the appropriate pedagogy of teachers. Further recommendations on this topic will be presented in the last chapter. The next chapter, 5, will deal with the quantitative findings of the research.

Chapter 5

QUANTITATIVE FINDINGS

5.1 Introduction

This chapter presents the findings from the quantitative components of this study in order to answer the research questions: 1) What are teachers' perceptions of their self-efficacy and attitudes towards the use of digital technologies? 2) What are teachers' perceptions of their technological, pedagogical, and content knowledge (TPACK)? 3) In what ways do teachers' self-efficacy and attitudes towards the use of digital technologies affect their use of technological, pedagogical, and content knowledge (TPACK)? 4) What are the factors that promote or inhibit digital technology use in the classroom? 5) What are the digital technologies used by teachers and how are they being used in the classroom? The chapter begins with the participants' demographic and background characteristics, which included the participants' gender, age, level of education, the subject taught, teaching experience, teacher development program, and ICT training during pre-service and in-service in order to describe the sample. Then the findings of each research question are presented, respectively.

5.2 Participants' Demographic and Background Characteristics

Respondents who participated in this study were teachers of senior high school from eighteen schools in Pekanbaru, Riau Province, Indonesia. They were teachers across the subjects. The selection process of the participants as well as the distribution of the survey have been described in chapter 3, while the response rate of the survey has been presented in chapter 4. The participants' demographic and background characteristics are described as follows:

5.2.1 Participants' Gender

The majority of teachers who participated in this study were female, with 369 (76%), followed by males with 113 (24%).

5.2.2 Participants' Age

The age of the participants who took part in this study ranged from 21 to 59. There was no very prominent age group, but those whose ages ranged from 21 to 25 were among the fewest participants in this study. Interestingly, the number of respondents whose ages were 50 and above was higher than expected in this study. The details are described in Table 5.1:

Table 5.1

Participants by Age

Age	Frequency	Percent
21-25	28	5.9
26-30	71	14.7
31-35	63	13.1
36-40	60	12.5
41-45	73	15.1
46-50	65	13.5
51-55	67	13.9
56-60	44	9.2
Missing	11	2.3
Total	**482**	**100.0**

Note. The age of the participants who took part in this study ranged from 21 to 59.

5.2.3 *Participants' Level of Education*

Participants with a bachelor's degree dominated the study. Their number comprised more than 78% (379) of the total participants, followed by those with master's degrees with 14% (69) as the second largest group of participants. Data also identified that there were 3.7% (18) of respondents who was still doing their master degree. Surprisingly, there were a small number of participants who, by regulations, were not qualified to become teachers because they did not have a bachelor’s degree as stipulated by the 2003 national educational law. Their number was 3.7% (18). Details are presented in Table 5.2:

Table 5.2

Participants by Academic Qualification

Level of Education	Frequency	Percent
Diploma	8	1.7
Pursuing Bachelor	18	3.7
Bachelor	379	78.6
Pursuing Master	8	1.7
Master	69	14.3
Total	**482**	**100.0**

Note. The majority of the participants were teachers with a bachelor's degree (78%, or 379).

5.2.4 Participants' Subject Taught

The majority of participants in this study were teachers who taught sciences, social sciences, and languages, with 20% (97), 19% (92), and 17% (84), respectively. The fourth largest group was math teachers with 11% (55). Teachers from other subjects such as health and sports; art, culture, and crafts; religious education; Pancasila and civic education; counseling; and others were less than 6% (30). There were two missing data. Details are presented in Table 5.3:

Table 5.3

Participants by Subject Taught

Subjects	Frequency	Percent
Sciences	97	20.1
Social Sciences	92	19.1
Languages	84	17.4
Math	55	11.4
Health and Sports	31	6.4
Pancasila and Civic Education	31	6.4
Art, Culture, and Crafts	23	4.8
Counseling	28	5.8
Religious Edu	26	5.4
Others	13	2.7
Total	**480**	**99.6**

Note. The majority of participants in this study were teachers who taught sciences, social sciences, and languages.

5.2.5 Participants' Teaching Experience

Participants with 13-16 years of teaching were regarded as the highest group of teachers (20.3%) participated in this study, followed by participants with 9-12 years of teaching (17.7%) respectively. On the other hand, teachers with teaching experience between 21 and 24 years old (6.4%) were regarded as the lowest group of respondents involved in this research. In general, the data showed that a quarter of the participants were senior teachers with teaching experience spanning more than 20 years (24.4%). The rest were teachers with teaching experience less than 20 years (63.4%) who still had a long working period, so that they should keep improving their knowledge and skills. Details are presented in Table 5.4:

Table 5.4

Participants' Teaching Experience

Experience	Frequency	Percent
1–4 years	53	11.1
5–8 years	56	12.1
9–12 years – 12 Years	82	17.7
13 – 16 Years	94	20.3
17 – 20 Years	61	13.2
21 – 24 Years	30	6.4
25 – 28 Years	35	7.5
29 Years and Up	41	10.5
Missing	20	4.1
Total	**482**	**100.0**

Note. Participants' teaching experience ranged from 1–29 years.

5.2.6 Participants Who Completed the Teacher Professional Program

Data showed that 58% (282) of the participants in this study completed the Teacher Professional Program, and only 42% (197) of them did not completed the program. Teacher's professional program is a two years' educational program to prepare teachers with necessary skills in order to fully master the teacher's competence in accordance with the national standards of education. Thus, the majority of the respondents had already received the Teacher Professional Program conducted by the Ministry of Education and Culture, which aimed to address the problems of low competence of teachers and skills.

5.2.7 Participants' ICT Trainings during Pre-Service and In-Service

The number of participants who took ICT training during pre-service was only 22% (107). The majority (77%, or 373) stated that they never took the training. In addition, 32% of in-service teachers stated that they took ICT training during their service as teachers, while 67% (324) said that they never took the training. These findings suggested that teachers did not receive appropriate ICT training either during pre-service or in-service.

5.2.8 Participants' Daily Internet Usage

Most of the participants reported that they spent one to two hours each day connecting to the internet, either preparing the teaching materials or teaching their students, with a percentage of 63% (307). Another 25% (124) stated that they spent three to four hours, and another 9% (43) spent more than five hours per day connecting to the internet for teaching and learning purposes. Interestingly, there were four participants indicated that they used no internet at all in teaching. However, this informed that getting access to the internet was not a big deal for teachers, and they used it for their daily teaching and learning activities. Many participants stated that they used the internet for searching the teaching materials as well as to deliver and evaluate the subject content. Details can be seen in Table 5.5:

Table 5.5

Participants' Daily Internet Usage

Daily Internet Use	Frequency	Percent
One to two hours	307	63.7
Three to four hours	124	25.7
More than five hours	43	8.9
Use no internet	4	.8
Missing	4	.8
Total	**478**	**99.2**

Note. Majority of participants reported to use internet from 1-2 hours per day.

5.3 Research Questions 1

What are teachers' perceptions of their self-efficacy and attitudes towards the use of digital technologies?

Results for research question 1 were reported using frequency distributions, means, and standard deviations. The question was addressed by calculating the descriptive statistics (i.e., means, standard deviations, and frequency distributions) for each of the measured self-efficacy subscales.

5.3.1 Teachers' Self-Efficacy Towards the Use of Digital Technologies

With regards to teachers' self-efficacy, teachers were asked to rate how confident they felt about their ability to use and integrate digital technology into teaching on a five-point Likert scale. Results from descriptive statistics showed that teachers felt fairly confident that they have good self-efficacy towards digital technology integration, as shown in their score rating in the survey. Their composite mean score was 3.84 and SD= .49 which were above the mid-point of a 5-point scale. Overall, *Teacher's self-efficacy* subscales showed to have the highest mean score among other subscales with M= 3.96 and SD= .44. In addition, all self-efficacy subscales' mean scores indicated that teachers possessed a positive response to the scales. The mean scores ranged from 3.70 to 3.96. Details are presented in Table 5.6:

Table 5.6

Mean Scores and Standard Deviations of Self-Efficacy Subscales

Subscales	(α)	Mean	Std. Deviation
Digital technology self-efficacy	0.80	3.88	.55
Teacher's self-efficacy	0.82	3.96	.44
DT Integration Self-Efficacy	0.88	3.70	.54

Note. N=482.

Further analyses were carried out to examine the highest and lowest means of the subscales. The results identified that item *1* (I feel confident that I can use digital technology efficiently) had the highest mean score. On average, teachers perceived that they can use digital technology efficiently with M= 4.10 and SD= .67.

Furthermore, results found that all items on the subscales of *teacher self-efficacy* (teacher self-efficacy 2, teacher self-efficacy 3, and teacher self-efficacy 1) were scored to be among the highest mean scores. Item on *Teacher Self-Efficacy 2* (I feel confident that I can motivate my students to be actively involved in their learning) was rated as the second highest mean score by teachers with M = 3.98 and SD =.50, followed by item on *Teacher Self-Efficacy 3SD =.51M =* (I feel confident that I can motivate my students to be actively involved in their learning) as the third highest mean score with M= 3.96 and SD=. 51, and item on *Teacher Self-Efficacy 1* (I feel confident that I can create meaningful learning experiences for my students' learning) as the fourth highest mean score with M = 3.95 and SD =.50. The findings suggested that teachers were able to use digital technology efficiently in their teaching, and they agreed that they have higher self-efficacy in teaching.

It was observed that items on the subscale of *"digital technology integration"* were among the lowest mean scores of those rated by teachers. For example, items of *Digital*

Technology Integration1 (I feel confident that when I use digital technology I can solve any technical problems) and *Digital Technology Integration 4* (I feel confident that I can evaluate the strengths and the weaknesses of digital technology to improve my classroom activities) showed to have the lowest scores with M= 3.56 and SD= .6, and M= 3.62 and SD= .75. This may suggest that teachers were confident enough to integrate digital technology in the classroom, though it was not as high as the other items. Their confidence level to deal with problems related to technical issues and to evaluate the benefits of digital technology use in the classroom was just above the mid-point of a 5-point scale (See Table 5.7).

Descriptive frequency of self-efficacy items also suggested that "agree" was chosen as the most common response provided by participants (60%) in the survey. Only a small percent of respondents chose "neutral" or "strongly agree" (23% and 13% respectively) as their responses. On the other hand, there were only a few participants who responded "strongly disagree" or "disagree" with the percentage under 3%. These findings suggested that most of teachers possesed good self-efficacy towards digital technology integration in teaching. The following table 5.7 describes the mean scores of self-efficacy items as well as its descriptive frequency.

Table 5.7

Mean Scores of Self-Efficacy Individual Items From the Highest To the Lowest and Its Descriptive Frequency

Subscales	Mean	SD	Frequency (%)				
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Digital technology self-efficacy 1	4.10	.67	0.2	1.0	13.7	58.3	26.0
Teacher self-efficacy 2	3.98	.50	0.4	6.6	20.7	49.4	22.0
Teacher self-efficacy 3	3.96	.51	-	5.2	16.2	60.4	18.0
Teacher self-efficacy 1	3.95	.50	-	0.6	29.9	61.0	8.5
Digital Technology Self-Efficacy 3	3.91	.73	0.2	1.0	31.3	57.5	10.0
Digital technology self-efficacy 2	3.87	.85	-	1.2	27.2	54.6	17.0
Digital technology self-efficacy	3.87	.69	-	-	15.1	74.5	10.4
DT integration self-efficacy 2	3.83	.64	-	0.4	12.0	75.9	11.6
DT integration self-efficacy 3	3.77	.77	0.4	-	12.9	76.3	10.4
Digital Technology Self-Efficacy 4	3.77	.59	0.2	6.8	32.8	50.6	9.5
Digital technology self-efficacy 5	3.75	.64	2.1	2.1	24.3	61.6	12.0
DT integration self-efficacy 1	3.62	.75	0.6	6.0	21.8	58.3	13.3

Subscales	Mean	SD	Frequency (%) Strongly disagree	Disagree	Neutral	Agree	Strongly agree
DT integration self-efficacy 4	3.56	.67	0.2	2.5	44.6	45.6	7.1

Note. N=482.

Further analyses on the difference in teachers' self-efficacy towards digital technology integration according to variables such as teacher professional program, digital technology training during pre-service, and digital technology training during in-service were examined by using an independent sample t-test, while the difference in demographic variables based on teachers' professional experiences and teachers' level of education were examined by using a one-way ANOVA. Participants' difference based on gender and age group were not examined in this study because the researcher believed that regardless their sex and age, the integration of digital technology remained important. Knowing the sex and age group differences contributed insignificant implications to stakeholders. However, findings regarding respondents' differences on professional program, digital technology training during pre-service and in-service, professional experience, and educational level would provide important input to improve teachers' skills and knowledge.

It was clearly seen that there was statistically significance difference of the self-efficacy scale in terms of ICT course during pre-service between those who took the program (N=100, M=3.97, SD=.501) and those who did not take the program (N=341, M=3.80, SD=.441, t=-3.264, df=439, sig=.001<0.05) and ICT course during in service between those who took the program (N=142, M=3.92, SD=.496) and those who did not take the program (N=299, M=3.80, SD=.439, t=2.672, df=439, sig=.008<0.05). On the contrary, there was no significant difference in teachers' self-efficacy level in terms of the teacher professional program. Results are given in Table 5.8:

Table 5.8

Teachers' Self-Efficacy Level Difference Based on Teacher Professional Program, ICT Course During Pre-Service Program, And ICT Course During In-Service Program.

Scales	Variables	N	M	SD	t	df	Sig
Self-Efficacy	Completed the teacher professional program.	270	3.84	.48	-.058	439	.954
	Have not completed the teacher professional program.	171	3.84	.42			
	Took the ICT course during pre-service	100	3.97	.50	3.264	439	.001*
	Did not take the ICT course during pre-service	341	3.80	.44			
	Took the ICT course during in-service	142	3.92	.49	2.672	439	.008*
	Did not take the ICT course during in-service	299	3.80	.43			

Note. Sig= p<0.05.

With regard to teaching experiences, data shows that teachers with 5-8 years of teaching experience are identified as having the highest self-efficacy (M = 3.98). Furthermore, teachers' self-efficacy based on educational level revealed that those who were pursuing master's degrees have the highest mean score (M = 4.17). Results are given in Table 5.9:

Table 5.9

Teachers' Self-Efficacy Mean Scores and Standard Deviation Based on Teaching Experiences

Scales	Teaching Experiences	N	Mean	Std. Deviation
Self-Efficacy	1-4	55	3.85	xx
	5-8	44	3.98	.36
	9-12	76	3.80	.43
	13-16	87	3.88	.53
	17-20	59	3.85	.51
	21-24	28	3.93	.46
	25-8	33	3.68	.41
	28>	41	3.66	.40

Scales	Teaching Experiences	N	Mean	Std. Deviation
	Diploma	5	3.71	.63
	Pursuing Bachelor	17	3.58	.37
	Bachelor	349	3.83	.44
	Pursuing Master	8	4.17	.57
	Master	64	3.94	.50

Note: Teachers with 5-8 years of teaching experience and teachers who were pursuing a master's degree were identified as having the highest self-efficacy.

One-way ANOVA analyses showed that there were statistically significant differences in teachers' self-efficacy based on teaching experiences (F = 3.355, sig = 0.001) and based on educational levels (F = 2.431, sig = 0.003). These findings suggested that teachers' teaching experience and their educational level were the only significant variables which affected their self-efficacy in integrating digital technology in teaching. Details are given in Table 5.10:

Table 5.10

Teachers' Self-Efficacy Level Based on Educational Background

ANOVA Table

		Sum of Squares	df	Mean Square	F	Sig.
Self-efficacy based on teaching experiences	Between Groups	2.794	4	.699	3.355	.001*
	Within Groups	91.195	438	.208		
	Total	**93.990**	**442**			
Self-efficacy based on educational level	Between Groups	3.585	7	.512	2.431	.003*
	Within Groups	87.428	415	.211		
	Total	**91.014**	**422**			

Note. Sig= $p<0.05$.

5.3.2 Teachers' Attitudes Towards the Use of Digital Technologies

Regarding the teachers' attitudes, a five-point Likert scale questionnaire was distributed to ask teachers' responses on the use of digital technology in teaching. what attitudes they feel when they use digital technology in the classroom. Descriptive statistics analyses revealed that teachers felt fairly positive attitudes towards digital technology integration as shown in their score rating in the survey. Their mean score was good, with M

= 3.76 and SD = 37. It suggested that their attitude level was above the mid-point of a 5-point scale. In addition, the mean scores for the attitudes subscales indicated that teachers had a positive response to the scales. Details are presented in Table 5.11:

Table 5.11

Mean Scores, Standard Deviations, and Reliability of Attitudes Subscales

Subscales	(α)	Mean	Std. Deviation
Willingness	0.90	3.91	.49
Anxiety	0.71	3.46	.58

Note. *N=482*.

In-depth analyses of teachers' attitudes towards digital technology integration revealed that teachers' mean scores were higher on the items of *willingness 4* (digital technology helps teachers create engaging, interesting, and well-designed classroom activities) and *willingness 1* (digital technology plays a critical role in contemporary education). Each was M= 4.07 and SD= .63, and M= 4.00 and SD= . 64. In addition, items on *Willingness 3* (digital technology helps teachers manage their classrooms efficiently) and *Willingness 2* (digital technology is a useful means to attain educational goals) also showed higher mean scores, with M = 3.99 and SD =.68, and with M = 3.96 and SD =.56 (See Table 5.12).

On the contrary, findings identified that items in *Anxiety 2* (teaching with digital technology is more complicated and takes more time) and *Anxiety 1* (digital technology turns teaching into a monotonous and mechanical process) had the lowest mean scores. Each scored with M= 3.18 and SD= . 89, and M= 3.17 and SD= .90 respectively. Overall, teachers believed that digital technology was important. They possessed a good willingness to use digital technology in teaching. This was suggested from the results, for example, that they considered digital technology to be critical in today's education and that digital technology helps them very much in designing engaging and interesting classroom activities.

However, teachers also admitted that digital technology may have some negative consequences if it is not treated wisely by teachers. Findings suggested that teachers may worry about the application of digital technology, which is more complicated and takes more time than conventional methods. In addition, they also could annoy with digital technology that may turn classroom activities into a monotonous and mechanical process.

Analyses on frequency distribution found that the most frequent responses chosen by respondents were "agree", "neutral" and "strongly agree" respectively. Each was chosen by 58.7% or 283 participants, 22.2% or 107 participants, and 12.3% or 59 participants. Besides, there was small number of respondents who responded "strongly disagree" and "disagree". These findings revealed that most of teachers had positive attitudes towards digital technology integration in teaching. For instance, many teachers agreed that digital technology enhances interaction and increases students' engagement (68.7%) and improves students' knowledge retention (70.3%). Furthermore, 23.7% respondents strongly agree that digital technology may be useful in designing the engaging and interesting classroom activities. The results also suggested that there were one third of the participants (33.6%) who responded "neutral" when they were asked whether digital technology would be more complicated and took more time than the conventional ways. Under the same item, there were 25% of responded who stated that they did not agree if digital technology is complicated and takes more time than the traditional methods. Details are presented in Table 5.12:

Table 5.12

Mean Scores of Attitudes Individual Items From the Highest To the Lowest and Its Descriptive Frequency

			Frequency (%)				
Subscales	**Mean**	**SD**	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
Willingness 4	4.07	.63	-	0.6	18.9	60.2	20.3
Willingness 1	4.00	.64	-	0.8	14.9	71.0	13.3
Willingness 3	3.99	.68	-	2.1	17.2	59.5	21.2
Willingness 2	3.96	.56	-	1.0	13.7	61.6	23.7
Willingness 6	3.87	.57	0.2	2.7	19.7	68.7	8.7
Anxiety 3	3.83	.75	-	1.5	18.7	70.3	9.5
Willingness 5	3.82	.61	-	3.9	25.3	61.0	9.8
Willingness 8	3.80	.66	0.4	2.5	24.1	62.4	10.6
Willingness 7	3.76	.67	2.5	23	32.2	39.0	3.3
Anxiety 4	3.64	.73	0.4	25.9	33.6	35.1	5.0
Anxiety 2	3.18	.89	0.6	5.6	17.6	61.6	14.5
Anxiety 1	3.17	.90	0.8	4.8	31.5	54.8	8.1

Note. N=482.

Further analyses on the difference of teachers' attitude towards digital technology integration according to demographic variables such as teacher professional program, ICT training during pre-service, and ICT training during in-service were examined by using independent sample t-test, while the difference of demographic variables based on teachers' professional experiences and teachers' level of education were examined by using one-way ANOVA. It was clearly seen that there were no statistically significance difference of the self-efficacy scale in terms of teacher professional program, ICT course during pre-service, and ICT course during in-service.

With regard to teaching experiences, data shows that teachers with teaching experience 9-12 years identified to have the highest self-efficacy (M=3.75). Furthermore, teachers' self-efficacy based on educational level revealed that those who were pursuing master degree have the highest mean score (M=3.86) (see Table 5.13). One-way ANOVA analyses showed that there was no statistically significant difference in teachers' attitude either based on teaching experiences or educational levels.

Table 5.13

Teachers' Attitude Means Score and Standard Deviation Based on Teaching Experiences and Educational Background

Scales	Teaching Experiences	N	Mean	Std. Deviation
Attitude	1-4	55	3.72	.38
	5-8	44	3.65	.31
	9-12	76	3.75	.35
	13-16	87	3.71	.34
	17-20	59	3.69	.38
	21-24	28	3.70	.37
	25-8	33	3.62	.29
	28>	41	3.66	.32
	Diploma	5	3.58	.30
	Pursuing Bachelor	17	3.54	.29
	Bachelor	349	3.73	.34
	Pursuing Master	8	3.86	.45
	Master	64	3.68	.34

Note. Teachers with 9-12 years teaching experiences and teachers who pursuing master degree were identified to have the highest attitude.

5.3.3 Summary of Research Question 1

Overall self-efficacy and attitudes level fall between 3 and 4 on a continuous Likertlg-type scale of measurement where (1) strongly disagree; (2) disagree; (3) neutral; (4) agree; and (5) strongly agree. The findings implied that teachers' self-efficacy and attitudes towards digital technology integration were good, where their mean scores were above the mid-point. Analyses also suggested that there were statistically difference on teachers' self-efficacy according to ICT training during pre-service, ICT training during in-service, teaching experiences, and educational background. However, there was no statistically difference on teachers' attitude with respect to the ICT training during pre-service, ICT training during in-service, teaching experiences, and educational background.

5.4 Research Questions 2

What are teachers' perceptions of their technological, pedagogical, and content knowledge (TPACK) in teaching?

Results for research question 2 were reported using frequency distributions, means, and standard deviations. The question was addressed by calculating the descriptive statistics (i.e. means and standard deviations) for each of the TPACK subscales.

In general, findings suggested that teachers' TPACK was good where they felt quite confident in all TPACK domains as shown in their score rating from the survey. All mean scores of the subscales ranged from 3.39 to 3.89 which provide a generally positive response to the scales. It was observed that teachers' Content Knowledge (CK) scored the highest among all subscales with M= 3.89 and SD= .45, while Pedagogical Knowledge (PK) was considered as the lowest with M= 3.39 and SD= .58. Details are presented in Table 5.14:

Table 5.14

Mean Scores, Standard Deviations, and Reliability Scores of TPACK Subscales

Subscales	(α)	Mean	Std. Deviation
Pedagogical Knowledge (PK)	.89	3.39	.58
Content Knowledge (CK)	.77	3.89	.45

Subscales	(α)	Mean	Std. Deviation
Technology Knowledge (TK)	.79	3.77	.41
Pedagogical Content Knowledge (PCK)	.90	3.85	.33
Technological Pedagogical Knowledge (TPK)	.94	3.57	.56
Technological Content Knowledge (TCK)	.90	3.57	.53
Technological Pedagogical Content Knowledge (TPACK)	.95	3.59	.54

Note. N=482.

In addition, results from descriptive analyses revealed that within Pedagogical Knowledge (PK) domain, the mean scores' differences among the items were very small. Item of "I know the teaching methods to encourage students communicating effectively" (PK4) showed to have the highest score with M= 3.81 and SD= .45 and subsequently followed by item of "I know the teaching methods to support the student's problem solving skills" (PK6) with M= 3.79 and SD= .46. Besides, item of "I know the teaching methods to guide students working collaboratively" (PK3) was recognized as the lowest score with M=3.74 and SD= .50. This may be understood that teachers were positive with their Pedagogical Knowledge as identified by their mean scores which ranged from M= 3.74 to 3.81 and SD=. 50 to .45.

Further analyses on frequency distribution suggested that on average of 72.4 % of respondents preferred to choose "agree" as the most frequent responses with regard to Pedagogical Knowledge (PK). Another 24.5 % of respondendts chose to be neutral, and there were very small number of participants who chose categories such as "strongly disagree", "disagree", or "strongly agree". These may have revealed that most of respondents agreed that they were confident with their PK in teaching. Details are presented in Table 5.15:

Table 5.15

Mean Scores of PK Individual Items From the Highest to the Lowest and Its Descriptive Frequency

Pedagogical Knowledge (PK)		Mean	SD	Frequency (%) Strongly disagree	Disagree	Neutral	Agree	Strongly agree
PK4	(I know the teaching methods to encourage students communicating effectively)	3.81	.45	-	0.2	20.7	76.8	2.3
PK6	(I know the teaching methods to support the student's problem solving skills)	3.79	.46	-	0.2	22.8	74.5	2.5
PK5	(I know the teaching methods to guide students planning their own learning)	3.75	.46	-	0.4	24.5	72.8	2.3
PK3	(I know the teaching methods to guide students working collaboratively)	3.74	.50	-	-	25.7	72.8	1.5
Total Score				-	**1.2**	**24.5**	**72.4**	**1.9**

Note. *N=482.*

With respect to Content Knowledge (CK) subscale, teachers self-rated themselves that they "know the basic theories and concepts of the subject the teach" (CK2) as the highest score from all three items of the subscale, at the same time they rated item of "I have sufficient knowledge in developing contents in the subject I teach" (CK1) to be the smallest score within the subscale. The scores were M= 4.05 and SD= .53 and M= 3.72 and SD= .59 respectively. Overall, teachers' Content Knowledge (CK) confidence level was satisfying. Teachers were optimist that they master the basic theories and concept of the subject they teach at school.

Analyses on frequency distribution revealed that majority of respondents agreed that they mastered Content Knowledge (CK) with the percentage of 69.7%, and another 18.7 % identified themselves to be neutral. There were very small number of participants who chose categories such as "strongly disagree", "disagree", or "strongly agree". These may have revealed that most of respondents agreed that they were confident with their CK in teaching. Details are presented in Table 5.16:

Table 5.16

Mean Scores of CK Individual Items From the Highest To the Lowest and Its Descriptive Frequency

Content Knowledge (PK)	Mean	SD	Frequency (%)				
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree
CK2 (I know the basic theories and concepts of the subject I teach)	4.05	.53	-	2.7	27.6	64.5	5.2
CK3 (I know the history and development of important theories in the subject I teach)	3.90	.52	-	0.4	10.6	72.2	16.8
CK1 (I have sufficient knowledge in developing contents in the subject I teach)	3.72	.59	-	0.4	18.0	72.6	8.3
Total Score			**-**	**1.1**	**18.7**	**69.7**	**10.1**

Note. N=482.

Descriptive analyses on Technological Knowledge (TK) domain found that teachers perceived that they "know several digital technologies which benefit teaching and learning" (TK4) as the highest mean score of the subscale. In addition to that, they agreed that they "are familiar with new digital technologies and their features which benefit teaching and learning" (TK2) with M= 3.41 and SD= .71. However, they rated that they can solve digital technology related problems" as their lowest score with M= 3.16 and SD= .73.

Frequency distribution findings showed that 44.6% of participants agreed that they know Technological Knowledge (TK) in teaching. Furthermore, 42.4% of respondents chose “neutral” category and only some of participants chose categories such as "strongly disagree", "disagree", or "strongly agree". These may have revealed that almost half of respondents agreed that they were confident with their TK in teaching. Details are presented in Table 5.17:

Table 5.17

Mean Scores of TK Individual Items From the Highest To the Lowest and Its Descriptive Frequency

Technological Knowledge (TK)		Mean	SD	Frequency (%)				
				Strongly disagree	Disagree	Neutral	Agree	Strongly agree
TK4	(I know several digital technologies which benefit teaching and learning)	3.59	.59	0.2	18.3	48.1	32.0	1.5
TK2	(I am familiar with new digital technologies and their features which benefit teaching and learning)	3.41	.71	-	9.5	43.2	43.4	3.9
TK1	(I can solve digital technology related problems)	3.16	.73	-	3.1	36.1	58.5	2.3
Total Score				**0.06**	**10.3**	**42.4**	**44.6**	**2.5**

Note. N=482

In general, from the rating of Pedagogical Content Knowledge (PCK) domain, it was observed that there were very small discrepancies in the average of mean scores among the measured items. Teachers agreed that they "know how to encourage students to communicate effectively in the classroom" (PCK4) which was considered as the highest score with the M=3.87 and SD= .37. Likewise, teachers were confident that they know how to support students' creative thinking in the subject they teach (PCK2), know how to guide students to plan their own learning in the classroom (PCK5), know how to support students' problem-solving skills in the subject they teach (PCK6), and know how to guide students to work collaboratively on the subject they teach (PCK3). They also agreed that they can know how to support students' critical thinking in the subject I teach (PCK1) even though it was their lowest score within the subscale with the mean score of M=3.79 and SD= .44.

Frequency distribution showed that 81% of participants agreed that they know Pedagogical Content Knowledge (PCK) in teaching, while 16.6% of respondents were "neutral". Other categories were rarely chosen by participants. These may have revealed that majority of respondents agreed that they were confident with their PCK in teaching. Details are presented in Table 5.18:

Table 5.18

Mean Scores of PCK Individual Items From the Highest To the Lowest and Its Descriptive Frequency

Pedagogical Content Knowledge (PCK)	Mean	SD	Frequency (%) Strongly disagree	Disagree	Neutral	Agree	Strongly agree
PCK4 (I know how to encourage students to communicate effectively in my classroom)	3.87	.37	-	0.2	21.6	76.8	1.5
PCK2 (I know how to support students' creative thinking in the subject I teach)	3.87	.39	-	0.4	13.7	84.2	1.7
PCK5 (I know how to guide students to plan their own learning in my classroom)	3.86	.42	-	-	17.4	81.5	1.0
PCK6 (I know how to support students' problem-solving skills in the subject I teach)	3.86	.43	-	-	13.9	84.2	1.9
PCK3 (I know how to guide students to work collaboratively on the subject I teach)	3.83	.39	-	-	16.8	80.3	2.9
PCK1 (I know how to support students' critical thinking in the subject I teach)	3.79	.44	-	0.2	16.6	79.7	3.5
Total Score			-	**0.13**	**16.6**	**81.1**	**2.0**

Note. N=482.

Similar to Pedagogical Content Knowledge (PCK), the differences of mean scores among the items for TPK domain were very small. All items' mean scores ranged from 3.62 to 3.53. Item on "I know how to use digital technology as an effective tool for student communication" (TPK4) was rated with the highest mean score (M=3.62 and SD= .55). On the other hand, the lowest rated score was item on "I know how to use digital technology as a tool for students' critical thinking" (TPK1) with M=3.53 and SD= .61. These results revealed that teachers were confidence with their Technological Pedagogical Knowledge (TPK) skill. Furthermore, frequency distribution showed that more than a half of participants agreed that they know TPK in teaching, while 35% of respondents preferred to choose "neutral" category. Other categories were rarely chosen by participants. Details are presented in Table 5.19:

Table 5.19

Mean Scores of TPK Individual Items From the Highest To the Lowest and Its Descriptive Frequency

Tecgnological Pedagogical Knowledge (TPK)	Mean	SD	Frequency (%)				
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree
TPK4 (I know how to use digital technology as an effective tool for student communication)	3.62	.55	-	6.0	35.5	57.9	0.6
TPK6 (I know how to use digital technology as a tool for support students' problem-solving)	3.57	.63	-	5.4	34.0	59.3	1.2
TPK5 (I know how to use digital technology as a tool for students to plan their own learning)	3.57	.62	-	3.7	38.0	57.3	1.0
TPK2 (I know how to use digital technology as a tool for students' creative thinking)	3.56	.61	-	2.1	35.1	61.0	1.9
TPK3 (I know how to use digital technology as a tool for sharing ideas and working collaboratively)	3.55	.58	-	5.4	34.0	58.5	2.1
TPK1 (I know how to use digital technology as a tool for students' critical thinking)	3.53	.61	0.2	4.8	34.2	58.5	2.3
Total Score			**0.3**	**4.5**	**35.1**	**58.7**	**1.5**

Note. N=482

For Technological Content Knowledge (TCK) domain, findings suggested that teachers' agreed that they "know digital technology which can enable them to make self-learning in the subject they teach"(TCK2) as the highest mean score (M= 3.69 and SD= .58). They perceived that "they know digital technologies which are used by professionals in the subject they teach" as the lowest mean score (M= 3.43 and SD= .69). In addition, analyses on frequency distribution showed that 57.2% of participants agreed that they know TCK in teaching, while 34% of respondents were "neutral". Other categories were only chosen by a small number of participants. Details are presented in Table 5.20:

Table 5.20

Mean Scores of TCK Individual Items From the Highest To the Lowest and Its Descriptive Frequency

Technological Content Knowledge (TCK)	Mean	SD	Frequency (%)				
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree
TCK2 (I know digital technology which can enable me self-learning in the subject I teach)	3.69	.58	-	3.5	28.8	63.9	3.7
TCK1 (I know websites with materials suitable for studying the subject I teach)	3.67	.60	-	2.9	28.4	64.9	3.7
TCK4 (I know digital technologies which I can use to illustrate difficult contents in the subject I teach)	3.49	.66	0.2	8.7	40.9	47.5	2.7
TCK3 (I know digital technologies which are used by professionals in the subject I teach)	3.43	.69	-	7.3	38.0	52.7	2.1
Total Score			**0.05**	**5.6**	**34.0**	**57.2**	**3.0**

Note. N=482

The last domain of TPACK measured in this study was Technological Pedagogical Content Knowledge (TPCK). It is the combination three different types of knowledge; technological, pedagogical, and content knowledge, which was the core domain. These combined domains were more complex to understand. Item of "I know how to use digital technology to deliver specific subject content as a tool for students' problem-solving" was rated as the highest mean score (M=3.62, SD= .63) by the participants. On the contrary, item of "I know how to use digital technology to deliver specific subject content as a tool for students' creative thinking " was to be the smallest mean score rated by teachers with M= 3.56 and SD= .59. Generally, there was not significant disparity of mean scores among Technological Pedagogical Content Knowledge (TPCK) domain. The mean scores ranged from 3.62 to 3.56. It revealed that teachers' Technological Pedagogical Content Knowledge (TPCK) confident was good.

Further analyses on frequency distribution suggested that on average of 63% (304 respondents) of respondents preferred to choose "agree" as the most frequent responses with regard to Technological Pedagogical Content Knowledge (TPACK) measurement. The second most common responses chose by participants of this study was "neutral" with 29.7% (143 respondents). Other categories such as "strongly disagree", "disagree", and "strongly agree" were very rarely chosen by respondents with the percentage under 3.5% on average. Details are presented in Table 5.21:

Table 5.21

Mean Scores of TPCK Individual Items From the Highest To the Lowest and Its Frequency

Technological Pedagogical Content Knowledge (TPCK)		Mean	SD	Frequency (%) Strongly disagree	Disagree	Neutral	Agree	Strongly agree
TPACK6	(I know how to use digital technology to deliver specific subject content as a tool for students' problem-solving)	3.62	.63	-	2.1	39.2	56.6	2.1
TPACK5	(I know how to use digital technology to deliver specific subject content as a tool for students to plan their own learning)	3.61	.64	-	3.7	37.6	56.8	1.9
TPACK4	(I know how to use digital technology to deliver specific subject content as a tool for student communication)	3.60	.55	-	3.7	36.9	57.1	2.3
TPACK1	(I know how to use digital technology to deliver specific subject content as a tool for students' critical thinking)	3.58	.57	0.2	1.0	38.8	58.1	1.9

Technological Pedagogical Content Knowledge (TPCK)	Mean	SD	Frequency (%)				
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree
TPACK3 (I know how to use digital technology to deliver specific subject content as a tool for sharing ideas and working collaboratively)	3.57	.60	-	3.1	38.4	52.7	5.8
TPACK2 (I know how to use digital technology to deliver specific subject content as a tool for students' creative thinking)	3.56	.59	-	3.1	36.9	54.8	5.2
Total Score			**-**	**1.2**	**24.5**	**72.4**	**1.9**

Note. N=482.

In addition, Pedagogical Content Knowledge (PCK) domain was observed as the highest domain where 81.1% of respondents agreed that they had confidence level of Pedagogical Content Knowledge (PCK). The second domain which "agrees" largely selected by many respondents was Pedagogical Knowledge (PK). There were 73.8% of respondents who agreed that they possessed adequate Pedagogical Knowledge (PK). However, only 44.4% of respondents agreed that they know Technological Knowledge (TK). Under the same domain, there were 42% of respondents who answered "neutral" and 10.3% who disagreed that they were confident with their Technological Knowledge (TK). It suggested that teachers possessed fairly Technological Knowledge (TK) which still needs to be developed.

Further analyses on the difference in teachers' TPACK according to demographic variables such as teacher professional program, ICT training during pre-service, and ICT training during in-service were examined by using an independent sample t-test, while the difference based on teachers' professional experiences and teachers' level of education was examined by using a one-way ANOVA.

Based on the variable of teacher's professional program, it was clearly seen that there was only one statistically significant difference on the TPACK's subscales which was Pedagogical Knowledge (PK), between those who have taken the teacher's professional program ($N = 270$, $M = 3.81$, $SD = .383$, $t = 2.632$, $df = 439$, $sig = .009 < 0.05$) and those who have not taken the program (N = 171, M = 3.71, SD =.410). Other TPACK's subscales showed to have no significance difference. Results are given in Table 5.22:

Table 5.22

Teachers' TPACK Difference by Teacher's Professional Program

Scales	Teacher Professional Program	N	M	SD	t	df	Sig
TK	Completed the program.	270	3.40	.62	-1.241	439	.215
	Have not completed the program.	171	3.47	.50			
CK	Completed the program.	270	3.82	.44	0.180	439	.857
	Have not completed the program.	171	3.81	.39			
PK	Completed the program.	270	3.81	.38	2.632	439	.009*
	Have not completed the program.	171	3.71	.41			
PCK	Completed the program.	270	3.86	.32	1.585	439	.114
	Have not completed the program.	171	3.81	.36			
TCK	Completed the program.	270	3.54	.56	-1.453	439	.147
	Have not completed the program.	171	3.62	.55			
TPK	Completed the program.	270	3.55	.54	-0.603	439	.547
	Have not completed the program.	171	3.58	.52			
TPCK	Completed the program.	270	3.58	.57	-0.712	439	.477
	Have not completed the program.	171	3.62	.48			

Note. *Sig=p<0.05.*

In terms of the variable of ICT course during pre-service, the data showed that there was no statistically significant difference in the TPACK's subscales between those who took the program and those who did not take the program. Results are given in Table 5.23:

Table 5.23

Teachers'TPACK Difference by ICT Course During Pre-Service

Scales	ICT course during pre-service	N	M	SD	t	df	Sig
TK	Take the program.	100	3.52	.53	1.680	439	.094
	Did not take the program	341	3.40	.59			
CK	Take the program.	100	3.80	.43	-.552	439	.581
	Did not take the program	341	3.82	.42			
PK	Take the program.	100	3.78	.39	.231	439	.817
	Did not take the program	341	3.77	.39			
PCK	Take the program.	100	3.80	.37	-1.408	439	.160
	Did not take the program	341	3.85	.33			
TCK	Take the program.	100	3.59	.53	.133	439	.894
	Did not take the program	341	3.58	.57			
TPK	Take the program.	341	3.55	.54	1.155	439	.249
	Did not take the program	100	3.59	.53			
TPCK	Take the program.	341	3.61	.55	-.421	439	.674
	Did not take the program	100	3.52	.53			

Note. Sig=p<0.05

With regard to the variable of ICT course during in-service, data shows that there was no statistically significant difference in the TPACK's subscales between those who took the program and those who did not take the program. Results are given in Table 5.24:

Table 5.24

Teachers' TPACK Difference by ICT Course During In-Service

Factor	ICT course during in-service	N	M	SD	t	df	Sig
TK	Take the program.	142	3.50	.54	1.666	439	.096
	Did not take the program	299	3.40	.59			
CK	Take the program.	142	3.80	.39	-.427	439	.669
	Did not take the program	299	3.82	.44			
PK	Take the program.	142	3.82	.38	1.687	439	.092
	Did not take the program	299	3.75	.40			
PCK	Take the program.	142	3.87	.30	1.370	439	.171
	Did not take the program	299	3.83	.35			
TCK	Take the program.	142	3.60	.50	.641	439	.522
	Did not take the program	299	3.57	.59			
TPK	Take the program.	142	3.59	.53	.832	439	.406
	Did not take the program	299	3.54	.54			
TPCK	Take the program.	142	3.62	.48	.539	439	.591
	Did not take the program	299	3.59	.57			

Note. Sig=p<0.05

With regard to the variable of teaching experiences, data shows that within Technological Knowledge subscale (TK), teachers with teaching experience 5-18 years were identified to have the highest score (M=3.63), within Content Knowledge (CK), teachers with teaching experiences 13-16 years were scored the highest score (M=3.91), within Pedagogical Knowledge (PK), teachers with teaching experiences 28> years were reported to have the highest score (3.87), within Pedagogical Content Knowledge (PCK), teachers with teaching experiences 17-20 years showed to have the highest score (M=3.92), within Pedagogical Content Knowledge (TCK), teachers with teaching experiences 5-8 years were scored the highest score (M=3.75), within Technological Pedagogical Knowledge (TPK), teachers with teaching experiences 5-8 years were scored the highest score (M=3.78), and within Technological Pedagogical Content Knowledge (TPCK), teachers with teaching experiences 5-8 years were scored the highest score (M=3.79). Results are given in Table 5.25:

Table 5.25

Teachers' TPACK Difference by Teaching Experiences

Factor	Teaching Experiences	N	Mean	Std. Deviation
TK	1-4	55	3.51	.49
	5-8	44	3.63	.41
	9-12	76	3.43	.44
	13-16	80	3.45	.62
	17-20	59	3.41	.60
	21-24	28	3.38	.58
	25-8	33	3.33	.81
	28>	41	3.20	.65
CK	1-4	55	3.80	.49
	5-8	44	3.77	.37
	9-12	76	3.78	.40
	13-16	80	3.91	.42
	17-20	59	3.90	.40
	21-24	28	3.69	.39
	25-8	33	3.74	.46
	28>	41	3.75	.47
PK	1-4	55	3.69	.40
	5-8	44	3.79	.40
	9-12	76	3.73	.38
	13-16	80	3.77	.38
	17-20	59	3.79	.42
	21-24	28	3.74	.42
	25-8	33	3.85	.38
	28>	41	3.87	.39
PCK	1-4	55	3.76	.40
	5-8	44	3.83	.29
	9-12	76	3.81	.36
	13-16	80	3.85	.31
	17-20	59	3.92	.29
	21-24	28	3.83	.32
	25-8	33	3.85	.36
	28>	41	3.87	.32

Factor	Teaching Experiences	N	Mean	Std. Deviation
TCK	1-4	55	3.64	.55
	5-8	44	3.75	.37
	9-12	76	3.52	.58
	13-16	80	3.57	.55
	17-20	59	3.62	.56
	21-24	28	3.58	.51
	25-8	33	3.36	.69
	28>	41	3.42	.65
TPK	1-4	55	3.59	.47
	5-8	44	3.78	.36
	9-12	76	3.47	.53
	13-16	80	3.54	.61
	17-20	59	3.60	.55
	21-24	28	3.60	.47
	25-8	33	3.52	.54
	28>	41	3.32	.61
TPCK	1-4	55	3.65	.54
	5-8	44	3.79	.38
	9-12	76	3.52	.51
	13-16	80	3.60	.57
	17-20	59	3.62	.61
	21-24	28	3.56	.47
	25-8	33	3.61	.59
	28>	41	3.45	.55

Note. Teachers' TPACK level according to teaching experiences

One-way ANOVA analyses showed that within TPACK subscales, there were statistically significant differences in teachers' technological Knowledge (TK) based on teaching experiences ($F=2.105$, $p=0.004<0.05$) and teachers' technological pedagogical knowledge (TPK) based on teaching experiences ($F=2.667$, $p=0.001<0.05$). Other subscales were found to be not significant statistically. Details are given in Table 5.26:

Table 5.26

Teachers' TPACK Difference by Teaching Experiences

ANOVA Table

		Sum of Squares	df	Mean Square	F	Sig.
TK based on teaching experiences	Between Groups	4.908	7	.701	2.105	.004*
	Within Groups	138.257	415	.333		
	Total	**143.165**	**422**			
CK based on teaching experiences	Between Groups	2.123	7	.303	1.639	.123
	Within Groups	76.764	415	.185		
	Total	**78.887**	**422**			
PK based on teaching experiences	Between Groups	1.245	7	.178	1.136	.339
	Within Groups	64.984	415	.157		
	Total	**66.230**	**422**			
PCK based on teaching experiences	Between Groups	0.828	7	.118	1.034	.407
	Within Groups	47.482	415	.114		
	Total	**48.310**	**422**			
TCK based on teaching experiences	Between Groups	4.336	7	.619	1.934	.063
	Within Groups	132.938	415	.320		
	Total	**137.274**	**422**			
TPK based on teaching experiences	Between Groups	5.423	7	.775	2.667	.001*
	Within Groups	120.539	415	.290		
	Total	**125.962**	**422**			
TPCK based on teaching experiences	Between Groups	3.141	7	.449	1.525	.157
	Within Groups	122.093	415	.294		

Note. *Sig=p<0.05*

In addition, based on teachers' educational level, data showed that teachers who were pursuing master degree reported to have the highest mean score in all TPACK subscales (TK: M=3.93, CK: M=3.93, PK: M=4.02, PCK: M=4.02, TCK: M=3.87, TPK: M=3.79, TPCK: M=3.81). Details are presented in Table 5.27:

Table 5.27

Teachers' TPACK Difference by Background

Factor	Educational level	N	Mean	Std. Deviation
TK	Diploma	5	3.50	.68
	Pursuing Bachelor	17	3.79	.45
	Bachelor	349	3.80	.42
	Pursuing master	8	3.93	.60
	Master	64	3.88	.45
CK	Diploma	5	3.75	.39
	Pursuing Bachelor	17	3.79	.46
	Bachelor	349	3.80	.42
	Pursuing master	8	3.93	.60
	Master	64	3.88	.45
PK	Diploma	5	3.38	.29
	Pursuing Bachelor	17	3.64	.39
	Bachelor	349	3.76	.39
	Pursuing master	8	4.02	.42
	Master	64	3.87	.38
PCK	Diploma	5	3.66	.47
	Pursuing Bachelor	17	3.79	.40
	Bachelor	349	3.84	.33
	Pursuing master	8	4.02	.45
	Master	64	3.87	.30
TCK	Diploma	5	3.55	.59
	Pursuing Bachelor	17	3.50	.69
	Bachelor	349	3.56	.56
	Pursuing master	8	3.87	.51
	Master	64	3.69	.52
TPK	Diploma	17	3.60	.56
	Pursuing Bachelor	349	3.59	.60
	Bachelor	8	3.53	.53
	Pursuing master	64	3.79	.52
	Master	5	3.67	.53
TPCK	Diploma	5	3.76	.32
	Pursuing Bachelor	17	3.64	.67
	Bachelor	349	3.57	.54
	Pursuing master	8	3.81	.53
	Master	64	3.75	.52

Note: Teachers' TPACK level according to educational level

One-way ANOVA analyses showed that within TPACK subscales, there was only a statistically significant difference in teachers' pedagogical knowledge (TK) based on educational level ($F = 2.482$, $p = 0.004 < 0.05$). Other subscales were found to be not significant statistically. Details are given in Table 5.28:

Table 5.28

Teachers' TPACK Difference by Educational Level

ANOVA Table

		Sum of Squares	df	Mean Square	F	Sig.
TK based on Educational Level	Between Groups	2.085	4	.521	1.545	.188
	Within Groups	147.740	438	.337		
	Total	**149.824**	**442**			
CK based on Educational Level	Between Groups	0.469	4	.117	0.632	.640
	Within Groups	81.193	438	.185		
	Total	**81.662**	**442**			
PK based on Educational Level	Between Groups	1.540	4	.385	2.482	.004*
	Within Groups	67.926	438	.155		
	Total	**69.466**	**442**			
PCK based on Educational Level	Between Groups	0.518	4	.129	1.114	.349
	Within Groups	50.890	438	.116		
	Total	**51.408**	**442**			
TCK based on Educational Level	Between Groups	1.794	4	.448	1.397	.234
	Within Groups	140.595	438	.321		
	Total	**142.389**	**442**			
TPK based on Educational Level	Between Groups	1.558	4	.390	1.333	.257
	Within Groups	128.020	438	.292		
	Total	**129.579**	**442**			
TPCK based on Educational Level	Between Groups	2.327	4	.582	1.967	.099
	Within Groups	129.568	438	.296		
	Total	**131.895**	**442**			

Note. Sig=p<0.05

5.4.1 Summary of Research Question 2

Overall, teachers' self-rated technological pedagogical content knowledge (TPACK) was between 3 and 4 on a Likert-type scale of measurement. The results from descriptive analyses (mean, standard deviation, and frequency) suggested teachers' TPACK level was moderately confident (M = 3.6 and SD =.36), where their mean scores were above the mid-point. Findings also implied that, from the seven domains of TPACK, teachers' confidence level in their content knowledge (CK) was the highest. Analyses on the difference in teachers' TPACK according to demographic variables such as their teacher professional program, their ICT training during pre-service, and their ICT training during in-service were also examined by using independent t-tests and one-way ANOVA.

5.5 Research Questions 3

In what ways do teachers' self-efficacy and attitudes toward the use of digital technologies affect their use of technological, pedagogical, and content knowledge (TPACK)?

In addressing this research question, regression analysis was used to examine the relationship among teachers' self-efficacy, attitudes, and technological pedagogical content knowledge (TPACK). Besides, the strength of the relationship among the variables was also investigated.

Findings suggested that there was a significant relationship between the variables. Table 5.29 describes the correlation matrix among the dependent variables, self-efficacy and attitudes, and the independent variable, technological pedagogical content knowledge (TPACK). There was a positive correlation between self-efficacy and Technological Pedagogical Content Knowledge (TPACK) (r = .54) and a weak correlation between attitudes and Technological Pedagogical Content Knowledge (TPACK) (r = .49). This correlation revealed that teachers' self-efficacy and attitudes towards digital technology integration were significantly related to their technological pedagogical content knowledge (TPACK). In other words, teachers' self-efficacy and positive attitudes toward integrating digital technology play an important role in teaching. Specifically, self-efficacy was the strongest predictor of teachers' TPACK. Details are presented in Table 5.29:

Table 5.29

Pearson Correlation among Self-Efficacy, Attitudes, and TPACK

Variables		**Self-Efficacy**	**Attitudes**	**TPACK**
Self-Efficacy	Pearson Correlation	1	.498**	.549**
	Sig. (2-tailed)		.000	.000
	N		482	482
Attitudes	Pearson Correlation		1	.342**
	Sig. (2-tailed)			.000
	N			482
TPACK	Pearson Correlation			1
	Sig. (2-tailed)			
	N			

Note. **. The correlation is significant at the 0.01 level (2-tailed).

In addition, the extent to which self-efficacy and attitudes towards digital technology integration predict technological pedagogical content knowledge (TPACK) was carried out by employing multiple regression tests. The ANOVA test was used to determine the effect of the independent variables on the dependent variable. Results identified that there was an effect of teachers' self-efficacy and attitudes towards digital technology integration on their TPACK (p =.000.05). Details are presented in Table 5.30:

Table 5.30

ANOVA: Predicting the Relationship Between TPACK and A Subset of Independent Variables

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	20.006	2	10.003	106.253	.000[b]
	Residual	45.094	479	0.094		
	Total	**65.100**	**481**			

[a] (significant, p 0.05)
[b] Dependent Variable: TPACK
[c] Predictors: (constant), attitudes, self-efficacy

Furthermore, findings from multiple regressions analyses also revealed that the results are statistically significant (p=.000 < 0.05). These findings suggested that teachers' self-efficacy and attitudes towards digital technology integration do predict teachers' technological pedagogical content knowledge (TPACK) in their classroom. This revealed that teachers with more self-efficacy and positive attitudes towards digital technology integration possessed better TPACK. Details are presented in Table 5.31:

Table 5.31

Multiple Regressions: The Relationship Between TPACK and a Subset of Independent Variables

		Unstandardized Coefficients		Standardized Coefficients		
Model		**B**	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	1.768	.151		11.688	.000
	Self-Efficacy	0.407	.035	.503	11.474	.000*
	Attitudes	0.089	.043	.091	2.077	.038*

[a] (significant, p 0.05)
[b] Dependent Variable: TPACK

Further analyses were done to examine whether independent variables such as level of education, teaching experience, and completion of the teacher professional program (PPG), completion of ICT courses during pre-service, and completion of ICT courses during in-service were significantly affecting teachers' self-efficacy, attitudes, and TPACK.

5.5.1 Teachers' Self-efficacy

Findings revealed that level of education and teaching experience showed to have significant effect on teacher's self-efficacy (p= 0.002<0.05 and p= 0.006<0.05). These findings suggest that a teacher's level of education and teaching experience predict a teacher's self-efficacy towards digital technology integration. However, teacher professional program teacher's, ICT training during pre-service and teacher's ICT training during in-service were not significantly affect teacher's self-efficacy (p=.121>0.05, p= 0.064>0.05, and p= 0.326>0.05). Details are presented in Table 5.32:

Table 5.32

Multiple Regressions: The Relationship between Self-Efficacy and a Subset of Independent Variables

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.973	.139		28.570	.000
	Level of education	.084	.027	.143	3.104	.002*
	Teaching Experience	-.007	.003	-.135	-2.765	.006*
	Teacher Professional Program	-.026	.017	-.074	-1.552	.121
	ICT training during pre-service	-.101	.054	-.095	-1.857	.064
	ICT training during in-service	-.047	.048	-.049	-.983	.326

[a] (significant, p 0.05)
[b] Dependent Variable: Self-Efficacy

5.5.2 Teachers' Attitude

Regression analysis suggested that none of the predictors (level of education, teaching experience, teacher professional program, and ICT training during pre-service) significantly affect teachers' attitudes. Details are presented in Table 5.33:

Table 5.33

Multiple Regressions: The relationship Between Attitudes and a Subset of Independent Variables

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.781	.118		31.983	.000
	Level of education	0.035	.023	.071	1.513	.131
	Teaching Experience	-0.002	.002	-.044	-0.877	.381
	Teacher Professional Program	0.005	.014	.016	0.329	.742
	ICT training during pre-service	0.004	.046	.005	0.090	.928
	ICT training during in-service	-0.069	.041	-.087	-1.694	.091

Note. Dependent Variable: Attitudes

5.5.3 Teachers' TPACK

Findings suggested that among six independent variables (level of education, teaching experience, teacher professional program, and ICT training during pre-service), there was only one variable that significantly predicted the dependent variable (TPACK). The variable was level of education ($p = 0.004<0.05$). It can be understood that teachers with a higher level of education may have a higher level of TPACK. Details are presented in Table 5.34:

Table 5.34

Multiple Regressions: The Relationship between TPACK and a Subset of Independent Variables

		Unstandardized Coefficients		Standardized Coefficients		
Model		**B**	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	3.609	.113		31.797	.000
	Level of education	0.055	.022	.116	2.465	.004*
	Teaching Experience	-0.003	.002	-.079	-1.586	.113
	Teacher Professional Program	0.006	.014	.023	0.469	.639
	ICT training during pre-service	-0.007	.044	-.008	-0.156	.876
	ICT training during in-service	-0.043	.039	-.056	-1.094	.275

[a] (significant, p 0.05)
[b] Dependent Variable: TPACK

5.5.4 Summary of Research Question 3

Overall, Pearson correlation analyses found that teachers' self-efficacy and attitudes towards digital technology integration positively correlate with their technological pedagogical content knowledge (TPACK). Findings also revealed that self-efficacy and attitudes significantly predict teachers' TPACK. Thus, it was clear that statistically, self-efficacy and attitudes significantly affect teachers' TPACK to some degree. Teachers with higher self-efficacy and attitudes believed that they had a higher TPACK in teaching. However, independent variables such as teaching experience, teacher professional program, ICT training during pre-service, and ICT training during in-service were not significantly predict teachers' TPACK. The only variable that predicted TPACK was the teacher's level of education. More elaboration with respect to research question 3 (in what ways do teachers' self-efficacy and attitudes towards digital technology integration affect teachers' technological pedagogical content knowledge (TPACK)?) will be discussed in the next chapter.

5.6 Research Questions 4

What are the factors that promote or inhibit digital technology use in the classroom?

Descriptive analyses were carried out to address this research question. Teachers were asked to examine a list consisted of some barriers that could be possible making them difficult to integrate digital technology in teaching. The berries as mentioned in the literature included: (1) lack of ICT training from the school; (2) lack of ICT facilities at the school; (3) lack of ICT access at the school; (4) lack of teacher's ICT knowledge and skills; (5) lack of ICT technical support at the school; (6) poor internet connection; (7) lack of time for ICT use in teaching; (8) uninformed principles about digital technology; and (9) the school's incomplete digital technology plan.

Lack of ICT Training

Overall, findings from descriptive analyses suggested that lack of ICT training was the most common response given by respondents with respect to barriers to digital technology use in teaching. There were 78.2% of respondents (377) who agreed that lack of ICT training was one of the factors inhibiting the use of digital technology. Only 21.8 percent of participants (105) considered that a lack of ICT training could prevent them from using digital technology for teaching. It can be understood since results from descriptive analyses of participants' background information in relation to participants' ICT training during pre-service and in-service also showed that most of them never got the training (77%). This finding suggested that providing appropriate and sufficient ICT training is important to increase teachers' ICT skills.

Lack of ICT Facilities

With reference to the barrier of a lack of ICT facilities, the number of participants who agreed and did not agree was not very different. The agreed group believed that lack of ICT facilities may bother them from integrating digital technology in teaching (47.1% or 227 respondents). On the other hand, its counterpart considered that it did not restrict their activities in using digital technologies as all (52.9% or 255 participants). This finding may reveal that some schools may have good ICT facilities, while others may need to receive more ICT facilities.

Lack of ICT Access

Results revealed that more than 50% of respondents acknowledged that lack of ICT facilities was not an issue in digital technology integration at school. They did not agree if lack of facilities was regarded as one of the barriers (55.4% or 267 respondents). However, another 44.6% (215) of respondents considered that lack of ICT access made them difficult to use the digital technology. Thus, they admitted it as the barrier in digital technology integration.

Lack of Teachers' ICT Knowledge and Skills

Furthermore, teachers also admitted that they possessed insufficient ICT knowledge and skills, which may discourage them from using the technology in teaching, though the number was not that high (58.5% of participants, or 282). On the contrary, 41.5% of participants did not believe that they lacked the ICT knowledge and skills necessary for teaching, which affect digital technology integration.

Lack of ICT Technical Support

Lack of ICT technical support was considered one of the barriers to digital technology integration by more than half of the participants. Their percentage was 53.9% (257 respondents) in comparison with those who considered that it was not the barrier (46.1%, or 222 respondents). This finding revealed that technical support is important in order to successfully integrate digital technology into the curriculum.

Poor Internet Connection

Poor internet connection was observed by more than 50% of the participants as one of the obstacles they face when using digital technology. They agreed that it may limit the effectiveness of digital technology use in the classroom. Yet, there were 47.3% (228 participants) who thought they had no issues with their internet connection. Therefore, they did not include an internet connection as the barrier that fit their real problem with using digital technology.

Lack of Time for ICT Use in Teaching

Findings revealed that lack of time for ICT use in teaching was considered one of the obstacles faced by teachers in the use of digital technology in teaching. 53.3% (257) of respondents answered that they agreed that a lack of time may hinder them from using digital technology in the classroom. While 46.7% (225) of the respondents stated that they did not find it a difficulty while utilizing digital technology for teaching,

Uninformed Principals About Digital Technology

Findings also suggested that the majority of respondents (89.9%, or 433) believed that uninformed principals about digital technology did not have any relation to digital technology integration. In other word, they disagreed if poorly educated principals on digital technology was one of the obstacles faced by teachers. However, there were a small number of respondents who believe that uninformed principals about digital technology may contribute to the obstacles teachers face in teaching (10.2% or 49 respondents).

School's Incomprehensive Digital Technology Plan

Similarly, most of the respondents did not see that their schools had an incomprehensive digital technology plan, which may hinder the integration of technology in the classroom (89.9%, or 433 respondents). Only a few of them (15.4% or 74 participants) thought that their schools had an incomplete digital technology plan that restricted its integration in the classroom. Details are presented in Table 5.35:

Table 5.35

The Frequency of Barriers to Digital Technology Integration

Statements	Frequency (%)	
	Agree	**Disagree**
Lack of ICT training from the school	78.2	21.8
Lack of ICT facilities at the school	47.1	52.9
Lack of ICT access at the school	44.6	55.4
Lack of teachers' ICT knowledge and skills	58.5	41.5
Lack of ICT technical support at the school	53.9	46.1
Poor internet connection	52.7	47.3
Lack of time for ICT use in teaching	53.3	46.7
Uninformed principals about digital technology	10.2	89.9
School's incomprehensive digital technology plan	15.4	84.6

Note. N=482

5.6.1 Summary of Research Question 4

In general, the item "lack of ICT training from the school" was largely considered by participants as the first barrier to digital technology integration (78.2% or 377 respondents). They agreed that the "lack of ICT training from the school" may discourage them from using digital technology in teaching. The item "lack of teacher's ICT knowledge and skills" was subsequently agreed upon by more than half of respondents as the second obstacle to digital technology integration (58.5% or 282 respondents). In contrast, the items "uninformed principles about digital technology" and "the school's incomprehensive plan towards digital technology" were highly considered not to be part of the digital technology barriers. Most of respondents revealed that they did not see those two items as the problems with the percentage of 89.9% (433) and 84.6% (408) respectively. Thus, the findings suggested that "uninformed principals about digital technology" and "the school's incomprehensive digital technology plan" could be eliminated as barriers to digital technology integration. Table 5.36 shows the top seven barriers to digital technology integration suggested by this study:

Table 5.36

Frequency of Barriers From the Largest To the Smallest

Statements	Frequency (%)	
	Agree	**Disagree**
Lack of ICT training from the school	78.2	21.8
Lack of teachers' ICT knowledge and skills	58.5	41.5
Lack of ICT technical support at the school	53.9	46.1
Lack of time for ICT use in teaching	53.3	46.7
Poor internet connection	52.7	47.3
Lack of ICT facilities at the school	47.1	52.9
Lack of ICT access at the school	44.6	55.4

Note. N=482

5.7 Research Questions 5

What are the digital technologies used by teachers, and how are they being used in the classroom?

The research question 5 was addressed using descriptive statistics, and the results for this research question were reported using frequency distributions. Teachers were asked to identify a list of digital technologies that they may use in teaching. Besides, they were also asked to describe how often they use the technology (daily, biweekly, weekly, fortnightly, monthly, bimonthly, and never).

5.7.1 What Are the Digital Technologies Used By Teachers?

In general, findings from this study suggested that digital technologies in teaching were not something new for teachers. They used many different digital technologies in their classroom activities. In terms of hardware, digital technology such as laptops was used by almost all of the participants in their classroom (94.3% or 455 respondents) and was subsequently followed by those who used smartphones (84.6% or 408 respondents). There were only 16.15% (78) participants who stated that they took advantage of tablets for teaching.

Furthermore, with respect to the software, email and YouTube were the most popular digital technologies employed by participants. The percentages of participants who reported that they used email and YouTube were 83.8 percent (404) and 80.2% (387). Besides, 79.8% (385) of participants mentioned that they took advantage of Microsoft Office (Word, Excel, and PowerPoint) in teaching, and 74% (357) of them also stated that they got benefits from videoconferencing software to teach their students. Other tools such as a video/audio downloader, social media, interactive learning resources, games, and quizzes were also used by the majority of the participants (> 50%). Nevertheless, survey and learning feedback tools, teachers' productivity tools, and collaborative learning tools were not popular among the participants and used only by a small number of them, which was under 30%. Details are presented in Table 5.37:

Table 5.37

From the Largest To the Smallest, Frequency of Use of Digital Technologies

Digital technologies	Percent
Hardware	
Laptop	94.3
Smartphone	84.6
Personal Computer	42.7
Projector	35.8
Tablet	16.1
Software	
Email	83.8
YouTube	80.2
Microsoft Offices (Words, Excel, Power Point)	79.8
Video conferences	74.0
Video/audio downloader	73.4
Social medias	60.5
Interactive learning resources	56.0
Game and quiz	50.6
Cloud Storage	48.3
Teacher’s productivity	27.1
Survey and learning feedback	22.8
Collaborative learning	17.0

Note. *N=482*

5.7.2 How Are They Being Used In the Classroom?

Results from this study revealed that teachers made use of many kinds of digital technology in their teaching, as described in the previous section. In accordance with the question of how they are being used in the classroom, statistical analysis showed that those technologies had been used at different frequencies by teachers. Teachers used many kinds of digital technology from preparing materials and planning activities, delivering subject content, and evaluating the course. Details are presented as follows:

5.7.2.1 Laptop

Laptops were utilized a lot by the majority of participants. It was considered the most popular tool and the most used tool among participants. Most of the participants (93% or 314) stated that they used laptop from class preparation, content delivery, and class evaluation. In addition, the frequency distribution showed that 68.7% (331) of participants employed it on a daily basis. Another 22.4% (108) of respondents identified that they used laptops once or twice a week. Interestingly, there were 2.15% (12) of respondents who only used laptops once or twice in two months, and there were 5.6% (27) of respondents who stated that they never used laptops in the teaching and learning process. Details are presented in Table 5.38:

Table 5.38

Frequency of Laptop Use

	Frequency	Percent
Daily	331	68.7
Biweekly	56	11.6
Weekly	52	10.8
Never	27	5.6
Monthly	9	1.9
Fortnightly	4	.8
Bimonthly	3	.6
Total	**482**	**100.0**

Note. N=482

5.7.2.2 Smartphone

Most of the respondents mentioned that they used their smartphones for teaching every day (75.7% or 365). The devices were commonly reported for searching information to support the teaching materials and accessing social medias (68% or 248). On the other hand, 15.4% (74) respondents answered that they never used a smartphone as one of the tools to teach their students. Findings also suggested that 8.8% (43) of respondents stated that they made the use of smartphone for at least once in two months. Details are presented in Table 5.39:

Table 5.39

The Frequency of Use of Smartphones

	Frequency	Percent
Daily	365	75.7
Never	74	15.4
Biweekly	20	4.1
Weekly	15	3.1
Monthly	4	.8
Fortnightly	3	.6
Bimonthly	1	.2
Total	**482**	**100.0**

Note. N=482

5.7.2.3 Personal Computer

Personal computers were not utilized by many of the respondents for the teaching and learning process. Distribution frequency showed that 57.3% of teachers never use a personal computer. Only 38.1% (183) of respondents admitted that they used a personal computer available at schools, mostly once a week. The tool was used for delivering the subject. Furthermore, 4.8% (23 teachers) mentioned that within two months, a personal computer had been utilized a few times. Details are presented in Table 5.40:

Table 5.40

Frequency of Use of Personal Computers

	Frequency	Percent
Never	276	57.3
Daily	114	23.7
Weekly	35	7.3
Biweekly	34	7.1
Monthly	10	2.1
Bimonthly	8	1.7
Fortnightly	5	1.0
Total	**482**	**100.0**

Note. N=482

5.7.2.4 Projector

Projector has been used by many schools as one of useful required in teaching process. Findings from this study revealed that projectors were not used by most participants at school. The tool was used during classroom activities. However, since most of teaching activities were conducted online, most of the respondents (64.1% or 309) reported that they did not take advantage of projectors in teaching. Other respondents (5.8% or 28; 6.6% or 52; and 10% or 48) decided to use projectors a few times within a week. Findings also suggested that a very small number of participants (1.8% or 9) decided to use tablets at least twice a week. Details are presented in Table 5.41:

Table 5.41
Frequency Use of Projector

	Frequency	Percent
Never	309	64.1
Weekly	48	10.0
Monthly	33	6.8
Biweekly	32	6.6
Daily	28	5.8
Fortnightly	22	4.6
Bimonthly	10	2.1
Total	**482**	**100.0**

Note. N=482

5.7.2.5 Tablet

Unlike smartphones, tablets were not a common digital technology used in teaching by teachers. Results revealed that the majority of participants never use tablets in their teaching activities. There were 83.8% (404) of teachers who reported that they did not take advantage of the benefits of tablets as a tool to boost the teaching and learning process. Other 9.8% (47), 2.7% (13), and 1.9% (9) of respondents chose to use tablet at least once a week to support their teaching activities in the classroom. Details are presented in Table 5.42:

Table 5.42

Frequency Use of Tablet

	Frequency	Percent
Never	404	83.8
Daily	47	9.8
Biweekly	13	2.7
Weekly	9	1.9
Fortnightly	4	.8
Monthly	4	.8
Bimonthly	1	.2
Total	**482**	**100.0**

Note. N=482

5.7.2.6 Email

Email was reported to be used by a lot of participants. There were 47.9% (231) participants who used email on a daily basis. Another 26.8% (128) of respondents stated that they utilized email on a biweekly or weekly basis. Results also identified that only 16.2% (78) of teachers never used email in their teaching activities and 9.3% (45) of teachers used email with rare frequency. Findings showed that Email was used mostly as to access several teaching platforms such as google classroom, google form, and microsoft teams (74% or 298). Details are presented in Table 5.43:

Table 5.43

Frequency of Use of Email

	Frequency	Percent
Daily	231	47.9
Weekly	78	16.2
Never	78	16.2
Biweekly	50	10.4
Monthly	17	3.5
Bimonthly	16	3.3
Fortnightly	12	2.5
Total	**482**	**100.0**

Note. N=482

5.7.2.7 YouTube

YouTube is an online video sharing site that is quite popular among teachers. Findings suggested that the number of teachers who accessed YouTube as a teaching and learning booster was high. There were 42.9% (207) teachers who accessed YouTube every day. Moreover, 27% (130) of participants stated that they went to YouTube to get some useful videos for teaching at least once or twice a week. Another small number of teachers (5.4% or 26), 4.6% or 22), and 0.4% or 2) reported that they connected YouTube for searching relevant teaching materials though it was once a month or twice a month. However, there were 19.7% (95) of teachers who decided not to use YouTube at all. Details are presented in Table 5.44:

Table 5.44

Frequency of Use of YouTube

	Frequency	Percent
Daily	207	42.9
Never	95	19.7
Weekly	80	16.6
Biweekly	50	10.4
Fortnightly	26	5.4
Monthly	22	4.6
Bimonthly	2	.4
Total	**482**	**100.0**

Note. N=482

5.7.2.8 Microsoft Offices

Microsoft offices were reported to be used by the majority of teachers on a daily basis for teaching and other administrative duties. The percentage was 54.6% (263). Some participants (21.9 percent, or 106) also mentioned that they often use Microsoft Office for teaching needs. At least it was used every two weeks. In addition, only very few teachers (2.4% or 16) used Microsoft Office on a very rare frequency (monthly or bimonthly). Surprisingly, there were 20.1% (97) of teachers who never use Microsoft Office in the teaching and learning process. Details are presented in Table 5.45:

Table 5.45

Frequency of Use of Microsoft Offices

	Frequency	Percent
Daily	263	54.6
Never	97	20.1
Biweekly	56	11.6
Weekly	44	9.1
Monthly	8	1.7
Bimonthly	8	1.7
Fortnightly	6	1.2
Total	**482**	**100.0**

Note. N=482

5.7.2.9 Video Conference Tools

Since the pandemic of COVID-19, video conference tools are becoming famous among teachers as one of the alternative tools to teach in the classroom. The tools were utilised to replace offline class in order to ensure that the classroom activities continue during the pandemic. Results suggested that video conference tools (Zoom Meeting, Google Meet, and Microsoft Teams) were used by 20.1% (97) on a daily basis, 17% (82) on a biweekly basis, and 22.4% (108) on a weekly basis by teachers. In addition, 14.5% (70) of participants decided to use video conferences on a bimonthly basis at the maximum. Findings also showed that a quarter of the participants never use videoconferencing tools in teaching. Details are presented in Table 5.46:

Table 5.46

Frequency Use of Video Conferencing Tools

	Frequency	Percent
Never	124	25.7
Weekly	108	22.4
Daily	97	20.1
Biweekly	82	17.0
Monthly	41	8.5
Fortnightly	19	3.9
Bimonthly	10	2.1
Total	**481**	**99.8**

Note. N=482

5.7.2.10 Downloader Tools

Findings suggested that 59.4% (286) of participants reported that they decided to use the tools to download important teaching materials at least once a week. Reports also showed that 14.2% (68) respondents were rarely utilized video/audio downloader. They chose to use it not very often within one or two months. In addition, one-fourth of the participants never use video or audio downloaders for their teaching. Details are presented in Table 5.47:

Table 5.47

Frequency of Use of the Video/Audio Downloader

	Frequency	Percent
Never	128	26.6
Daily	115	23.9
Weekly	95	19.7
Biweekly	76	15.8
Monthly	37	7.7
Fortnightly	23	4.8
Bimonthly	8	1.7
Total	**482**	**100.0**

Note. N=482

5.7.2.11 Social Media Platforms

The use of social media in education is something new. There are many kinds of social media that are available and can be used to support teaching and learning activities, such as WhatsApp, Instagram, Facebook, Twitter, and Tiktok. Respondents informed that 46.9% (226) of them connected to their social media platforms mostly for teaching needs such as to gain interesting teaching materials on daily basis. Others stated that they connected to their social media platforms biweekly (4.8%, or 23) and weekly (6.2%, or 30). However, 39.4% respondents described that they never use social media as one of the useful tools in teaching. Details are presented in Table 5.48:

Table 5.48

The Frequency of Use of Social Media Platforms

	Frequency	Percent
Daily	226	46.9
Never	190	39.4
Weekly	30	6.2
Biweekly	23	4.8
Monthly	6	1.2
Bimonthly	5	1.0
Fortnightly	2	.4
Total	**482**	**100.0**

Note. N=482

5.7.2.12 Interactive Learning Tools

Recently, interactive learning tools have become so popular among teachers and students. They were available online. Among the popular tools that were mentioned by participants were Rumah Belajar, Ruang Guru, Zenius, Livebinders, Educandy, Moodle, and Google Classroom. Results described that half of respondents may spend several times a week accessing the tools (50.8% or 245) to gain new insights in their subject. A small number of respondents preferred to join the tools at least fortnightly (1% or 5), monthly (3.3% or 16), or bimonthly (0.8% or 4). Findings also revealed that there were quite many of respondents who never use the tools (43.8% or 212). Details are presented in Table 5.49:

Table 5.49

Frequency of Use of Interactive Learning Resources

	Frequency	Percent
Never	212	43.8
Daily	101	21.0
Biweekly	72	14.9
Weekly	72	14.9
Monthly	16	3.3
Fortnightly	5	1.0
Bimonthly	4	.8
Total	**482**	**.2**

Note. N=482

5.7.2.13 Game and Quiz Tools

Game and quiz tools were also among the digital technologies used by teachers in teaching. Some teachers used the tools to attract students' attention in learning (75% or 173), and other used them for class evaluation (56 or 25%). A small number of participants (6% or 29) reported that they used online games and quizzes such as Google Forms, Quizzes, Kahoot, and Edmodo Quizzes on daily basis. Other respondents revealed that they connected to the tools at least once or twice a week (28% or 138). In addition, 15.8% (62) of participants also decided to use games and quizzes monthly or bimonthly. However, almost half of participants stated that they never used the tools for quizzes in the classroom. Details are presented in Table 5.50:

Table 5.50

Frequency Use of Game and Quiz Tools

	Frequency	Percent
Never	239	49.4
Weekly	80	16.6
Biweekly	58	12.0
Monthly	48	10.0
Daily	29	6.0
Fortnightly	24	5.0

	Frequency	Percent
Bimonthly	4	.8
Total	**482**	**100.0**

Note. N=482

5.7.2.14 Cloud Storage

Cloud storage has become very useful for everyone, including teachers, to store any data necessary for teaching. According to the participants, 26.3% (127) of them accessed the cloud storage (Google Cloud) on a daily basis. Another 23.3% (98) of respondents described that they connected to the cloud storage biweekly, weekly, or monthly. Findings also revealed that half of the participants never use the tools to store their data. Details are presented in Table 5.51:

Table 5.51

Frequency of Use of Cloud Storage

	Frequency	Percent
Never	249	51.7
Daily	127	26.3
Weekly	36	7.5
Biweekly	33	6.8
Monthly	17	3.5
Fortnightly	12	2.5
Bimonthly	8	1.7
Total	**482**	**100.0**

Note. N=482

5.7.2.15 Survey and Learning Feedback Tools

Another useful tool in education is a survey and learning feedback. Though there are many kinds of survey and learning feedback available online, teachers reported that they only used Google Forms. 22.4% (108) of participants described that they could use it on a daily, weekly, or even monthly basis for classroom evaluation. However, the majority of respondents stated that they never used the tools at all (77.2% or 3,74). Details are presented in Table 5.52:

Table 5.52

Survey and Learning Feedback Tools

	Frequency	Percent
Never	374	77.2
Weekly	36	7.5
Daily	21	4.4
Monthly	19	3.9
Biweekly	18	3.7
Bimonthly	11	2.3
Fortnightly	3	.6
Total	**482**	**100.0**

Note. N=482

5.7.2.16 Collaborative Learning Tools

Collaborative learning is an interesting tool that can boost the teaching and learning process. Findings suggested that the majority of the respondents never use collaborative learning tools in their classrooms (82.2% or 400). Another 17.1% (82) of teachers admitted that they used collaborative learning tools such as Padlet and Canvas in teaching at different frequencies. Some would be daily, weekly, or monthly. The details are described in Table 5.53:

Table 5.53

Collaborative Learning Tools

	Frequency	Percent
Never	400	82.8
Weekly	34	7.1
Daily	22	4.6
Biweekly	10	2.1
Monthly	9	1.9
Bimonthly	4	.8
Fortnightly	3	.6
Total	**482**	**100.0**

Note. N=482

5.7.2.17 Teachers' Productivity Tools

Teachers' productivity tools are tools that can be used to support teachers' teaching activities, including to help them managing their administrative duties. However, most of the participants stated that they never used the tools for teaching (72.8% or 351). 6.4% (31) of respondents reported using the tools, such as video editors, every day, while 7.1% (34) reported that they use the tools twice a week. In addition, 13.7% (66) of respondents decided to use the tools at least monthly as presented in the Table 5.54:

Table 5.54

Teachers' Productivity Tools

	Frequency	Percent
Never	351	72.8
Weekly	53	11.0
Biweekly	34	7.1
Daily	31	6.4
Monthly	7	1.5
Fortnightly	3	.6
Bimonthly	3	.6
Total	**482**	**100**

Note. N=482.

5.7.3 Summary of Research Question 5

Overall, there were many kinds of digital technology used by teachers to support the teaching and learning process; preparing the subject, delivery the content, and evaluating the class, at different frequencies. It was clear that laptop was the most frequent digital technology utilized participants in teaching (94.3% or 455). Laptop was put to use by majority of participants (68.7% or 331) on daily basis, and 22.4% subsequently used it on weekly basis. The second-most-favourite digital technology used by teachers was the smartphone. It was used by 84.6% of the 408 participants, and 75.7% of them utilized it every day. However, tablet was not common to be used in teaching by teachers. There were only one fourth of the participants who used it in teaching every single day. Other tools such as email, YouTube, video conferences, social media, and quizzes were also utilized by more than 50% of the participants, with varying degrees of use. Findings also suggested that tools such as a projector, cloud storage, survey, and feedback were only used by a few participants with different frequencies. Details are presented in Table 5.55:

Table 5.55

The Frequency Distribution of Digital Technology Use In the Classroom

		Frequency (%)					
Digital Technologies	**User**	**Daily**	**Biweekly**	**Weekly**	**Fort-nightly**	**Monthly**	**Bi-monthly**
Laptop	94.3	68.7	11.6	10.8	0.8	1.9	0.6
Smartphone	84.6	75.7	4.1	3.1	0.6	0.8	0.2
Email	83.8	47.9	10.4	16.2	2.5	3.5	3.3
YouTube	80.2	42.9	10.4	16.6	5.4	4.6	0.4
Microsoft Offices	79.8	54.6	11.6	9.1	1.2	1.7	1.7
Video conferences	74.0	20.1	17.0	22.4	3.9	8.5	2.1
Downloader	73.4	23.9	15.8	19.7	4.8	7.7	1.7
Social medias	60.5	46.9	4.8	6.2	0.4	1.2	1.0
Interactive learning	56.0	21.0	14.9	14.9	1.0	3.3	0.8
Game and quiz	50.6	6.0	12.0	16.6	5.0	10.0	0.8
Cloud Storage	48.3	26.3	6.8	7.5	2.5	3.5	1.7
Personal Computer	42.7	23.7	7.1	7.3	1.0	2.1	1.7
Projector	35.8	5.8	6.6	10.0	4.6	6.8	2.1
Teacher’s productivity	27.1	6.4	7.1	11.0	0.6	1.5	0.6
Survey	22.8	4.4	3.7	7.5	0.6	3.9	2.3
Collaborative Learning	17.0	4.6	2.1	7.1	0.6	1.9	0.8
Tablet	16.1	9.8	2.7	1.9	0.8	0.8	0.2

Note. N=482.

5.8 Chapter Conclusion

This chapter describes the quantitative findings of the study. The findings implied that teachers’ self-efficacy and attitudes towards digital technology integration were adequately good. The results also suggested that teachers’ TPACK level was moderately confident (M = 3.6 and SD =.36) as their mean scores were above the mid-point. Findings also implied that, from the seven domains of TPACK, teachers’ confidence level in their content knowledge (CK) was the highest.

Pearson correlation analyses found that teachers' self-efficacy and attitudes towards digital technology integration positively correlated with their technological pedagogical content knowledge (TPACK). Self-efficacy and attitudes also significantly predicted teachers' TPACK. Regarding the barriers to digital technology integration, findings suggested that "lack of digital technology training from the school," "lack of teacher’s digital technology knowledge and skills," and "lack of technical support" were among the most common obstacles faced by respondents. Lastly, the study also found that there were many kinds of digital technology used by teachers to support the teaching and learning process and used at different frequencies, such as laptops, smartphones, email, YouTube, video conferences, social media, and quizzes.

Chapter 6

QUALITATIVE FINDINGS

6.1 Introduction

Qualitative findings from this study identified that teacher' self-efficacy and attitudes towards digital technology integration positively correlated to teachers' TPACK which confirms the study of Durak (2019) and Baturay, Gokcearslan, and Sahin (2017). The survey results provided the opportunity to tailor the interview questions in following up the significant responses, to adjust the interview protocols, as well as to select the suitable participants for qualitative phase in order to explore the statistical findings deeply and to obtain deeper understanding on the research topic. The analyses of the interview data yielded several themes and subthemes. The chapter begins with the presentation of the participants' and schools' backgrounds, followed by the analyses of the findings. The study used a theme-based narrative style guided by five research questions. The following research questions were used to guide this study:

Q1. What are teachers' perceptions of their self-efficacy and attitudes towards the use of digital technologies?

Q2. What are teachers' perceptions of their technological, pedagogical, and content knowledge (TPACK) in teaching?

Q3. In what ways do teachers' self-efficacy and attitudes toward the use of digital technologies affect their use of technological, pedagogical, and content knowledge (TPACK)?

Q4. What are the factors that promote or inhibit digital technology use in the classroom?

Q5. What are the digital technologies used by teachers, and how are they being used in the classroom?

6.2 The Participants' Background Information

In this study, twelve participants included in the qualitative phase of the study. The respondents were five males and seven females across the subjects taught from nine senior high schools. They were teachers who identified themselves to have high level of self-efficacy and attitude in integrating digital technology in teaching as well as those who rated themselves to have high TPACK level from survey findings. Furthermore, they were selected because they had passed the teacher's professional program to ensure that they gained adequate training in teaching. The schools included in the study were also schools that meet the national education standards (standard of content, standard of classroom process, standard of educational assessment, standard of graduate competence, standard of educators and education personnel, standard of management, standard of education financing, and standard of facilities and infrastructure). In addition, the schools were accredited by national accrediting agencies under the ministry of education which earn very good accreditation. These criteria are important to make sure that the selected teachers are the one who used digital technologies since the research was aimed to investigate teachers' self-efficacy, teachers' attitude, and teachers' TPACK in digital technology use in the classroom as well as its barriers.

Due to the selection method for participants in the qualitative phase that conclusion from the qualitative data represents the leading edge in Indonesian schools since the schools and teachers included in this study were considered the best according to the researcher's assessment to represent the whole community. Details of participants' demographic information are presented in Table 6.1:

Table 6.1

Interviewee Background Information

No	Participant	School	Gender	Teaching Experience	Subject
1	Participant 1	SMAN 6 Pekanbaru	M	5 Years	Chemistry
2	Participant 2	MA Alihsan	M	5 Years	English
3	Participant 3	SMAN 7 Pekanbaru	M	5 Years	Art and Music
4	Participant 4	SMAN 9 Pekanabru	F	15 Years	Sociology
5	Participant 5	SMAN 14 Pekanabru	F	10 Years	History
6	Participant 6	SMAN 14 Pekanabru	F	7 Years	Biology
7	Participant 7	SMAN 13 Pekanbaru	F	14 Years	Biology
8	Participant 8	SMAN 5, Pekanbaru	F	6 Years	Math
9	Participant 9	SMAN 13 Pekanabru	M	10 Years	Islamic Education
10	Participant 10	SMAN 7 Peknabaru	M	6 Years	Islamic Education
11	Participant 11	SMAN 16 Pekanbaru	F	7 Years	Biology
12	Participant 12	SMAN 2 Pekanbaru	F	10 Years	Counseling

Note. Participants' demographic information

6.3 Schools' Background Information

Senior High School 7

Pekanbaru Senior High School 7 is located in an urban area with an A (very good) accredited school. The school has 960 students and 60 teachers. From the participant's description and the researcher's observation, the school provided all necessary digital tools for teaching, such as a projector, computer, laptop, printer, and good internet connection. However, all those tools are not available in the classroom for security reason from thieves. Every teacher should set up the tools before teaching. In addition, the schools are also equipped with a good computer lab connected into internet that is available to everyone, including students.

Senior High School Alihsan

Pekanabru Senior High School al-Ihsan is located in the suburbs and is a B-rated (good) accredited school with 720 students and 46 teachers. From the researcher's observation and interviewee's description, the school had the necessary digital technology tools needed in the classroom, such as a computer, laptop, projector, printer, and internet connection. The school also had a good computer lab available for everyone, including students. However, those technologies should be installed before teaching in the classroom to protect against thieves and other technical reasons.

Senior High School 6

Pekanbaru Senior High School 6 is located in an urban area with an A (very good) accredited school. The school has 1042 students and 79 teachers. From the researcher's observation and the participants' descriptions, the classroom was equipped with good digital technology facilities. A computer, a projector, and good internet access. The school also had a good computer lab, a podcast room, and a library multimedia corner, which provided many computers. The computers were all connected to the *Wi-Fi* connection. All ICT tools in the computer lab and library could be accessed by teachers and students alike.

Senior High School 9

Pekanbaru senior high school 9 is a school located at the heart of the city with an A (very good) accredited school. The school has 1042 students and 90 teachers. From researcher's observation and participant's description, the school was equipped with complete ICT facilities such as a computer lab available for everyone, a multimedia room, a library, a projector in each classroom, computers, printer, and good internet access for teachers and students. Limited numbers of laptops were also available for teachers who did not have their own.

Senior High School 16

Pekanbaru Senior High School 14 is located in an urban area with an A (very good) accredited school. The school has 501 students and 38 teachers. From the researcher's observation and interview, the school had a good lab computer connected with internet available for teachers and students and a library multimedia room. In addition, projectors, printers, and laptops were available for teaching. However, internet access was still not available in some buildings. Some teachers should use their own internet data or go to the area covered by an internet connection. Since the projector and laptop were not available in the classroom, teachers should assemble them just before the class started.

Senior High School 13

Pekanbaru Senior High School 13 is located in the suburbs and is an A (very good) accredited school. The school has 548 students and 37 teachers. From interviewees' descriptions and the researcher's observations, the school had a good computer lab connected with internet available for teachers and students as well. In addition, the library also equipped with many computers connected to the internet. A great quantities of projectors, computers, laptops, and printers were also available for teachers. However, Internet connection problems often occur, mainly after a storm and heavy rain. Just like many other schools, teachers need to set up the ICT tools in the classroom, such as the laptop and projector, before starting the class.

Senior High School 5

Pekanbaru Senior High School 5 is a school located at the heart of the city with an A (very good) accreditation. The school has 785 students and 56 teachers. From the participant's description and the researcher's classroom observation, the school has a great computer lab and a library connected with internet available for everyone. However, the classroom was not equipped with a computer or a projector for security and other technical reasons. But the school had a large number of projectors, laptops, and a good internet connection that teachers may use and install them in the classroom activities.

Senior High School 14

Pekanbaru Senior High School 16 is a school located in the suburbs with an A (Very good) accreditation. The school has 1122 students and 80 teachers. It is a new school in the area. According to the participant's description and the researcher's observation, the school has a computer lab and library that are equipped with many computers connected to the internet that available for both teachers and students. The school also provides laptops, printers, and projectors. In addition, the school's internet connection was good. Teacher who wants to teach their class by using laptop and projector can take the laptop and the projector from administration room.

Senior High School 2

Pekanbaru Senior High School 2 is a school located in the heart of the city with an A (very good) accreditation. The school has 1074 students and 78 teachers. Based on the interview and the researcher's classroom observation, the school has a good computer lab and a library multimedia room that are available for everyone. Computers, internet connections, and printers were also provided in each room. Besides, each classroom was equipped with a projector. Teachers could use the school's laptop or bring their own into the classroom.

6.4 Presentation of Qualitative Findings

Since all participants involved in this study were not English speakers, their words have been translated into English and quoted in italics. The interviews were conducted in Bahasa (the Indonesian national language); however, for the purpose of reporting the results of this study, all comments were carefully translated by the researcher and checked by a translator before it was shared to the participants for member checking. Besides, classroom observation was conducted once for a short period of time (30 minutes) because of the limitations of face-to-face learning implemented in Indonesia due to the COVID-19 pandemic.

RQ1 (What are teachers' perceptions of their self-efficacy and attitudes towards the use of digital technologies?) and RQ2 (What are teachers' perceptions of their technological, pedagogical, and content knowledge?) were analyzed descriptively to explain teachers' levels of self-efficacy and attitudes towards digital technology integration in the classroom, as well as teachers' levels of TPACK. Teachers' TPACK was described descriptively based on the individual domains: TK, CK, PK, PCK, TCK, TPK, and TPACK. Details are presented in Table 6.2:

Table 6.2

Qualitative Data Analyses Based on RQs

RQs		Data Analyses
RQ1	What are teachers' perceptions of their self-efficacy and attitudes towards the use of digital technologies?	Descriptive analyses
RQ2	What are teachers' perceptions of their technological, pedagogical, and content knowledge (TPACK) in teaching?	Descriptive analyses
RQ3	In what ways do teachers' self-efficacy and attitudes toward the use of digital technologies affect their use of technological, pedagogical, and content knowledge (TPACK)?	Thematic analyses
RQ4	What are the factors that promote or inhibit digital technology use in the classroom?	Thematic analyses
RQ5	What are the digital technologies used by teachers, and how are they being used in the classroom?	Descriptive and Thematic analyses

Furthermore, RQ3, RQ4, and RQ5 were analyzed based on the themes and sub-themes that emerged. Table 6.3 is an example of how the coding process was carried out:

Table 6.3

An Example of the Coding Process

Theory	Theme	Sub-themes	Codes	Quotation
Factors that promote or inhibit digital technology use in the classroom	Teachers' factors	ICT Training	During Pre-service	"*we had a subject on computer basic skills, we learnt at the computer lab once a week*"
				"*The first time I learnt computer when my parents bought me one during my early pre-service training. it was the first time I learnt it*"
			During In-service	"*..I learnt the Microsoft excel myself when I became a teacher here*"
				"*During in-service, I have not received any training yet. I am a self-taught learning on computer*"
		ICT facilities	School' ICT facilities	"*School's ICT facilities are sufficient, including the internet access…*"
				"*Projectors are available at the administration room*"
				" *If I were at school, I just used my flash disk and I borrowed a school's laptop*"

Theory	Theme	Sub-themes	Codes	Quotation
			Teachers' ICT facilities	"*At home, I used my own laptop and I smartphone*"
		Internet connection	School's internet access	"*After being hit by lightning, the internet network often dropped, so I used my own internet data and connected to my laptop*"
			Teacher's internet access	"*School's ICT facilities are sufficient, including the internet access. But after being hit by lightning, the internet network often dropped, so we used our own internet data and connected to our laptop*"
			Government internet assistance program	"*Once government provided the internet assistance program for teachers and students, it reduces teachers' financial spending*"

Note. Process of coding and analyses.

In addition, RQ3 (In what ways teachers' self-efficacy and attitudes in the use of digital technologies affect their use of TPACK) was answered by using the case study, which was structured into three themes: the internal drive for using digital technology (DT), digital technology (DT) beliefs in teaching, and digital technology (DT) ability in teaching. In depicting the RQ4 (challenges of digital technology integration in the classroom), three themes emerged from the data: students' level factors, teachers' level factors, and school's level factors. Furthermore, RQ5 (What are the digital technologies used by teachers?) was analyzed descriptively, and RQ6 (How are they being used in the classroom?) was analyzed qualitatively and resulted in three themes: teaching preparation, teaching and learning process, and evaluation steps. Details are presented in Table 6.4:

Table 6.4

Themes and Subthemes Derived From the Individual Interviews

RQ3. In what ways does teachers' self-efficacy and attitudes in the use of digital technologies affect their use of technological, pedagogical and content knowledge (TPACK)?	
Theme 1	Intrinsic Motivation for DT in teaching
subthemes	*Motivation to use DT*
	Confidence to use DT
Theme 2	Beliefs in digital technology for teaching
subthemes	*Increase students' engagement*

	Support teaching activities
	Enlarge Teaching knowledge and skills
Theme 3	The ability to use digital technology in teaching
subthemes	*Able to use apps and digital platforms*
	Able to Solve the Technical Problem
RQ4. What are the factors that promote or inhibit digital technology use in the classroom?	
Theme 1	Students' factors
subthemes	*Students' ICT facilities*
	Students' Internet access
Theme 2	Teachers' factors
Subthemes	*Teachers' ICT skills*
	Teacher's ICT Training
	Teachers' ICT facilities
	Teacher's Internet access
Theme 3	Schools' factors
Subthemes	*Schools' ICT facilities*
	Schools' ICT training supports

RQ5. What are the digital technologies used by teachers and how are they being used in the classroom?	
Theme 1	DT used for class preparation
Subthemes	*Developing Content knowledge*
	Developing Teaching materials
Theme 2	DT used for classroom activities
subthemes	*Teaching Effectiveness*
	Keep class interesting
	Developing Communication and collaboration
Theme 3	DT used for Evaluation process
subthemes	*Class quiz*
	Class assignments
	Class Examination

Note. Themes and Subthemes

The themes in this study were drawn from broad categories derived from participants' interviews. Each theme is presented narratively with its own set of themes and communalities. Each subtheme is described with participants' comments during the face to face interviews. The subthemes mostly described with the participants' words.

6.4.1 Research Question 1

What are teachers' perceptions of their self-efficacy and attitudes towards the use of digital technologies?

6.4.1.1 Teachers' Perceptions of Their Self-Efficacy Towards Digital Technology Integration in Teaching

The majority of the participants stated that they were highly confidence with their ability to use digital technologies in the classroom. Only two participants made a comment that their self-efficacy was only in a moderate level due to lack of training related to digital technology used in the classroom. However, all the participants recognized that they believed to have high self-efficacy to employ digital technology in the classroom in the digital era.

Some were confident in using digital technology in teaching because they received adequate ICT training during pre-service, as stated by participants 8 and 12. Participant 8 stated that she had very good ICT skills because she learned them a lot in pre-service training. She used to develop ICT-based learning media in her college and received the best award at the campus level competition for two years in a row. In consistent fashion, Participant 12 identified her digital technology self-efficacy as high because she took the ICT subjects in two consecutive semesters when she was in college.

Other participants explained that Covid-19 pandemic had improved teachers' ICT skills very much. Participant 10 stated that he was confident with his ICT skills in teaching and he was able to incorporate digital technology into his classroom, particularly during the pandemic Covid-19 outbreak. During the pandemic, he had employed various digital technologies in the class.

> "*During this pandemic, I always employ apps such as canva to create posters in order to attract students' interest to study. In addition, I also used other apps such as bendicam, video recorder, and canva to create instructional video. I have utilized them for almost two years*" (Participant 10, 14th November, 2021).

Similarly, participant 4 rated her digital technology self-efficacy at the level of very good. She believed that she had good ICT skills necessary for teaching and she was confident with her skill because she had to use lot of digital technologies in performing her tasks during the pandemic. She used tools such as canva (graphic design tool), mentimeter (interactive presentation tool), and jamboard (digital collaborative board) in her classroom which developed her ICT skill. "*In this pandemic situation, my ICT skill is much increased. As I am a multitasking person, technology has helped me executing my tasks*" (Participant 4, 15th September, 2021).

Additionally, Participant 6 perceived that she had good ICT skill which was sufficient to support her teaching needs. She claimed that she knew how to use many kinds of digital technology in teaching; moreover, the pandemic caused her to learn and apply lot of technologies in the classroom. "*I know how to use the apps and the technology. With the current situation, of course teachers were forced to use a variety of apps*" (Participant 6, 8th October, 2021). With her confidence, participant 6 stated that she was able to deal with the technical issues which often occurred in the use of ICT in the classroom.

Participant 3 commented that his ICT skill was good enough where he could handle all technical problems he faced himself. "*I tried to solve all the issues by myself. I am a kind of curious person. I will work hard to clear up the problem. If I ask for help, it does not* *challenge me*" (Participant 3, 27th November 2021). In teaching, he used several kinds of digital tools such as instructional videos, e-learning platforms, video conferences and exciting quiz app to encourage students' interest in learning. Thus, all respondents perceived good self-efficacy in using digital technology in the classroom.

In sum, most of the participants claimed that they possessed good self-efficacy to use digital technologies in the classroom. Their self-efficacy improved significantly due to the pandemic Covid-19 which required them to use digital devices in the classroom. Some teachers recieved more training from school in utilizing the devices, while some others learnt to use the technology themselves.

6.4.1.2 Teachers' Perceptions of Their Attitude Towards Digital Technology Integration in Teaching

All participants were confident in saying that they have a high attitude toward using digital technology in teaching. They showed positive attitudes towards digital technology in their teaching and agreed that digital technology is very important in today's digital era. There is no doubt that digital technology provides teachers with more tools to support students' learning experiences and to make teaching more effective and convenient.

Besides its advantages, digital technology has negative effects on the class and may distract students from learning if it is not used safely and appropriately by teachers, students, and schools. Most of the participants considered the bad consequences of digital technology, such as students' technology misuse in the classroom and other threats such as viruses and malware. Therefore, all participants believed that with safe and responsible use of digital technology, it brought more benefits to the classroom and fewer drawbacks.

Participant 1 stated that digital technology is important in teaching.

> "*For me, digital technology is very important in today's digital era; surely everything is connected with ICT. So in my view, the use of digital technology in teaching is very urgent and cannot be separated. Now it is time for ICT*" (Participant 1, November 21st, 2021).

Further, he stated that with the advance of technology, a teacher could use many online tools to deliver the subject content effectively in the classroom. Likewise, students could also expand their knowledge and access information through digital technology in order to open their minds. However, he was a little bit afraid that digital technology was vulnerable to virus and malware threats and could distract students' focus on studying. Participant 1 stated the importance of shielding the digital devices such as laptop and smartphone by keeping the antivirus software up to date and put the emphasis on the important role of teacher in the classroom. Regardless of the negative effects of digital technology in teaching, he believed that digital technology should be used in teaching.

In addition, participant 6 also claimed that she had positive attitudes towards digital technology in teaching. She believed that digital technology was important in the teaching and learning process. It helped teachers perform their tasks much better.

> "*In biology, digital technology helps teachers teach the subject content effectively. For instance, in today's situation where a teacher has limited time for face-to-face meetings in the classroom, she can send the instructional video to the class. Then students can learn it before the class. So, during the meeting, a teacher can easily explain the materials. It was very helpful*" (Participant 6, October 8, 2021).

Participant 6 was a little worried if her devices were damaged by viruses and malware, but luckily it has not happened yet. Therefore, she equipped the devices with the necessary protection. She believed that digital technology was only a learning aid in the classroom, and it did not discourage her from using digital technology in the classroom. Besides, technology would not substitute for teachers' role in the classroom. For her, technology only tools to make easier the teaching and learning process. "*Technology is only to support, while the key point is the teacher*" (Participant 6, 8th October, 2021).

Similarly, participant 11 agreed with the importance of digital technology integration in the classroom. She stated that teachers should keep up with technology in teaching.

> "*Today's kids are raised in a world of digital technology; they are digital natives and more skilled. Everything is digital-based now. So it affects the teaching process. Teacher should adapt to students' ICT habits*" (Participant 11, September 21, 2021).

She described how digital technology brings a lot of benefits to teaching. Technology helped her prepare the teaching materials and deliver the subject content to the students. However, she stated that a teacher should manage the classroom well to avoid students misusing digital technology during the teaching and learning process.

Participant 3 described the importance of using digital technology in his classroom.

> "*In the subject of art and music, for example, to provide descriptions of traditional musical instruments, the text book only gave one example of the instrument from Sumatra and one example from Java. If I said that there was a musical instrument called "angklung" in Java, students would only be able to imagine. But with the use of technology, I could show the instruments by using a PowerPoint slide presentation projected from a laptop, or if it is an online meeting, we can just search through Google*" (Participant 3, November 27, 2021).

Interestingly, participant 3 explained that he did not worry much about the virus and malware threat. For him, the threat can be easily fixed; "*yes, it's normal because the devices can be reinstalled*" (Participant 3, November 27, 2021). Since digital technology is only supporting tools in the classroom, the teacher's role would not be replaced by technology. "*Though all information is available on the internet, a teacher's role is to guide students to be good. Students should be guided to know which is good and which is wrong*."(Participant 9, 19th November, 2021)

All of the participants informed me that they had positive attitudes towards digital technology use in the classroom. They believed that digital technology is important in today's education to assist teachers in the classroom. They claimed that digital technology made it easier for them to carry out their duties as teachers and improved students' learning involvement.

Thus, teachers were perceived to have good self-efficacy and attitudes towards digital technology in teaching. They were identified as having confidence in their ability to integrate digital devices in the classroom and perceived that digital technology plays a vital role in the classroom regardless of the threats to data security and privacy from viruses and malware.

6.4.2 Research Question 2

What are teachers' perceptions of their technological, pedagogical, and content knowledge (TPACK) in teaching?

The results of the survey identified that all participants rated their TPACK ability highly. Similarly, most teachers described that they had good TPACK skills in the classroom, particularly related to the individual domains of TPACK such as technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). With respect to the complex skills of TPACK such as pedagogical content knowledge (PCK), technological content knowledge (TPK), and technology content knowledge (TCK), all of them believed that they understood and knew how to implement the skills in teaching. The description of participants' TPACK domains is presented as follows:

6.4.2.1 TK

With regard to TK, the majority of participants believed that they have good ICT skills required for classroom activities. One respondent rated her ICT skills as adequate because she believed that she still needed more ICT training. Participant 6, for instance, claimed that she was confident in her TK ability to support her classroom. Besides receiving sufficient ICT trainings, she also described how the COVID-19 pandemic situation improved her ICT skills since she used many kinds of digital technology, such as a laptop, smartphone, video conferences, a video maker, social media platforms, and online learning tools and apps. "*With the current situation, of course teachers were forced to use many kinds of learning tools and apps*" (Participant 6, October 8, 2021).

Similarly, participant 1 believed that he had the very good TK required for teaching. "*My ICT skill is almost very good because at this school I am not only a teacher but also a school's ICT operator assistant"* (Participant 1, 21st November 2021). His good TK was also observed through his description to use a Chemsketch, a molecular design program which allows the creation and modification of images of chemical structure in his chemistry subject. The result from this modeling program was then presented in an instructional video to help students understand how carbon is moved. In the same way, participant 3 commented that his ICT skills were good and he could handle all technical problems by himself. "*I tried to solve all the issues by myself. I am a curious person. I will work hard to clear up the problem. If I ask for help, it does not challenge me*" (Participant 3, 27 *November 2021)*.

Participant 12 identified her ICT skill as high because she took the ICT subjects in two consecutive semesters when she was in the college. "*When I was at the college, I took the ICT subject in the third and fourth semesters. I got an A for the ICT course*" (Participant 12, 9 October 2021). On the other hand, Participant 5 just believed that her ICT was adequate and she still needed to improve her skills: "*In my context as a teacher, as I keep learning, my ICT skill is adequate*" (Participant 5, September 12, 2021). Nevertheless, further discussion identified that she was able to use and integrate the necessary digital tools into her teaching, as she described that she often utilizes videos of historical films to improve students' understanding of one particular topic in history.

6.4.2.2 CK

All respondents confidently mentioned that they had good CK because they learned the CK they taught during the teacher training program. In addition, their teaching experiences also developed their understanding of the CK. Participant 3, for example, positively stated that he possessed good CK and comprehended the necessary concepts in his subject well. He further commented that besides using the text books provided by schools, he also used many other online references to develop his understanding because text books alone were inadequate to develop his ideas.

> "*Now, I rarely use the text books. I prefer searching for references on the internet. The books only offer simple ideas. I want to develop my ideas, so I look for references on YouTube and other relevant apps*" (Participant 3, November 27, 2021).

In addition, participant 10 also confidently described his CK as good. He was confident with his CK because the syllabus helped him develop it.

> "*At the senior high school level, we have the syllabus as our instructional guidelines, so we have to know it. Praise to Almighty God, I master all the topics required for grades 10, 11, and 12*" (Participant 10, 14 November 2021).

Similarly, participant 4 commented that she has a good understanding of CK because she has been teaching sociology for many years. She further emphasized the importance of both teaching the concepts and implementing their understanding in the community at the same time.

> "*In my view, my CK is very good. It is because with my teaching experiences from junior high school till senior high school, I do not only teach the students theoretically. I require them to practice their understanding. It is because sociology was an abstract subject. If they can not apply their understanding into the community, for me, my students are not understanding yet.* " (Participant 4, September 15, 2021).

6.4.2.3 PK

All respondents clearly stated that they had good PK in teaching. Participant 1, for instance, rated his ability at a good level. He stated that he understood the teaching pedagogies for the topics well because he learned the teaching pedagogies during his teacher's training, as he described:

> "*In chemistry, calculation and memorization should be balanced. I was taught to use several teaching methods for calculation in chemistry and some teaching methods for memorization. Calculation and memorization can't be taught by using the same methods, so I understand the teaching methods well*" (Participant 1, 21st November, 2021).

The same response was also stated by participant 3. His description showed that he was able to apply PK to teaching, though he did not know what to call the pedagogies he used in the classroom. He commented that different topics cannot be taught by using one template of teaching approaches which reflected his understanding of employing the PK in teaching:

> "*Each topic of the lesson would be different in the way of teaching it. There will be certain methods suitable for teaching traditional music, and there will be certain different methods appropriate for teaching dance. Even within the topic of musical instruments itself, the teaching methods for marwas, for melodic instruments, or for rhythm instruments would be different. They cannot be considered the same*" (Participant 3, November 27, 2021).

Furthermore, participant 4 claimed that she knew well about the PK needed for her subject. She commented that in the sociology subject, methods such as inquiry, simulation, and discussion would be more effective. She preferred teaching sociological concepts by asking students to go into the community and discover them for themselves. "*If students discovered it by themselves, they would know and feel it, and I would not be too tired to teach*" (Participant 4, September 15th, 2021). She described that performance indicators and students' learning comprehension would be some of her considerations in employing the teaching pedagogies.

6.4.2.4 PCK

In relation to PCK, all of the respondents agreed that they understood how to implement PCK in their classroom. Some of the interviewees informed us that before the outbreak of COVID-19, schools regularly provided workshops and training on implementing the curriculum, including the teaching pedagogies. Thus, they understood PCK well. Participant 4 for instance provided a description which reflected her understanding on PCK when she taught the students and asked the class to do social experiment:

> *"I requested my students do a social experiment in their neighborhood. Why I tend to ask them doing the field work? Because there were many things changed in my students. Two years ago, my students did social experiment to know their social environment. One of my students interacted with a young kid, a garbage collector. The kid told him about his life, his daily activities from morning until evening, and his studies as well. After conducting his social experiment, he presented the documentation video of his social interaction in the class. Then many students cried. When I asked them why they cried, they responded that they were luckier, so students learn from their community"* (Participant 4, 15th September, 2021).

To employ the PCK into teaching is not a big deal for teachers since they were equipped with those skills either during the pre-service or in-service. Much like participant 4, another respondent, interviewee 11, positively stated that she had good PCK in teaching. When teaching about the classification of living things, she preferred asking her students to go to the school's environment to make the necessary ecological observations. This simple assignment was effective to teach the topic where students would be so interested to learn.

Furthermore, teacher-good PCK was also revealed from participant 6's description. She explained that certain teaching models would be best for particular topics. Even within the same topics, teachers sometimes need several approaches to teach the sub-topics of the subject. For example, in the topic of reproduction systems, how the reproduction system works would be best taught using discovery learning, while its diseases would be best taught using problem-based learning.

6.4.2.5 TPK

Though the K-13 curriculum urged the using of ICT into classroom, in fact there were not many teachers integrating the technology in teaching. It was not until the global spread of Covid-19 forced schools and other public sites to be closed and Indonesian government enacted the restriction of travel and community activities. Then the use of digital technology was massively introduced and used by schools, although there were many obstacles at the beginning. Government supported by private sectors extensively and intensively provided ICT trainings to teachers on utilizing digital technologies in teaching where teachers started to largely integrated digital technologies in the classroom.

The majority of respondents stated that they understood the TPK and knew how to apply it in the classroom. According to them, the COVID-19 global pandemic remarkably increased their understanding of how to implement TPK in the classroom. Participant 7 identified that she was able to employ TPK in the classroom. She described using a virtual lab simulation to show the process of enzyme metabolism. The tools provided students with the experience of a real laboratory experiment. The use of the virtual biology lab was easy and took little time for preparation compared to the real lab experiment. In addition, students enjoyed the class.

In the same way, participant 1 explained that he had no problem implementing TPK in teaching. He explained that he used quite a few digital tools in his class, such as ChemSketch to draw an atom model, a video editor to create instructional videos, Instagram to post some relevant questions to his class, and a quiz app for his class. In using a quiz app, for example, he used Kahoot, a game-based learning platform, to evaluate students' learning outcomes. "*If the topic is more on memorizing, I do not use paper-based exams, but I use Kahoot*" (Participant 1, November 21, 2021).

According to him, Kahoot was effective to increase student's motivation in learning since the result of their exam can be seen directly. Moreover, their speed and accuracy in answering the questions posed a unique challenge for students.

> "*By using Kahoot, students not only learn but also play a game. In a conventional exam, students sit and answer the questions, but by using Kahoot, they compete within the specified time. So I think it is more effective*" (Participant 1, November 21st, 2021).

Participant 6 was also observed to have good TPK. She employed many digital technologies in the classroom and knew all the required pedagogies related to her subject. Her ability to combine these two skills, TK and PK, and to implement them in the classroom was understood from her description. For instance, she described using the Jamboard online app, an interactive digital board, to discuss a sociological topic, where students can capture and share thoughts, ideas, and notes in a creative way using the apps on their smartphones. Students' jamboard-shared thoughts were then discussed together in the classroom.

6.4.2.6 TCK

The advance of digital technology helps teachers in many ways. One of the benefits is that technology makes it easier for teachers to improve their content knowledge. There are abundant of information available on internet. However, participants 7 and 9 confirmed that they rarely used digital technology to develop their CK. According to them, the textbooks and other teaching modules were sufficient to expand their CK. In contrast, participant 3 stated that he occasionally used text books and other printed teaching resources. He used digital resources such as search engines, YouTube videos, and musical apps to improve his TCK on the topic.

Participant 1 showed an understanding of how to use digital technology to improve his understanding of the subject. Besides using the text books and the existing printed modules, he often uses YouTube videos to increase his CK. "*I used YouTube as additional references*" (Participant 1, 21st November, 2021).

In addition, participant 6 showed that she had good TCK and was able to implement it in the classroom. She stated that she used to utilize search engines to look for relevant information to increase her CK. Besides, she also used YouTube to develop her understanding. Correspondently, participant 11 used more digital resources to improve her CQ, such as websites, YouTube, an online tutoring app, and social media. She claimed that she used social media platforms to expand her information on the latest biology invention. "*Sometimes, social media platforms provide the up to date biology inventions, for example the inventions on new species which we learn in the class*" (Participant 11, 21st September 2021).

6.4.2.7 TPACK

With regard to the ability to blend all TPACK domains in teaching, all of the participants positively believed that they knew how to employ TPACK in the classroom. Some of them identified their TPACK level as medium, while others claimed that their TPACL level was good.

Participant 9 stated that his TPACK level was adequate, and he kept learning to be excellent at implementing TPACK. However, he believed that he could implement TPACK in his classroom. Similarly, participants 3, 5, and 11 also described their TPACK level as moderate. Their TPACK belief was not really high because they felt that they still needed to improve their skills, particularly the ICT skills.

Participant 6 explained that she had almost very good TPACK ability in teaching because she had passed the teacher's professional program. According to her, the professional program provided the necessary teaching skills required in the classroom, including the ICT skills. In addition, class observation showed that she was able to blend the appropriate teaching approaches and suitable digital technology with the content knowledge.

Consistent with participant 6, participant 4 also confirmed that her TPACK understanding was good: "*With what I have done so far, my TPACK is very good*" (Participant 4, 15 September, 2021). Participant 4 was observed to have a good understanding of applying TPACK during a limited face-to-face classroom visit. When she taught a topic in the sociology course, she was able to deliver the subject content well, and the students seemed to enjoy the class. To support her classroom, she used a laptop, a tablet, a projector, a PowerPoint presentation, and a jamboard, a digital interactive whiteboard. She allowed her students to use the smartphone to access the jamboard apps. To increase students' participation in the classroom, she requested that her students share their thoughts related to the topic via jamboard apps, then discuss the ideas together.

Another participant, participant 8, was also considered to have good TPACK ability. She said that her TPACK ability was good. Further, she described that in her online classroom, she used self-recorded videos for teaching. "*The video was produced by utilizing a PowerPoint presentation, and it was uploaded to YouTube as well as the school's e-learning platform*" (Participant 8, October 11, 2021). *Then students can open it and learn it.*" In addition, she explained that creating her own learning videos and uploading them to YouTube was more effective than just teaching the subject through a video conference. "*I created YouTube videos because the videos can be watched over and over. If it is a video conference for mathematics, it cannot be watched over and over by students*" (Participant 8, October 11, 2021). From her description, it can be inferred that she was able to apply TPACK to teaching.

In summary, all participants described that they possessed good TPAC understanding and were able to implement the knowledge in the classroom. They also showed good ability on each of the TPACK domains, particularly on the single domains such as CK, PK, and TK. Document analysis as well as class observation affirmed that teachers were capable of employing digital technologies in the classroom. They employed many different kinds of digital tools in the classroom, which supported their teaching topics and increased students' engagement.

6.4.3 *Research Question 3*

In what ways do teachers' self-efficacy and attitudes toward the use of digital technologies affect their use of technological, pedagogical, and content knowledge (TPACK)?

With regard to RQS 3, three themes were identified based on the respondents' interview transcriptions and analyses of their responses. Each of the themes is explored with its sub-themes. Details are presented in Table 6.5:

Table 6.5

Themes and Sub-Themes From RQS 3

RQ3. In what ways does teachers' self-efficacy and attitudes in the use of digital technologies affect their use of technological, pedagogical and content knowledge (TPACK)?	
Theme 1	Intrinsic Motivation for DT in teaching
subthemes	*Motivation to use DT*
	Confidence to use DT
Theme 2	Beliefs in digital technology for teaching
subthemes	*Increase students' engagement*
	Support teaching activities
	Enlarge Teaching knowledge and skills
Theme 3	The ability to use digital technology in teaching
subthemes	*Able to use apps and digital platforms*
	Able to Solve the Technical Problem

6.4.3.1 Intrinsic Motivation for Digital Technology in Teaching

All of the respondents confirmed that their good self-efficacy and attitudes towards digital technology integration in the classroom positively encourage them to learn and use digital technology in teaching. They believed that digital technology could empower them with access to data, information, tools, and the cloud, which would help students face the future workforce with digital skills and competencies. Thus, this internal drive made them aware of digital technology's use in teaching.

Participant 3 described that he was motivated to employ new digital technology in teaching because he believed that technology reinforced his classroom activities very much. If there was one digital technology introduced to him, he believed that he would be able to use it since he was still young and was eager to learn. "*I like new things. I will try the* *technology, whether it can be implemented in teaching or not. Technology is important now*" (Participant 3, 27th November 2021). He also described how students would be encouraged to learn if he used digital technology in teaching.

Similarly, participant 4 claimed that she was interested in learning and using new technology because every time she could implement the tools in her classroom, she would feel satisfied. She further commented that by employing several digital technologies in her classroom, her students were also prompted to study. Thus, she chose to employ the tools to increase students' enthusiasm for learning by using a variety of apps such as Zoom meetings, Jamboard, and social media platforms. Participant 5 also commented that she was enthusiastic to learn and use new technology in teaching. She provided an example of how she was eager to learn the tools. During the pandemic, when all teachers should use learning apps such as video conferences, she received a short training on using the video conferences. However, it was not enough for her to learn the app in detail. Therefore, she decided to explore everything by practicing it directly in her class. In addition, participant 2 stated, "*I am the kind of person who is excited by the new technology. I have a great concern with the use of new technology in daily life, particularly in the field of education*" (Participant 2, September 15, 2021). He was keen to learn many digital tools beneficial for teaching.

In addition, all participants agreed that they confidently used digital technology in the classroom. Participant 1 was confident in his ability to use digital technology. He was sure that he could use any new digital technology for his classroom. His confidence was based on his belief that digital technology was learnable by anyone, including older people. He described how many senior teachers were able to use the technology during the pandemic. Thus, there was no reason for him not to be able to use new devices in teaching. Abdul also explained that he was really confident in his ICT skills and had no problem using whatever technology was offered to him.

"*In my view, with my confidence to use digital technology, I believed that if the headmaster instructed me to use one particular technology, I would not be skeptical anymore because I already have the skill. So I am confidence. Some teachers, when they were ordered to use certain technology, would feel it as a burden. But for me, because my ICT is good, I have no problem*" (Participant 1, 21st November, 2021).

In the same way, participant 7 claimed that he can easily learn to use any upated digital technology for classroom purposes as a result of everything was available from

YouTube and Google, including the way to use one specific technology. "*I can learn to use the technology. We can learn step by step from YouTube and Google" (Participant* 7, November 23, 2021) Further, she stated that she was self-taught to create the instructional videos by using several apps, such as KineMaster. So, it was not a big issue for her, and she was sure that she could use any new technology in her classroom. Similarly, participant 8 stated that she used to improve her ICT skills by joining trainings on digital technology. Therefore, she had the confidence to use new technology because, during the pandemic, she learned and used many devices and programs. "*With God's permission, I believed that I could use digital technology. Just now, I even learned to use a new app called Ruang Data* (Participant 8, October 11th, 2021).

6.4.3.2 Beliefs in Digital Technology for Teaching

After the COVID-19 global pandemic, digital technology was employed massively in the classroom. All participants believed that technology played an important role in today's digital era, where students were born as digital natives. Participant 11 stated that teachers should keep up with technology in teaching.

> "*Today's kids are raised in a world of digital technology; they are digital natives and more skillfull. Everything is digital-based now. So it affects the teaching process. Teacher should adapt to students' ICT habits*" (Participant 11, September 21, 2021).

Participant 3 commented that in teaching art and music, there were many interesting technologies that were useful for his class in order to improve students' participation in the classroom. "*Up to now, I still feel unsatisfactory. I will learn new apps and new technology to increase students' learning*" (Participant 3, November 27, 2021).

Participant 1 explained that he used Instagram, a social media platform, to increase students' engagement.

> *"Sometimes I love to post chemistry queries through Instagram stories, because I know almost all of my followers are my students. I posted a related question, and I shared the info via the class WhatsApp group, informing them that the deadline to answer the question was at 8:00 p.m., and it was an extra credit for them. Students were enthusiastic. Social media's role was also helpful without me being in the classroom"* (Participant 1, 21st November, 2021).

In addition, he described that he also often used Kahoot, a game-based learning platform that was effective in increasing students' motivation to learn since the result of their exam could be seen directly. Moreover, their speed and accuracy in answering the questions were also a challenge. In the same way, participant 5 explained that the integration of digital devices in the classroom could improve students’ focus on studying. In her class, instead of using the lecture method, she would rather employ historical movies and pictures to attract students’ attention. Once they have done with the movies, students will be interested in discussing the topic in the classroom.

All participants agreed that classroom activities become more interesting when they employ the digital technology in teaching. There were many kinds of digital technology used by teachers, such as e-learning platforms, social media platforms, videos, and so on. Participant 6 believed that digital technology was important in executing her complex tasks in the classroom effectively.

> "*In biology, digital technology helps me teach the subject content. For instance, in today’s situation, where I have limited time for face-to-face teaching, I should be able to select the material for the class well. I sent the instructional video to the class, and students can learn it before the class. In the classroom, I can easily explain the materials. So it was very helpful*" (Participant 6, October 8, 2021).

Participant 7 explained that digital technology brought lots of benefits for teachers. She provided an example of using virtual biology labs to carry out biology experiments easily and effectively. Similarly, participant 3 identified that he used many kinds of digital technology in his class. For example, he used the instructional videos from YouTube to strengthen the concepts: "*I showed a video to students, and they could understand the topic that was taught*" (Participant 3, November 27, 2021). In addition, he also used several digital technologies, such as video conferencing for face-to-face teaching, to support his teaching.

Furthermore, digital technology also helps teachers increase their knowledge and skills required for teaching. Participant 5 told me that she frequently used the YouTube video platform to get the appropriate teaching content as well as to learn how the topic was delivered to the class. In the same way, participant 2 used search engines, YouTube videos, and musical apps to increase his understanding of music and art. Participant 4 informed me that digital technology could help her learn new skills. For instance, she often used YouTube videos to learn new digital platforms for teaching.

6.4.3.3 The Ability in Using Digital Technology in Teaching

All respondents explained that they had sufficient digital technology skills required for the classroom and believed that they could use digital technology for teaching. Their ability in implementing the digital devices was adequate to perform any tasks, ranging from simple duties to complex duties. Participant 1 mentioned that he used several devices and apps in his classroom. "*To support my classroom activity, I used a laptop, projector, and gadget. I did not use a paper-based exam for rote learning; I used the Kahoot platform*" (Participant 1, November 21, 2021). During the online learning, he totally used digital technology as a medium to convey the subject content. "*I used Google Classroom, and I used KineMaster and Filmora to edit the video*" (Participant 1, November 21, 2021). He sent all the teaching materials into the Google classroom, where students could access and submit the assignment through the Google classroom.

In addition, participant 10 described that he employed digital tools in teaching, such as a laptop and projector, during offline learning mode. Besides, he used power point presentations and interesting videos to enhance the classroom and allowed his students to access their smartphones to access the learning materials from Google Classroom and to search for particular information related to the topic if they were asked to do so.

Furthermore, he explained that during the online learning, he used video conferencing to teach the topic. Sometimes, he just used e-learning, Google classroom, where all teaching materials including the video, attendance list, and students' assignment were available there.

With respect to the ability in settling the technical issues coming from digital technology integration in the classroom, most of the teachers informed that if they got into trouble to employ digital technology into teaching, they would try to find the problem before asking for help from others. Once they could not overcome the problems, then they would consult the problems with their colleagues. In fact, they stated that they could handle the problems themselves most of the time. Furthermore, a few participants stated that they never asked for help from others and settled the trouble themselves.

Participant 6 believed that her skill was sufficient to support her teaching needs, and she claimed that she was able to settle the technical problems herself. She knew how to deal with the technical issues that often occurred when she employed the digital technology for classroom purposes. However, if she had no idea in overcoming the problems, she would finally ask the ICT technician to figure out the problem.

Participant 3 commented that his ICT skills were good enough and he could handle all technical problems by himself. "*I tried to solve all the issues by myself." I am a curious person. I will work hard to clear up the problem. "If I ask for help, it does not challenge me*" (Participant 3, November 27, 2021). Similarly, participant 4 described that she used to find some difficulties in employing a particular digital technology for teaching. "*When I created a learning poster by using canva app, in that time I was not good yet in using the app, I got difficulty to use it, then I opened the YouTube to solve the problem step by step*" (Participant 4, 15th September, 2021). She considered that she was able to solve the technical problems herself by referring to online sources such as YouTube.

In general, participants' self-efficacy and attitudes with respect to the use of digital devices for teaching seemed to affect their self-perception of TPACK competence positively. Higher sense of self-efficacy as well as attitude to use modern devices showed to have a strong internal drive to use digital devices in their classrooms. They positively believed that digital technology was important to support his teaching and improve students' understanding. In addition, teachers were also identified to be proficient in integrating digital technologies and were able to overcome the most of technical problems they had.

6.4.4 Research Question 4

What are the factors that promote or inhibit digital technology use in the classroom?

Qualitative data analyses identified several factors that promote or hinder teachers' effort to integrate the devices in the classroom. Three themes emerged which followed by its sub-themes. Details are presented in Table 6.6:

Table 6.6

Themes and Sub-Themes For RQ4

RQ4. What are the factors that promote or inhibit digital technology use in the classroom?	
Theme 1	Students' factors
subthemes	*Students' ICT facilities*
	Students' Internet access
Theme 2	Teachers' factors
Subthemes	*Teachers' ICT skills*
	Teacher's ICT Training
	Teachers' ICT facilities
	Teacher's Internet access
Theme 3	Schools' factors
Subthemes	*Schools' ICT facilities*
	Schools' ICT training supports

6.4.4.1 Students' Factors

All of participants described that there were some factors from students that challenged teachers to use the devices for teaching purposes. According to them, a small number of students who were from low-income families could not support them with ICT facilities such as smartphones. These students had difficulties accessing the tools. As a consequence, they could not learn as well as their other classmates. Participant1 explained that there were some of his students who could not learn well during the closure of school because their family was penniless.

> "*For virtual learning, the percentage of learning achievement was only about 60% to 70%. It was because some of our students were from very weak economy family. The numbers of students who can learn online were not all. Sometimes, government provided internet data to them, but they had no smartphones*" (Participant 1, 21st November, 2021).

He then explained that in order for those students to learn, they were advised to come to the school's computer lab. In many cases, they learned together with their friends and borrowed their friends' devices. Participant 3 stated that he was unable to use several suitable digital technologies for teaching music in the classroom, such as music notation software, because of his students' limited ability to have the supported devices for the software. Therefore, he only used common digital technologies in teaching the music.

Participant 2 stated that he was unable to use several digital technologies that were suitable for teaching music in the classroom, such as music notation software, because students did not have the supported devices for the software. Therefore, he only used the common digital technology for classroom activities.

Furthemore, the majority of participants reported that students' internet connections were also one of the obstacles to employing digital technology in teaching. For financial reasons, not all students could afford internet access. To deal with this situation, schools allowed their students to either study at the computer lab or use the school's wifi internet connection at school.

6.4.4.2 Teachers' Factors

There were also some factors from teachers that were considered by all participants as a challenge in digital technologies integration in the classroom. Their ICT skill was considered to be important in classroom digital technology use. Most of the participants believed that their good ICT skills helped them incorporate digital technology into teaching.

Participant 6 described how digital technology helped her teach biology in the classroom. She said that during limited face-to-face learning, digital technology such as blended e-learning platforms, videos, and PowerPoint presentations was very helpful for her. With her good ICT skill, she could learn and use any appropriate digital tools in teaching.

Similarly, participant 4 identified that her ICT skill improved very much during the Covid-19 outbreak because she had to learn using many favorable devices for teaching. Her ICT skills helped her integrate several constructive tools and apps in the classroom. She described that once she knew useful digital technologies such as Mentimeter, interactive presentation software, and Canva, a graphic design tool, she used them in the classroom. The more she used the technology, the better she integrated the tools.

Furthermore, all participants considered that ICT training was important in integrating digital devices for classroom activities. However, some of them claimed that they did not receive adequate ICT training. Participant 2 commented that his school did not pay much attention to providing ICT training for teachers. The school still placed emphasis on classroom management training. Participant 2 claimed that he was self-taught on employing the digital tools in the classroom, and he was fine with it.

In the same way, participant 9 stated that he received insufficient ICT training, which made him have difficulties using particular educational tools in the classroom, such as a video maker. He mentioned that his school did not provide ICT training for its tutors and only sent a few selected teachers to join the ICT trainings outside. Furthermore, participant 5 also received imperfect ICT training from her school. She had to learn the digital technology herself. "*I have not gained any ICT training yet. Most of the training I followed was about lesson planning"* (Participant 5, September 12, 2021).

Other participants stated that they got strong ICT training at the schools. Participant 7 believed that trainings on digital technology were helpful for performing her daily tasks at the school. She followed many ICT trainings because she was eager to know more about digital technology in education. In the same way, participant 3 stated that he received enough ICT training at school. His school provided adequate ICT training for the teachers every afternoon.

> *"Currently, we have lots of ICT training. Today, the training is about Akun Belajar (digital platforms provided by the ministry of education to access any educational apps freely). Besides, there is also training on the Jamboard app, the Canva app, and the Google Classroom platforms. "* (Participant 3, 27th November 2021).

With respect to teachers' ICT access, all of the participants mentioned that they had enough supportive ICT devices required to teach, such as a laptop and smartphone. They also described that teachers could use all schools' ICT devices from laptop, computer, and projector for classroom activities. In addition, the school's computer lab and multimedia room could also be utilized by teachers for classroom purposes. Participant 10 mentioned that school ICT facilities encouraged teachers to use the devices for classroom purposes where they could get unlimited teaching resources. *"The school's ICT facilities are perfect. I used a school's laptop"* (Participant 10, November 14th, 2021). Similarly, participant 4 described that she had good access to the school's ICT devices. She used devices such as a laptop, projector, tablet, and smartphone in the classroom.

In addition, teacher's internet access was also considered important in classroom digital technology integration. Many educational platforms could only be accessed with an internet connection. All of the participants stated that their internet connection helped them perform their daily tasks at school, and the majority of them stated that they had satisfactory internet access, which is necessary for teaching. When they were at the schools, unlimited internet access was provided to support teachers’ activities.

However, participants 7 and 9 informed me that since the school was located in a rural area, the school’s internet connection often dropped. The signal got weak and disconnected mostly during and after a heavy rain and a big storm. "*School ICT facilities were complete. But now the internet connection often disconnects after a thunderstorm. So we have to use our own internet data*" (Participant 7, November 23rd, 2021). Other participants, participants 5 and 6, described that the internet network at their school still did not cover all buildings. Thus, they have to use their own internet data, which sometimes takes very long to access several educational platforms and apps. In general, internet connections supported teachers' efforts to integrate digital technology in the classroom.

6.4.4.3 The school's Factors

Besides factors from students and teachers, all participants stated that there were some factors from school that positively supported their choices to integrate the devices into classroom. ICT facilities as well as ICT training were considered the most important factors. All participants stated that their schools had sufficient ICT facilities required for digital technology used in teaching. Participant 1 described that his school offered good digital technology facilities, which helped him integrate digital technology into teaching. Teachers can easily search for useful information to improve their knowledge and can employ the tools to boost the classroom.

"Our school has good ICT facilities. With the available number of computers and a good internet connection, they support teachers very much. We have about 70 teachers, and I think our computers are more than enough for each teacher. Besides, our computer lab is also available for everyone who wants to learn" (Participant 1, November 21, 2021).

Similarly, Participant 8 stated that she had no problem with the ICT facilities because her school already provided sufficient ICT facilities required for teaching. "*This school has complete ICT facilities, so it is not a problem. For me, it is not a problem, but I do not know about the other teachers since many of them are over 50*" (Participant 8, October 11, 2021).

Furthermore, schools’ ICT training support was very important for teachers in assisting the integration of digital technology. Some participants stated that they had to learn the use of digital tools themselves because there was no ICT training provided by schools.

Those teachers claimed that they had no problem learning the digital tools alone since they were still quite young and eager to use the devices. Other participants described that their schools arranged many ICT trainings during the COVID-19 outbreak to help teachers utilize the devices.

Participant 4 described that during the pandemic, there were many ICT trainings provided by schools, the government, and NGOs, either online or offline. The trainings improved teachers' skills in employing the technology for teaching. Similarly, participant 12 explained that some online tutoring services came to her school and conducted a training on how to use the apps. Teachers could make use of the apps for their teaching. In addition, participant 7 mentioned that her school arranged adequate trainings on ICT, but they were not enough to fulfill her excitement: "*It is not because the training was not enough, but I myself feel that I am still not satisfied yet*" (Participant 7, 23 November, 2021).

In summary, based on participant's descriptions, classroom digital technology use can be characterized into three ponts: students' factors, teachers' factors, and school's factors. In todays' digital era, classroom digital technology integration requires students active involvment to use the devices that connected into internet such as smartphone. In fact, there were still a number of students who were not able to access the devices and the internet. Thus, school's ICT facilities and teachers' competence of using the digital devices were also important for digital technology integration in the classroom.

6.4.5 Research Question 5

What are the digital technologies used by teachers in the classroom?

All participants informed me that they used a variety of digital technologies in the classroom, from simple uses of digital technology up to complex uses of digital tools. Each participant might use similar or different digital technologies, depending on their preferences. Details of the digital technology employed in the classroom are described as follows (see Table 6.7):

Table 6.7

Digital Technologies Employed by Participants

Tools	Users
Laptop	12
Projector	12
Search engine (google)	12
Microsoft Office (Power Point)	12
Social media (Facebook, Instagram, Whatsup, YouTube)	12
Video	12
e-mail	12
e-study report	12
Video conferences (Zoom Meeting, Microsoft Teams, Google Meet)	10
e-learning (Google Classroom)	12
Smartphone	9
Quiz apps (Kahoot, Quizess, Google Form)	7
Video maker/editor (Kinemaster, Bendicam, Filmora)	6
Computer	5
Online tutoring apps (Ruang Guru, Rumah Belajar, Zenius, Quipper)	4
A digital interactive board (Jamboard)	3
Poster app (Canva)	2
Tablet	1
Sound system	1
Blog	1
e-library	1
e-book	1
Interactive presentation apps (Mentimeter)	1
URL shortener	1
Live worksheets	1
Google sheets	1

During the interview, participant 3 explained, for instance, that he employed many digital tools suitable for his art and music classes. Besides employing devices such as a laptop, computer, smartphone, and projector, he also used instructional videos, e-learning platforms, video conferences, and an exciting quiz app to encourage students' interest in learning. His lesson plan documents also identified that he integrated several digital tools in his class. Moreover, it was identified from his classroom observation that participant 3 used a variety of digital tools in teaching. He conducted an online course by using a computer, a smartphone, a Google meeting, a Google form, Google search engines, quiz apps, YouTube, a WhatsApp group, and a PDF text book.

Similarly, participant 1 described that he employed several kinds of digital tools for his chemistry class. Further, he described that to teach atomic models, he created instructional videos by utilizing a number of digital tools. He used the ChemSketch app to create models of atoms and presented them in an instructional video. He used a laptop screen recording technique to create the video, which he then edited using Filmora.

> "*I created seven educational videos. The videos were created by using screen recording tool to record the power point slide presentation from my laptop. Then they were edited by using Filmora, and I uploaded them into Google Classroom and YouTube as well"* (Participant 1, November 21st, 2021).

Another participant, participant 6, mentioned that she used many apps suitable for teaching. During online learning, she used Microsoft Teams as well as WhatsApp groups to communicate with the students. The subject content was organized in PowerPoint form and mostly supported by videos or images. Then, for the students' tasks, she used Google Classroom. On the other hand, during the limited face-to-face classroom, respondent 6 sent all teaching materials into Google Classroom before the class so that students could read them at home. Classroom observation showed that she and her students used their smartphones to access all the materials from Google Classroom.

How are digital technologies being used in the classroom?

All of the participants were teachers who had positive self-efficacy and attitudes towards the integration of digital devices into teaching, and perceived the critical use of digital devices today's classroom. Qualitative data analyses identified that there were three themes that emerged, showing that digital technology was used to prepare the lesson, deliver the topic, and evaluate students' comprehension. Each of the themes was followed subsequently followed by their sub-themes. Details are presented in Table 6.8:

Table 6.8

Themes and Sub-Themes for RQ5

RQ5. What are the digital technologies used by teachers and how are they being used in the classroom?	
Theme 1	DT used for class preparation
Subthemes	*Developing Content knowledge*
	Developing Teaching materials
Theme 2	DT used for classroom activities
subthemes	*Teaching Effectiveness*
	Keep class interesting
	Developing Communication and collaboration
Theme 3	DT used for Evaluation process
subthemes	*Class quiz*
	Class assignments
	Class Examination

6.4.5.1 Digital Technologies Are Used For Class Preparation.

All of the participants confirmed that they used digital technology not only to deliver the subject content in the classroom but also to prepare the teaching materials before the class.

Participant 6 described how she largely used digital technologies to improve her understanding before going to the class. Besides reading the text book, she used relevant websites and YouTube videos for references. "Firstl*y I read the book. Afterthat, I openee YouTube because it was easy to understand if wewatchedh the video; it provided the clear explanation”.* (Participant 6, October 8, 2021). Similarly, participant 11 also used the digital tools to prepare her classroom. According to her, technology made it very practical to search for and prepare the teaching materials. She regularly visits relevant websites for biology, such as Biologi Gonzaga, and frequently uses social media platforms for her teaching sources. "*I look for the updated information; sometimes the social media platforms provide the current discovery in biology, such as the finding of a new species*." (Participant 11, September 21, 2021).

Participant 4 described how she employed digital technology to organize her classroom activities. Most of all, she prepared the power point presentation for each of her subject areas and provided relevant teaching videos. According to her, relevant videos benefited her teaching because sometimes students did not understand abstract ideas in sociology, but they would understand if the concept was explained by using videos. In addition, she also used graphic design tools such as Canva to create posters for her classroom, particularly during the online teaching mode. In the same way, participant 5 also organized her teaching materials into a PowerPoint presentation. She prepared the relevant pictures for her presentation. "*History was identic with images. Sometimes it was difficult to describe the topic, so I presented the images of the difference among homo sapiens, for example, in my power point.* (Participant 5, 12th September 2021).

6.4.5.2 Digital Technologies Are Used For Classroom Activities

Digital technologies have been utilized by educators to deliver subject matter in the classroom for many reasons. Among the reasons are teaching effectiveness, keeping class interesting, and developing communication and collaboration. Participant 4 explained that she used a variety of digital technologies in her classroom, including learning videos. She described that video as very important to teach abstract concepts in sociology, where they would understand the concepts better if she presented a related video and requested them to analyze it.

Participant 7 identified that digital technology effectively helped her conduct classroom activities in biology class. One of the activities was a lab experiment. With school's lab limitations, she decided to use a virtual biology lab to give students the experience of biology lab practical. In addition, participant 8 informed that she created learning videos and uploaded the videos into school's e-learning and her YouTube channel. She stated that by uploading the videos into the school's e-portal and her YouTube channel, students can re-watch them to learn the math topic at any time.

> "*I use YouTube channel because the videos can be watched by students again and again. If I just teach through the video conference, as I teach math, it cannot be replayed by students*" (Participant 7, November 23, 2021).

In addition, Participant 10 explained that the use of digital tools in the classroom would create an interesting classroom to engage students' participation. He deshowed that he used to ask stto createreatinclass's assignments in the form of posters or videos. By doing the homework, students learnt the topics and the technology simultaneously. According to him, digital technology integration in the classroom would positively affect the students because "*..it attracted students' interest when they studied.*" (Participant 10, 14th November, 2021). Similarly, participant 5 confirmed that the use of digital media such as power point presentations, images, and videos encouraged students to learn and raised more questions.

> *"The use of digital technology in history is very supportive. Sleepy students would wake up. But if I used a conventional lecture method, many of them may fall asleep. On the topic of Indonesian history, such as the communist rebellion movement, I presented the related videos. Then the students were eager to ask many questions. If I just told the story, they would not ask any questions"* (Participant 5, September 12, 2021).

The implementation of digital technology also provided more opportunities to easily develop the skills for communicating and the skills for collaborating among the classroom members. During schools' termination in the COVID-19 global pandemic, schools used digital platforms for communication and collaboration. All of the participants stated that they used several digital tools, such as video conferences, e-learning platforms, social media platforms, and gamified student engagement platforms, to stay connected with their students. To help teachers communicate with their students, all of them used WhatsApp groups, the most popular feature of WhatsApp Messenger, which allow collections of users to share messages with each other. All teaching and learning activities were conducted via those tools.

6.4.5.3 Digital Technologies Are Used For Classroom Evaluation

Nowadays, digital technology can be used not only during the preparation and delivery stages of classroom activities but also be employed to evaluate students' understanding in interesting and easy ways. All of the respondents mentioned that they mostly used several digital platforms, such as quiz apps, social media, and an e-learning portal, to assess students' comprehension. Participants 1 for instance explained that he mostly used Kahoot, a quiz app, for classroom evaluation. According to him, Kahoot was a learning game that encouraged students to be more focused when learning. He preferred using Kahoot to a printed quiz because of its effectiveness and excitement.

> "*By using Kahoot with a specified time limit, say 10 seconds, students must quickly answer the questions. So I think it is more effective rather than I just sit down watching students do the exam*" (Participant 1, 21st November, 2021).

Furthermore, participant 3 also used a particular quiz app to evaluate the classroom's understanding. He described the quiz app as being used once a month in the classroom to encourage students to learn better. "*After I know, I try to use some interesting apps to make* *some questions. I used exciting apps such as quizzes to motivate students to learn*" (Participant 3, November 27, 2021). In the same way, participant 8 employed another kind of quiz app, which was classpoint.

> "*There are many apps that can be used to deliver the teaching topic. We can use them all, or we can use a particular app for a specific topic. For example, we can prepare the exam by using the ClassPoint app, where students can draw pictures, or it can be short answer questions or questions with multiple choice answers. The result is automatic*" (Participant 8, 11th October 2021).

Other participants, such as participant 9, used Google e-learning platforms such as Google Classroom and Google Forms for class evaluation. He described that he preferred using a Google form to a paper-based exam. According to him, the use of Google form as the instrument to evaluate students' comprehension was more effective and efficient, while the use of paper based test would take much time in correcting them. He further stated that he would continue to use the online exam even after the pandemic was over. Similarly, participant 7 used Google classroom platform where she could upload all classroom materials and worksheets via the online platform, instruct and collect the assignment as well.

Interestingly, teachers also showed that digital technology could be used to evaluate the classroom in different ways. Participant 4 and 10 identified that he used to evaluate students' understanding by using their self-created learning posters and videos. In addition, participant 1 used social media platforms, such as Instagram, to assess students' understanding. He posted questions related to the subject learned via Instagram stories and informed his students via a WhatsApp group to respond to the questions.

To sum up, digital technology was very important for teachers in their classroom. All participants agreed that the development of digital devices helped them very much to carry out their daily teaching activities. Digital tools connected to the internet were utilized to prepare their classroom, deliver the teaching topics, and evaluate students' understanding. With the advancement of digital technology, teachers could easily expand their understanding of content knowledge and improve their teaching approaches to increase student participation in the classroom.

6.5 Chapter Conclusion

Chapter six presents the findings from qualitative data analyses. The chapter begins with the presentation of the participants' and schools' backgrounds, followed by the analyses of the findings. The study used a theme-based narrative style guided by five research questions. RQ1 (What are teachers' perceptions of their self-efficacy and attitudes towards the use of digital technologies?) and RQ2 (What are teachers' perceptions of their technological, pedagogical, and content knowledge?) were analyzed descriptively to explain teachers' levels of self-efficacy and attitudes towards digital technology integration in the classroom, as well as teachers' levels of TPACK. Teachers' TPACK was described descriptively based on the individual domains: TK, CK, PK, PCK, TCK, TPK, and TPACK. In addition, RQ3 (In what ways teachers' self-efficacy and attitudes in the use of digital technologies affect their use of TPACK) was answered by using the case study, which was structured into three themes: the intrinsic motivation for using digital technology (DT), digital technology (DT) beliefs in teaching, and digital technology (DT) ability in teaching. In depicting the RQ4 (challenges of digital technology integration in the classroom), three themes emerged from the data: students' level factors, teachers' level factors, and school's level factors. Furthermore, RQ5 (What are the digital technologies used by teachers?) was analyzed descriptively, and RQ6 (How are they being used in the classroom?) was analyzed qualitatively and resulted in three themes: teaching preparation, teaching and learning process, and evaluation steps.

Chapter 7

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

7.1 Introduction

The rapid changes of digital technology in today's society have formed a new perspective of teaching and learning activities for teachers. Teachers have seen digital technology as an important tool to assist them managing the classroom in more effective and efficient ways. Slow but sure, majority of teachers begin to accept the integration of technology in their classroom and shift the conventional approaches into clasroom-based digital tools. In addition, a large sum of money has been invested by governement to welcome the digital era of learning and to promote the integration of digital tools in the classroom. In addition, todays' classroom also needs to prepare students with digital skills required for their future life. Nevertheless, teachers' role in the classroom remains important and cannot be replaced by technology. Digital technology helps teachers organize their classroom and deliver the subject matter in attractive ways.

This chapter presents the discussion of the findings of the study. It begins with the discourse on the quantitative findings as well as the qualitative findings of the research in a structured ways. Findings from five research questions which guided this study were discussed sequentially. Following to that, a section on research conclusion is also presented in clearly and concisely. Conclusions were drawn based on the empirical data gained from this study which may provide better understanding on the research topic. In addition, this chapter also explores the limitations of the study and provides recommendations to related parties, from government, educational institutions, and teachers, as well as to sum up the main points of the chapter.

7.2 Discussion of the Findings

This section discusses the findings from the quantitative data analyses and qualitative data set, as well as provides a description of how the findings relate to each research question. Findings from each research questions would be discussed from quantitative perspective and and would be enhanced from qualitative approach respectively. This sequential explanatory model provides a wider understanding on the researched topic.

7.2.1 Research Question 1

What are teachers' perception of their self-efficacy and attitudes towards the use of digital technologies?

This research question focused on teachers' self-perception to rate their belief in their ability to employ digital technologies in the classroom as well as identify their attitudes toward utilizing digital technology in teaching.

Quantitative findings suggested that teachers possessed good self-efficacy to incorporate digital technology into teaching. Their mean score was considerably good and passes through the mid-point, M= 3.84 and SD=.49. This result identified that teachers possessed good confidence and belief in incorporating digital devices into their teaching. Qualitative findings also revealed that all respondents showed to have higher confidence level and were capable of integrating digital tools for classroom purposes. Furthermore, the participants explained that they possessed adequate digital technology skills required for teaching which help them to complete their daily tasks and responsibility. Some described that they took the ICT course during pre-service training and others told that the Covid-19 outbreak encouraged them to learn and use the digital devices in teaching.

Finding from this study revealed that teachers possessed high self-efficacy in digital technology integration and gained sufficient digital technology skills in the classroom. Teachers believed that the use of digital technology in teaching increase their classroom effectivenes. It seemed to be consistent with the findings of Chutiyami, Zhang, and Nicoll (2021), Santi, Gorghiu, and Pribeanu (2020), and Mahdum, Hadriana, and Safriyanti (2019), which found that teachers showed good self-efficacy to employ digital devices during classroom activities. Furthermore, Mahdum, Hadriana, and Safriyanti (2019) identified that the use of digital technology in the classroom may help teachers to learn new skills and improve teaching performance.

Respondents also reported that their self-efficacy to use digital tools increased significantly during the COVID-19 global pandemic due to the widespread use of digital technology as well as the demand of the situation where the classroom activities converted a real-world setting into a virtual one. In the same way, the schools' closure had urged participants to use digital technology as the only possible media of teaching and learning, which finally improve their technical competencies in the classroom. This finding was consistent with the study of Perifanou, Economides, and Tzafilkou (2021) which stated that the pandemic crisis pushed teachers to use digital tools for developing teaching materials, delivering subject content, as well as for classroom evaluation and improve their daily emergent teaching responsibilities. Thus, finding from study shows that participants'self-efficacy to use digital technology in teaching was positive.

In addition, survey findings related to teachers' digital technology attitudes revealed that they showed to have positive mindset in the use of digital technology in the classroom. Descriptive statistics analyses identified that teachers' mean score was above the mid-point of a five-point scale, M= 3.76 and SD= . 37. Furthermore, the qualitative study revealed that all interviewees believed that they possessed good mood in regard to digital technology integration in the classroom. To their belief, digital technology played a very important role in today's education, where students were digital natives. Students were more advanced in using digital technology than their teachers and were more interested in learning by utilizing the tools. Therefore, teachers should be able to employ digital devices in the classroom in order to increase students' active involvement in learning and should keep increasing their ability to use digital tools for teaching as technology keeps advancing.

Finding from this study shows that teachers had positive attitude to use digital technology in teaching. In addition, teachers believed that digital technology is a vital media for teaching and learning in the classroom since the technology has changed the world. It confirmed the previous studies suggested that teachers possessed positive attitudes towards digital technology integration in teaching (Marpa, 2021; Islahi and Nasrin, 2019). Jogozai, Baloch, Jaffar, Shah, Khilji, and Bashir (2021) described that teachers' positive attitudes towards the use of classroom digital technology integration developed mainly by the COVID-19 pandemic situation where teachers had to opt for digital tools in teaching. Similarly, findings of Davidovitch and Yavich (2021) on the use of tablets in the classroom found that younger teachers (26-42 years old) have higher positive general attitudes towards the use of advanced technological tools as teaching and learning aids, but their older colleagues (43-65 years old) perceived lower attitudes in comparison to them. Therefore, finding of this study is compatible with other research which showed that teachers possessed good attitude towards digital technology integration in teaching. Teachers who had positive attitude to integrate digital technology would likely to use digital devices in teaching.

In addition, document analyses as well as classroom observation affirmed that the majority of participants in this study had adequate ICT skills for teaching, where they used several kinds of digital tools such as laptops, projectors, smartphones, Microsoft offices, videoconferencing platforms, e-learning platforms, social media platforms, and graphic design apps. Findings revealed that all participants did not only use digital technology to perform basic tasks in teaching, such as typing, searching, downloading, or presenting the power point, but also used the technology to perform advanced tasks, such as creating instructional videos, performing a virtual biology lab, and executing virtual learning. Their good self-efficacy in integrating digital technology was reflected in their daily practice of utilizing the tools for classroom activities.

Though the development of digital technology is important to today's education, there are some serious problems that should be considered by teachers, such as the issues of cyber security and data privacy. Technology was also identified as a way to distract students' attention from learning, where it could potentially be misused by students during the classroom session. Though teachers were a little worried of using digital tools, still they believed that digital technology was useful for teachers in performing their tasks in the classroom as well as to provide students with necessary future digital skills. They believed that technology was only a tool used to ease teachers' tasks and was not the main actor in education. This revealed that teachers viewed the their pivotal role in the classroom and they were not anti-technology. They perceived technology as an important tools assisting the classroom activities, and identified themselves to have positive attitudes to use digital technology in the classroom.

Findings from survey described that teachers' self-efficacy towards the use of technology was statistically different based on their ICT training during pre-service, ICT training during in-service, teaching experiences, and educational backgrounds. In contrast, findings reported that teachers' attitudes going from the ICT training during pre-service, the ICT training during in-service, teaching experiences, and educational backgrounds showed to have insignificant difference statistically.

Some participants mentioned that they were confidence enough in incorporating digital tools into teaching because they had received adequate ICT training that equipped them with the necessary ICT skills. This finding is significant as it aligns with previous studies emphasing the importance of self-efficacy in the effective use of digital technologies where technical digital competency was the most significant predictor of teachers' self-efficacy to employ digital tools for teaching (Kwon, et al., 2019; Ogodo, Simon, Morris, and Akubo, 2021).

Furthermore, all participants stated that their teaching experience during the COVID-19 global pandemic significantly increased their self-efficacy in employing the devices for teaching, which was adhere to the studies of Baroudi and Shaya (2022) and Li, Liu, Chen, and Ya (2022). In contrast, Pressley (2021) found that teaching experience did not lead to higher self-efficacy in implementing digital technology because there was a lack of teaching experience in using virtual technology before. This suggested that the use of digital technology in the classroom is important. However, adequate digital technology training, facilities, and support should be provided to improve the practice in the classroom.

In general, qualitative analyses supported the results of the survey, which provided a deeper understanding of teachers' perception of efficacy as well as teachers' attitude to integrate technology in teaching. To interviewees' belief, there were some factors that supported their positive self-efficacy and attitudes toward using digital devices in teaching. Some described to have adequate ICT training either during pre-service training or during in-service. Others stated that the global pandemic outbreak forced them in integrating the tools for classroom purposes, which in turn increased their self-efficacy and attitudes as well. In addition, teachers who were digital immigrants described that they had to change the conventional approaches in teaching in order to support students to learn effectively since they were born and brought up in the era of digital technology and were familiar with those technologies from an early age.

In summary, teachers' positive self-efficacy and attitudes to use digital technology in the classroom revealed that they have a progressive mindset which view the important of digital technology in the digital era. Their readiness to accept technology as well as their confidence to use it in the classroom would benefit both, teachers and students. In addition, teachers' competence of using digital technology must continue to be improved to equipp students with necessary skills and knowledge in digital era would help them exploring their world.

7.2.2 Research Questions 2

What are teachers' perceptions of their technological, pedagogical, and content knowledge (TPACK) in teaching?

This research question targeted teachers' understanding of their TPACK in Indonesia. Findings from quantitative analyses showed that teachers' TPACK was good. Overall, teachers believed that they could employ TPACK in teaching. Furthermore, teachers also showed to be confident with all TPACK domains. Their mean score ranged from 3.39 to 3.89 which passess through the mid-point, and providing a generally positive response to the scales. It confirmed the findings Ali and Mohammadzadeh (2022) which showed that teachers have higher self-perception on TPACK in general. A similar study in the region conducted by Ismail, Masari, Desi, Kasriyati, Herdi, and Andriani (2023), and Mahdum (2005) found that senior high school's teachers believed that they possessed high TPACK understanding and they have the necessary skills to apply TPACK in the classroom.

Qualitative analyses found that teachers believed that they could implement TPACK in the classroom. Moreover, during the closure of the schools, they worked hard to incorporate digital technologies in the classroom and found that technology was very effective in the classroom. One of the participants confidently explained that she understood the TPACK and could use the framework in teaching. During her classroom visit, she demonstrated the ability to manage her classroom well by integrating suitable digital technologies such as laptop, tablet, and projector. In addition, her students were allowed to access their smartphone to participate in the classroom activities. She showed to master the content knowledge and was able to encourage her students to learn actively. Further, She used several digital platforms to support the classroom activities. This scenario suggested that teachers were capable to develop TPACK in teaching.

Within TPACK's subscales, results of the study showed that content knowledge (CK) was observed to have the highest mean scores of all subscales ($M = 3.89$ and $SD = .45$), followed by their pedagogical content knowledge (PCK) ($M = 3.85$ and $SD = .33$) and technological knowledge (TK) ($M = 3.77$ and $SD = .41$). In contrast, Pedagogical Knowledge (PK) was considered as the lowest with $M = 3.39$ and $SD = .58$.

With regard to teachers CK, they identified themselves to be more confident with their CK compared to the other domains, as shown by the survey. Qualitative findings suggested that all teachers were highly confident with their CK. They claimed that they know CK well. One of the participant, for instance, stated that her understanding on the subject content was very good because of her long teaching experience. Other participants also confidently stated that they have good CK because they learned the subject content when they were still in the pre-service program, and they kept improving their CK.

Therefore, it can be revelaed that teachers possessed high perception of CK because they gained adequate training on the subject content during pre-service training. I addition, their teaching experience has developed their understanding of the subject content, and they continued to broaden their understanding on the subject well. This finding was adhere to several studies identifing teachers as having more confidence with their CK (Nordina, Davis, Faekah, & Ariffi, 2013; Tseng, 2014; Aniq & Drajati, 2019; Chen & Jang, 2019; Akturk & Saka Ozturk, 2019; Huang, Chen, & Jang, 2022). It suggested that teachers should first know the subject content they teach before incorporating the digital devices in their teaching because understanding the CK may be the most fundamental aspect of teacher competency. Teachers who are unfamiliar with a subject well are unlikely to possess the information necessary to assist students in learning this material (Ball, Thames, & Phelps, 2008). However, simply being an expert on a subject content might not be enough, and teachers need other teaching skills.

In addition, results from qauntitative data analyses showed that among others TPACK,s components, teachers were less confidence with their PK. Analyses of qualitative data indicated that some teachers showed to have less confidence of PK compared to other domains. All participants claimed that, in general, they understand PK in teaching. However, some further described that they were less assured about their PK abilities. Participant 5 for instance stated that though she already learnt the PK during the pre-service training, but she felt that her understanding on PK still needed to be improved. She stated that she mostly used classroom discussion and lecture methods in the classroom. Similarly, participant 2 explained that he was not really confident with his PK in teaching. This finding supported the study of Akturk and Saka Ozturk (2019) who identified that teachers were perceived to have less confidence in their PK. However, study of Hill and Uribe-Florez (2020), Ali and Mohammadzadeh (2022), Huang, Chen, and Jang, (2022) showed different results, where teachers identified themselves to have higher ability on PK. This suggested that improving PK is important. The effectiveness of the teaching-learning process can be improved by pedagogical skills, which can also improve collaborative learning, and promote a more individualised learning experience.

With respect to teachers' TK, it was interesting to see that teachers were confident to rate good TK in teaching, although at the same time, survey analyses identified that teachers did not receive appropriate ICT training either during pre-service or in-service. There were only 22% of the teachers who got ICT training during the pre-service period, and 32% of them received ICT training during the in-service period. This finding was in contrast with a similar study conducted by Li et al. (2021), Chieng and Tan (2021), Hill and Uribe-Florez (2020), and Chen and Jang (2018), which found that teachers were least confident in their TK. Factors such as a lack of devices for students, internet access, and technical support prevent them from implementing technology effectively (Hill & Uribe-Florez, 2020). Thus, teachers lacked the confidence in employing digital technology for teaching. Nonetheles, studies of Mohamad and Akun (2021) and Lefebvre, Samson, Gareau, and Brouillette (2016) were consistent with this study and found teachers to have a higher TK score.

Qualitative findings suggested that all participants believed they had the good TK required for classroom purposes since the COVID-19 pandemic situation forced them to teach students virtually by utilizing digital technologies. Furthermore, complete ICT facilities, a good internet connection, and adequate ICT training had also improved their TK. The fact that students are digital natives has changed the classroom approaches which provide some great opportunities in employing technology in the classroom. However, Mailizar and Fan (2020) identified that Indonesian mathematics and science teachers had inadequate TK in teaching compared to the other TPACK domains. Muhaimin et al. (2019) revealed that teachers perceived to have lower confidence in technological subscale because of their insufficient technological knowledge, lack of ICT facilities, and inadequate ICT training. However, this finding suggested that the massive spread of Covid-19 might become an important factor to increase teachers' belief on TK. They were pushed to use the digital tools to bridge the absence of off-line learning. In addition, the installation of digital technology facilities and access became the major concern from government to ensure the learning process continues during the pandemic.

Findings from this study also revealed that teachers possessed higher self-perception on TPK, TCK, and TPCK which is likely to be in line with that of Cahapay and Anoba (2021) which found that teachers possessed a high level of TPK to use the technology in teaching. Similarly, Kazu and Erten (2014) found that teachers perceived higher level of TCK, TPK, as well as PCK. In consistent with this study, Masrifah, Setiawan, Sinaga, and Setiawan (2018), and Fathi and Yousefifard (2019) found that teachers showed to have lower confidence to components related to technology such TCK, TPK, and TPACK. Although studies showed different results with respect to teachers' belief on the TPACK's individual components, it is vital for teachers to understand each elements of TPACK in order to successfully integrate digital technology in the classroom.

Further analyses were conducted to explore the difference in teachers' TPACK according to demographic variables based on the variables of the teachers' professional program, the teachers' professional experiences, and the teachers' level of education. Findings showed that those variables affect teachers' TPACK in the classroom. These findings were in harmony with the study of Antony, Subali, Pradana, Hapsari, and Astuti (2019); Li, Liu, and Su (2022) which found that teaching experience and academic qualification significantly affect teachers' TPACK.

With respect to the teacher professional program, PK showed to have a statistically significant difference between those who had taken the program and those who had not taken it. Teachers who received the program seemed to have more understanding of PK compared to those who did not get the program. It suggested that the teachers' professional program was effective to improve teachers' undertanding of how to deliver the subject content. However, the professional program did not considerably better to increase teachers' other TPACK's subscales. Thus, the professional program need to be improved to help enhancing TPACK in the classroom.

In addition, this study also showed that based on the teaching experience, teachers' TK and teachers' TPK showed to have significant difference statistically. Teachers with more experience were identified as being more proficient in TK and TPK as well. This seemed to confirmed that of Jang and Tsai (2013) which found that teachers's TPACK was statistically significant according to teaching experience. This finding revealed that teaching experience which combining training and developed abilities enables teachers to complete their duties more efficiently and improve their confidence. Thus, teaching experience are likely to be an important factor in influencing teachers' TPACK in teaching.

Findings also revealed that teachers' PK was difference significantly based on the educational level. Those who gained higher educational level would have more understanding on PK in teaching. This finding suggested that teachers' PK differed significantly based on their educational level, the higher the educational level, the better the teachers' PK abilities.

In general, findings from this study showed that teachers had good TPACK understanding in the classroom and were confident with their TPACK skills. Teachers' also showed to have good confidence with all TPACK domains and provided a generally positive response to the scales during interview. They were also observed to successfully employ digital technology in teaching, where their ability to implement TPACK into teaching was mainly due to the need to use virtual learning as the consequence of the hard situation during the COVID-19 global outbreak. In addition, finding suggested that the teachers' professional program, the teachers' professional experiences, and the teachers' level of education significantly affect their TPACK.

7.2.3 Research Questions 3

In what ways do teachers' self-efficacy and attitudes towards the use of digital technologies affect their use of technological, pedagogical, and content knowledge (TPACK)?

Findings from quantitative data analyses suggested a great relationship among the variables. The pearson correlation analyses revealed a moderate relationship between self-efficacy and TPACK, as well as between attitudes and TPACK. This correlation found that teachers' self-efficacy and attitudes towards digital technology integration were significantly related to their TPACK. Furthermore, multiple regression analyses also showed that teachers' self-efficacy and attitudes towards digital technology integration do predict their TPACK in their classroom. This revealed that teachers with more self-efficacy and positive attitudes towards digital technology integration possessed better TPACK. This is in harmony with the study conducted by Bakar, Maat, and Rosli (2020); Zeng, Wang, and Lis (2022) which found that TPACK and teachers' self-efficacy in integrating digital technology were closely related. In addition, Agustian, Aridah, and Iswari (2023) also found that ICT attitudes and TPACK levels had a substantial and favourable correlation.

Statistically, teachers' self-efficacy and attitudes towards digital technology affect their use of TPACK in the classroom. These two factors were the strongest predictors of teachers' TPACK use in the classroom. This finding was consistent with the studies of Abebe (2021) and Yildiz Durak (2019), which found that teachers' technology self-efficacy was a significant predictor of their TPACK. Putry, Astuti, and Sakh (2022) found that self-efficacy was very important because it was helpful to develop teachers' TPACK, as well as to affect teachers' practice of TPACK in the classroom. Similarly, Raygan and Moradkhani (2022) identified that attitude significantly predicted teachers' TPACK practice. Yulisman, Widodo, Riandi, and Nurina (2019) stated that teachers' positive attitude towards digital use in teaching was able to strengthen the positive relation between technology competency and teachers' TPACK. Thus, teachers can effectively use digital technology in the classroom and grow as digital technology users if they have a positive attitudes and high level of self-efficacy in integrating the digital tools. The higher their attitude and self-efficacy to use digital technology in the classroom, the higher their level of TPACK.

In addition, qualitative study also demonstrated that teachers' positive attitudes and self-efficacy to employ digital technology for teaching encouraged them to learn and use the tools in teaching. Participants stated that they were motivated to learn and use useful digital technology in the classroom once they know that digital technology helps them very much in the classroom. Some participants also explained that they would not stop using the digital tools they have used though the pandemic period was over. This revealed that self-efficacy and attitude to use digital technology in teaching might foster teachers' decision to use TPACK as well as to develop their understanding on the framework in order to successfully integrate the devices in their teaching.

Independent variables of teachers' educational level, teachers' teaching experience, teachers completing the teacher's professional program, teachers completing the ICT courses during pre-service, teachers completing the ICT courses during in-service, were examined to see the effect they may have on teachers' self-efficacy, teachers' attitudes, and teachers' TPACK. Findings identified that level of education, teaching experience, and teacher professional program predicted teachers' self-efficacy towards digital technology integration. These were likely to support the findingS of Baroudi and Shaya (2022) which showed that teachers with previous teaching experience and teachers who gained professional development predict their self-efficacy significantly. In contrast, Peng, Razak, and Halili (2023) described that teachers with less teaching experience exhibit significantly stronger self-efficacy in teaching compared to those who had more teaching experience. Nevertheles, this study suggested that higher education, teaching experience, and teacher professional program significantly influenced teachers' self-efficacy in integrating classroom digital technology. In addition, none of those variables remarkably affect teachers' attitudes toward employing digital devices in the classroom.

This study also suggested that level of education was the most significant predictor of teachers' TPACK. Teachers with a higher level of education would have an impact on their level of TPACK. It clearly supported the study of Akturk and Ozturk (2019) and Sojanah, Suwatno, Kodri, and Machmud (2021) which identified that professional experience makes a significant difference in teachers’ TPACK levels. In addition, findings of Mailizar, Hidayat, and Artika (2020) also suggested that teachers’ level of education was among some factors that significantly affect their TPACK. Li, Liu, and Su (2022) found that the seven TPACK sub-dimensions varied considerably according to teachers' educational backgrounds, with higher education levels being associated with greater TPACK skills in teachers. Thus, degree of education helps teachers establish the fundmentals knowledge and skills needed for teaching, and this study proved that academic level may influence teachers’ TPACK in the classroom.

Qualitative analyses identified that teachers’ self-efficacy and teachers’ attitudes to use digital technology in the classroom affected teachers’ TPACK competence in three aspects: first, their internal motivation in using digital technology for teaching; second, teachers’ belief in the importance of digital technology in teaching; and third, teachers’ belief in their ability to use digital technology in the classroom.

All of the participants in the qualitative stage described that they were motivated to use and to learn the digital technology in the classroom because the power of technology to enhance meaningful classroom setting. In addition, the application of digital technology in the classroom helped techers execute their works effectively and efficiently. Though some of them were afraid of cyberattacks, including viruses and malware, they still viewed digital technology as an important medium in supporting classroom activities.

The intrinsic motivation in using digital technology comes from teachers' desire to keep learning and using digital tools in teaching. According to Uluyol and Şahin (2014) teachers’ motivation in terms of encouragement, support, and opportunities must be developed in succeeding the classroom digital technology application. Furthermore, adequate ICT facilities and knowledge of ICT are important to motivate teachers in employing the devices for teaching. Findings suggested that there were no issues related to ICT facilities and training to employ the devices in teaching, which encouraged them to use the tools in teaching. Mirzajani, Mahmud, Mohd Ayub, and Wong (2016) identified that appropriate ICT skills and sufficient ICT resources were important factors that affected the motivation to use the ICT for teaching. However, Mahdum, Hadriana, and Safriyanti (2019) found in their study that teachers were stimulated to integrate the devices for teaching, though they faced limited ICT resources and knowledge. Of course, teachers would be more interested in using digital tools if they have adequate facilities and sufficient competence in employing them in the classroom.

Furthermore, participants agreed that digital technology plays an important role in today's classroom, where students were born as digital natives. Since educational curriculum and teachers were not fully designed and trained to fulfill the needs of digital natives, it was urgent for teachers; either they were digital immigrants or digital natives themselves, to find out learning approaches to support digital natives' needs in the classroom. Teachers shared a positive view of digital technologies in teaching. It was consistent with Hol and Aydin's (2020), which perceived digital technology integration positively. Thus, teachers should keep up with the technology in teaching. A study by Alberola-Mulet, Iglesias-Martne, and Lozano-Cabezas (2021) found strong belief on the capability to integrate digital technology significantly imporved educational process. In addition, Jimoyiannisa and Komis (2007) found that a great majority of teachers recognized the radical changes in education brought by ICT.

Finding also revealed that teachers believed in their competence in corporating that digital technology for teaching. Their strong confidence in integrating the devices relied on their belief that digital technology could be learned by everyone. This study found that the majority of teachers said they received enough ICT training and were able to use digital tools in their teaching. Besides, ICT infrastructures at school also improved significantly to support the virtual learning during Covid-19 outbreak. This difficult situation encouraged them in using the tools for teaching. It was consistent with finding of Maity, Sahu, and Sen (2020) and Vargo, Zhu, Benwell, and Yan (2020), which found a significant increase in classroom digital technology integration.

Thus, this study revealed that teachers' self-efficacy and teachers' attitude in digital technology integration affected teachers' practice of TPACk in teaching. Statistically, teachers' efficacy and attitudes towards digital technology integration do predict teachers' TPACK in their classroom. Furthermore, in-depth analyses showed that teachers' TPACK use in teaching was influenced by self-efficacy and attitudes in terms of their motivation to use digital devices, their positive beliefs about digital technology use, and their capability in integrating the technology in the classroom.

7.2.4 Research Questions 4

What are the factors that promote or inhibit digital technology use in the classroom?

Previous studies mentioned several barriers that prohibited classroom digital technology integration. Mulhim (2014) mentioned three challenging factors which prevent teachers to use technology in teaching; they are (1) poor ICT access, (2) poor ICT training, and (3) limited time to prepare the ICT in the classroom. Other studies also found that ICT skills and knowledge, ICT support, and ICT facilities were among the biggest barriers to ICT integration teachers felt in the classroom (Warioba et al., 2022; Chigama & Goronga, 2022; Ssenyonga et al., 2022; Turgut & Alper, 2021; Prasojo et al., 2019).

Findings from quantitative analyses confirmed the earlier studies which showed several factors may prevent or empower teachers to use technology in the classroom. The factors were digital technology training for teachers, digital technology knowledge and skills, digital technology technical support, time to prepare the use of digital technology, internet connection, digital technology facilities, and digital technology access, which supported the findings from earlier studies. Integrating digital technology in education requires adequate financing for digital technology infrastructures and training for teachers. Thus, this study suggested that full support must be given to schools by government agencies and other involved parties in increasing the use of digital technology in the classroom.

In general, the qualitative findings provided a deeper perspective which enrich the understanding of the study. Data analyses identified there important themes that promoted or inhibited the digital technology integration in the classroom. They were students' factors, teachers' factors, and schools' factors.

Digital technology integration is considered important for teachers to boost their teaching activities as well as to engage students in the classroom. It needs compatible digital devices and requires internet access in order to access the useful teaching and learning platforms and programs. With regrad to factors that come from students themselves, findings showed that not all students were equipped with the necessary tools for learning such as laptop, smartphone, or tablet. In addition, many students also reported not to have adequate internet access for learning since their parents were from low-income families. These findings seem to be consistent with the study conducted by Martinez-Dominguez and Fierros Gonzalez (2022); Adnand and Anwar (2020) which found that economic status and the availability of electronic devices were among the factors that affected students' internet access and usage patterns for learning. Furthermore, Werang and Leba (2022) identified that students' limited access to digital technology were the most significant factors affecting their engagement in online teaching and classroom learning. Many of students from low economic class had to go to the school's ICT lab or multimedia room to access the digital technololy for learning. Thus, for some degrees, it hinders the effectivenes of digital technology integration in the classroom.

In today's digital technology integration, a teacher is not the only person who uses digital tools in the classroom. In the past, teachers used the digital technologies in the classroom to empower their teaching, while their students just observed the presentation through the projector. During the global pandemic, the presence of digital tools provided greater opportunities for students to take part in learning. They can use the devices to participate in the classroom activities or to be self-regulated learning with digital technology. Interesting and useful learning platforms and programs provide attractive classroom activities for students. Therefore, appropriate digital technology use would increase students' engagement in the classroom.

Furthermore, findings identified that sufficient digital technology skill was important to boost the digital technology integration. Most of the respondents claimed not to have serious problems related to the use of digital technology in teaching. They mentioned to have necessary digital technology skills required for classroom digtal technology integration, and received enough training on digital technology. Only a few number of the participants that explained to have insufficient digital technology training. However, they could solve the issu by utilising the YouTube videos in learning the software or the platforms. Taking advantage of the available technology such as YouTube videos, teachers could increase their digital technology skills by self-learning. In addition, all of the participants stated that they had enough digital devices and internet access for teaching. In many schools, devices such as laptops and computers were provided, as well as a good internet connection. Therefore, adequate digital technology training, access to digital technology facilities, and connection to a good internet network were considered important to foster the integration of classroom digital technology.

Findings also showed that schools were equipped with sufficient infrustructures to support the integration of digital technology in teaching. It showed that school provided adequate digital tools such as laptop, computer, and projector. In addition, schools also provided good internet connection though few participants felt that the connection often dropped and did not cover all areas at the school. Besides, most of teachers also claimed that their schools provided enough digital trainings, so that they can integrate the tecnology in the classroom.

This study suggested that digital technology facilities and internet connection were important for digital technology integration. Class observation showed that all schools that participated in this study possessed good digital technology facilities, and some were considered to have excellent facilities. All of the participants also confirmed that they had no issues related to the digital technology facilities provided by the school. According to them, the facilities provided were adequate for digital-based classroom activities.

Overall, digital technology integration in teaching was not an easy task for teachers to execute. There are some factors that prohibit or promote teachers in integrating the digital devices for teaching. Digital technology facilities and Digital technology training were among the factors that may hinder or bolster up the digital technology integration. Adequate Digital technology infrastructure and technical skills were important to the integration's success. On the other hand, insufficient facilities and training may slow down the incorporation of digital technology for teaching.

7.2.5 Research Questions 5

What are the digital technologies used by teachers, and how are they being used in the classroom?

7.2.5.1 What Are the Digital Technologies Used by Teachers?

Findings showed that teachers employed a variety of digital devices to support their teaching activities. Among the tools that were mostly used in the classroom were laptop, smartphone, personal computer, projector, and tablet. Furthermore, there was a large number of software or programs, or platforms used for teaching and learning such as email, YouTube, Microsoft Office, video conferences, downloaders, social media platforms, interactive learning sources, games, and quizzes. Findings from other studies also showed that digital technologies such as Google Classroom (Alim, Linda, Gunawan, & Md Saad, 2019), quizzes (Zhao, 2019), instructional videos (Alpert & Hodkinson, 2019), and mobile devices (Dias & Victor, 2022) were extensively used by teachers in the classroom. Vargo, Zhu, Banwell, and Yen (2020) found that there were 15 types of hardware and more than 50 types of software used during the COVID-19 global outbreak.

Digital technology was important in the classroom. The study by Ansari and Khan (2020), for instance, showed that the use of social media platforms may increase students' interactivity for collaborative learning. In addition, Amin and Sundari (2020) found that Cisco WebEx meetings, Google Classroom, and WhatsApp gained positive responses in the classroom.

Furthermore, analyses showed that laptop was used by almost all of teachers in teaching. The majority of them reported that they used laptops on a daily basis, while some of them used laptops at least on a weekly basis. It can be understood that most teachers employ laptops in the classroom, perhaps because there is no such powerful device to complete any tasks required for teaching. By using laptops, teachers could search for the teaching materials, prepare the teaching materials, and deliver the teaching materials to their students in many ways, such as via video conference.

Findings also found that smartphones were the second-most-used daily tool by teachers for teaching. It was not surprising because smartphones combine the functions of a mobile phone and computing functions in a portable unit that is accessed by almost every individual in today’s society. Many tasks can be done by teachers via their smartphones, including preparing the classroom or teaching the classroom. However, in the classroom, most teachers still do not fully trust their students to access their smartphones during classroom activities for several reasons. Mostly, they were worried if their students misused the smartphone for other purposes.

Other tools such as smartphones, Microsoft Office, YouTube, video conferencing, interactive learning platforms, email, video, and quiz apps were also among the technologies that were used by many teachers in the classroom, at least once a week. Thus, it was clear that teachers employ many kinds of digital tools for executing effortless tasks such as preparing the PowerPoint presentation and complex tasks such as creating the instructional videos that help them teach in the classroom.

In the same way, qualitative analyses identified similar tools employed by teachers in the classroom. One of the participants, for instance, mentioned that he used some devices, such as a laptop, projector, smartphone, search engine, Microsoft Office, social media platforms, video editor, video conference, video, quiz app, e-mail, and interactive learning platforms, in teaching. According to him, those technologies were used for classroom purposes since the global Covid-19 pandemic forced education sector to close the schools and shifted the teaching into virtual learning. Findings identified that those devices were used to booster teaching and learning activities from class preparation to class evaluation. Tools such as canva for instance has been used to design the teaching materials in order to be more attractive for students. Some participants stated that even they used social media such as instagram to convey the material to students.Moreover, tools such as google classroom and google form also have been to deliver subject content as well as to evaluate students' achievement. However, the use of those devices still need to be explored to know the effectiveness in teaching. Though digital devices were very powerful for the classroom and were used mostly during the COVID-19 global pandemic as the implications of schools' closure, they are might no longer be used intensively after the Covid-19 has been declared as endemic in many countries. Thus, this study suggested that digital tools, such as laptops, smartphones, video conferences, e-learning platforms, and graphic design tools were widely used by teachers in to their teaching and they were very powerful for the classroom and were used mostly during the COVID-19 global pandemic. A further study need to be done to explore the current use of digital technology.

7.2.5.2 How Are They Being Used in the Classroom?

Digital technology was used by teachers to prepare the classroom, to deliver the topic, and to evaluate the classroom. The devices were used intensively and extensively, especially during the COVID-19 global pandemic, by teachers. In addition, the government spent a lot of money to build the ICT infrastructure as well as to provide technical training on ICT use in teaching.

Firstly, the presence of digital technology was very helpful for teachers to prepare the classroom, from searching to organizing the teaching materials. Most of the interviewees described that they used to use the search engines to find some relevant websites that provided materials for their classrooms. In addition to websites, some other teachers also explained that they also used to download the appropriate videos for their classroom. Then, they would organize the materials mostly into PowerPoint presentations or instructional videos. At this stage, teachers should demonstrate their capability to use digital technologies for preparing the teaching content.

Second, digital technology was utilized by teachers as the medium of instruction to deliver their subject matter in the classroom. During the global COVID-19 outbreak, digital devices were the only possible medium of teaching that might be used. A study by Ditzler, Hong, and Strudler (2016) found that teachers used digital technology as the medium for teaching the subject to their students. They used iPads to demonstrate the lesson to the class. Digital technology use such as Google Classroom can motivates and encourages students to learn effectively (Ramadhani, Umam, Abdurrahman, & Syazali, 2019).

Finally, digital technology was used to evaluate students' comprehension of the learning materials. All the participants stated that they did not use any written documents for students' assignments, quizzes, or exams. Many kinds of digital tools for evaluation were used by teachers, such as quiz apps, survey apps, social media platforms, and interactive e-learning. Zhao (2019), Nuci, Tahir, Wang, and Imran (2021) found that teachers utilized digital technology such as quiz platforms to evaluate students' understanding. The availability of technology has shifted the way teachers use the tools to assess the classroom. Previously, assignment-based papers were the most common way to evaluate the students' understanding. But now, technology provides a lot of opportunities for teachers to measure the classroom in interesting and easy ways.

Digital technology is considered to be very useful in the classroom and has been used largely in education. There are many kinds of digital devices that can be employed for teaching. Applying digital technology has significant connections with the development of students' self-reliance in learning and the promotion of their skills independently (Wiwin, Widiati, & Tarisman, 2022). (Jannah, Prasojo, & Jerusalem, 2020) stated that the ICT infrastructure was not the only key to the success of technology integration in teaching, but rather the teachers' competence. But, teachers who have good ICT facilities have better performance to employ digital technology in the classroom. However, Singh (2021) described that digital technology itself is not sufficient to create good learning atmosphere in teaching since digital technology has its own limit in a classroom, and the teaching and learning process involves human touch which can never be replaced by the technology no matter how advanced and sophisticated are they.

7.3 Conclusion

This study explored teachers' self-efficacy and attitudes toward digital technology integration in teaching. Besides, the modification of TPACK measurement was also investigated to produce the most suitable TPACK instrument in the Indonesian version. The model was developed by Mishra and Kohler (2005) and investigated by many other researchers up to now ((Beri & Sharma, 2019; De Freitas & Spangenberg, 2019; Roussinos

& Jimoyiannis, 2019; Hendra et al, 2019; Sarıçoban, Tosuncuoğlu, & Kırmızı, 2019; Wulansari, Adlim, & and Syukri, 2019; DeCoiton & Richardson, 2018).

TPACK is an effective framework used in understanding technology integration in the classroom. TPACK framework describes the interconnection of three main components of TPACK, which explain how subject content should be taught by using suitable teaching methods and appropriate technology. This intersection produces other interconnected elements such as TCK, PCK, TPK, and TPACK (Schmidt et al., 2009).

Originally developed by Koehler and Mishra in 2006, the framework is keep developing. One of the most popular approaches used by researchers to investigate TPACK is self-assessment. Many studies have been done to develop the TPACK's instrument such as Schmidt, et al (2009), Chai, et al (2010), Sahin, I (2011), Lux, et al, (2012), Jamieson-Proctor, et al (2013), Saengbanchong, et al (2014), Nordin, H (2014), Valtonen, et al (2015), Kartal, et al (2016), Kiray, S.A (2016), Valtonen, et al (2017), and Akyuz (2018), Chai, et al (2011), Jang, S.J., & Tsai, M.F. (2012), Yeh, et al (2017), and Yanuarto, et al (2020). In conducting this study, the self-survey developed by Valtoneen et al. (2015) was modified to assess teachers' TPACK at schools. Results suggested that the internal consistency (Cronbach's alpha) of all the TPACK's scales were considered reliable. In addition, the results of the exploratory factor analysis (EFA) were valid. These results particularly serve to provide a more relevant TPACK questionnaire for the Indonesian context in accordance with the current curriculum. The TPACK survey designed in this study could be used to increase teachers' understanding of their TPACK self-perception and provide information on technology integration as well as the appropriate pedagogy of teachers.

In general, it was found that teachers' self-efficacy and attitudes toward using digital technology in the classroom were good. Teachers showed a moderate perception of their self-efficacy and attitudes. Qualitative data found that the global COVID-19 pandemic pushed teachers and educational sectors to use digital technology in their activities, including the teaching and learning process. The school also provided a lot of training in digital technology use in the classroom in order to adapt to the situation. With that experience, teachers believed that they were able to use digital technology for teaching, and they believed that their digital technology skills had been developed. It seemed to increase their self-efficacy and attitudes toward classroom-based technology.

In addition, teachers also showed good TPACK understanding. Their ability to use the TPACK in the classroom was seen clearly through the class observations, where they could integrate the suitable technology to support the teaching materials in the classroom. Teachers' good TPACK was influenced by several things, mostly by the COVID-19 outbreak. During the outbreak, teachers were exposed to and forced to use many kinds of digital tools in teaching. In addition, supported facilities for the use of technology in teaching were also provided by the school's authority and government in order to facilitate the teaching and learning process, such as internet connections, trainings on digital technology use, and technical support in that difficult situation.

Findings also revealed that self-efficacy and attitudes toward using digital technology affected teachers' TPACK in the classroom. However, factors such as teachers' professional program, gender, and teaching experience were found to have no significant relationship to teachers' TPACK, except for the teacher's level of education. It was surprising because the researcher was expecting to see that those factors influenced TPACK significantly. It was also understood that self-efficacy and attitudes toward using digital technology shaped the teachers' perceptions of using digital technology in the classroom. With their good self-efficacy and attitudes toward digital technology use, teachers believed that they could use any kind of digital technology useful for teaching. Besides, they also consider the importance of continuing to develop digital technology skills since technology keeps advancing.

Furthermore, it was also found that many of today's teachers were familiar with up-to-date digital technology that can be used in the classroom. The development smartphone and internet where all information can be clicked and accessed quickly form teachers to be either digital natives or digital immigrants which consider the importance of digital tools in education. Tools such as laptops, smartphones, tablets, projectors, learning apps, and other related programs and software were used in the classroom. The variety of digital devices and the intensity of their use had increased significantly during the lockdown due to the COVID-19 pandemic. Teachers employed technology to organize the lesson, to deliver the lesson, and to evaluate the classroom. On many occasions, trials and errors in the use of digital technology had developed teachers' TPACK skills because they would learn and choose the suitable technology and pedagogy to teach a particular topic in the classroom.

However, integrating digital technology into a classroom is a complex process. Besides requiring teachers understanding to use the technology, to understand the pedagogy, and to master the subject content, digital technology facilitates also may affect the integration process. Findings from the quantitative study found that factors such as insufficient digital technology training, insufficient digital technology knowledge, insufficient technical support, insufficient time to use digital technology, problems with internet connections, and insufficient digital technology facilities were considered to prevent teachers from successfully incorporating digital technology in the classroom.

Qualitative findings suggested that all participants agreed that students' access to digital technology facilities was the most preventing factor for employing digital tools in the classroom. In the COVID-19 situation, both teachers and students needed to access digital technology in order to interact in the virtual classroom. To deal with this problem, some schools let their students study in the school's computer lab or multimedia room. In addition, digital technology such as a computer, laptop, smartphone, tablet, projector, learning apps, and other relevant programs and software have proven to help teachers in the classroom, from preparing the classroom to teaching the materials to evaluating the classroom. Thus, there is no doubt that digital technology plays a significant role in today's education, and teachers should be able to integrate it into their teaching.

7.4 Limitation

The study presents some limitations in terms of generalizability because the goal was to explore a particular population of teachers in a particular place, which was senior high school teachers in Pekanbaru, Indonesia. In order to explore teachers' self-efficacy and attitudes towards digital technology integration as well as their TPACK, the study used a mixed-method approach. Teachers who participated in this study were from schools located in urban areas equipped with good digital technology facilities and exposed to digital technology training. This approach allowed the researcher to conduct a comprehensive study of the phenomenon as well as make a contribution to the field of research. Assessing teachers who have good access to digital technology would be important to provide useful information regarding the practice in the schools. In addition, the study included a significant amount of translation from Bahasa to English, which challenged the researcher to transmit the meaning precisely during the translation process. Of course, it was time-consuming and completely difficult to accurately translate the meaning.

7.5 Recommendations

Findings from this study provide useful information to Indonesian Stakeholders in empowering the integration of digital technology in the classroom. Thus, this section describes the recommendations to the stakeholders, namely the government-related agencies; teacher training institutions; schools; and recommendations for future research.

7.5.1 Recommendations for Government Education Financing Service Center

Findings from this study showed that all of the participated schools were provided with adequate digital technology infrastructures required for digital technology integration such as computer lab, laptop and projector for each classroom, printer, and good internet connectivity. There was also an issue relating to the occasionally-disconnected and patchy internet connectivity throughout the classroom, but it was not a major problem. In addition, this study also found that some so called "favourite schools" were installed with multimedia rooms and they possessed a fully at ease and finished library with computers and internet ready. On the other hand, other schools were not equipped with the multimedia room and possessed a library without digital devices and internet access. This disparity needs to be addressed immediately so that all public schools can offer the greatest education for students equally in using digital technologies. Thus, findings from this study recommended that governmrnt education financing service center, should provide schools with adequate digital technology facilities required for digital technology integration. The initiatives to upgrade the digital technology infrastructure in schools must continue to advance.

7.5.2 Recommendation for the Ministry of Education, Culture, and Higher Education

Findings from this study identified that teachers' positive self-efficacy and attitudes toward integrating digital technology in the classroom were positively correlated to the practice of TPACK in the classroom. Findings also suggested that teachers' possessed good self-efficacy and attitudes in using digital technology in teaching and they believed on the urgent of digital technology integration in the classroom. This belief was reflected to their classroom practice which used many kinds of digital devices and platforms to reflect their understanding on the TPACK. However, their understanding on several TPACK components such as PK still needed to be improved. Considering the importance of improving teachers' skills in the classroom, including the use of digital technology in teaching, the ministry of education, culture, and higher must integrate the agenda of improving teachers' digital technology skills and literacy in the classroom. The inclusion of the agenda can be done through several existing programs such as "teachers' professional program" and "program guru penggerak" by strengthening the curriculum of the progrmas in improving teachers' positive self-efficacy and attitudes toward integrating digital technology in the classroom, as well as their TPACK. In addition, teachers' understanding of TPACK concepts should be assessed as part of the requirement to pass the programs

7.5.3 Recommendations for Teacher' Training Institutions

This study revealed that participants rated themselves to have good self-perception of self-efficacy and attitudes towards digital technology use in teaching, as well as their TPACK skills in the classroom. Meaning that teachers' training institutions have already developed pre-service teachers with necessary skills required for teaching, including the ability to use digital technology in the classroom. Nevertheless, finding showed that teachers still need to improve their PK in teaching. Among other TPACK's components, they showed to have lower PK skills. Therefore, besides developing pre-teachers' positive self-efficacy and attitudes towards digital technology use in the classroom as well as pre-service teachers' TPACK, teachers' training institutions should reinforce pre-teachers skills on pedagogical aspects. It is crucial in assisting them during in-service to comprehend the most effective classroom management strategies and provides them with understanding into how students learn differently in various disciplines so that they can adapt their teaching to meet these demands. It strives to raise students' educational experience standards. in addition, pre-service teachers' understanding of the TPACK concepts should be examined as part of the requirement to pass the program.

7.5.4 Recommendations for Schools

This study found that all schools were installed with adequate digital technology for classroom integration. The quantitative findings showed that many participants reported that they still did not gain sufficient training on the use of digital technology in teaching. In addition, interview found that some teachers should upgrade their own digital technology skills by wathching online tutorial videos. Thus, it is recommended that the schools should provide teachers with relevant trainings on digital technology use in the classroom. Schools are also advised to spend enough budget for maintaining and upgrading the digital tools required for teaching and learning in the classroom and encourage teachers to keep learning and integrating digital technology in the classroom.

7.5.5 Recommendations for Teachers

Finding from this study showed that teachers possessed lower PK in teaching compared to the other TPACK's components. PK is important for a classroom setting. With the help of PK, teachers can better personalize their courses to meet the needs of their students. Knowing the many ways that students learn will help them better tailor their courses to their students' requirements. Both the quality of instruction and how students take to it are expected to rise. In addition, it is found that training in digital technology use in the classroom is really needed by teachers to upgarde their digital skills in teaching. Therefore, it is recommended that any necessary coachings to increase teachers' skills in digital technology integration should be given more attention, especially by subject teacher deliberation. It is a forum where teachers who teach the same subject will gather, discuss, and exchange their experiences and idea in the classroom periodically. Teachers are advised to be actively involved in this forum to increase their knowledge and skills.

7.5.6 Recommendations for Future Research

As this study modified the TPACK instruments for 21st-century skills and proved that the instrument was valid and reliable, it is recommended to replicate the study in order to expand our understanding in this field. The validity of this modified instrument in other similar Indonesian settings may confirm and generalize the findings of this study. Furthermore, the modification of the TPACK survey used in this study was modified in accordance with Indonesian settings, which may change with time, situation, and policies. Further improvement is suggested to produce the most suitable instruments for the current Indonesian context.

Future researchers are advised to investigate more insights to deepen their understanding of how digital technology is effectively integrated into the classroom since the current study only explored teachers' self-efficacy and attitudes toward using digital technology as well as their TPACK skills. By doing such research, new understanding and knowledge with respect to digital technology integration may enrich the current body of knowledge.

Besides, this study only identified what digital technologies were employed by teachers in the classroom. Further research on how effective those digital tools in the classroom are suggested to be conducted to expand the understanding on the topic.

In addition, since this study was conducted during the global pandemic of COVID-19, where all schools were shut down, it is recommended to investigate a similar study in a new normal era to broaden the understanding of the findings in the research field. During the pandemic situation, digital technology was used as the main medium of instruction in the classroom. A similar study in a new-normal situation may provide more insights on teachers' TPACK use in the classroom.

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Zhao, F. (2019). Using Quizizz to Integrate Fun Multiplayer Activity in the Accounting Classroom. International Journal of Higher Education, 8(1), 37-43.Every reasonable attempt has been made to acknowledge the owners of copyright material. I would be pleased to hear from any copyright owner who has been omitted or incorrectly acknowledged.

APPENDICES

Appendix A

Curtin Law Risk Research Approval

Curtin University

Research Office at Curtin

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Facsimile +61 8 9266 3793
Web research.curtin.edu.au

15-Dec-2020

Name: Martin Cooper
Department/School: School of Education
Email: Martin.Cooper@curtin.edu.au

Dear Martin Cooper

RE: Ethics Office approval
Approval number: HRE2020-0761

Thank you for submitting your application to the Human Research Ethics Office for the project **The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge** .

Your application was reviewed through the Curtin University Low risk review process.

The review outcome is: **Approved**.

Your proposal meets the requirements described in the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research (2007).*

Approval is granted for a period of one year from **15-Dec-2020** to **14-Dec-2021**. Continuation of approval will be granted on an annual basis following submission of an annual report.

Personnel authorised to work on this project:

Name	Role
Cooper, Martin	CI
Asrofi,	Co-Inv

Approved documents:

Document

Standard conditions of approval

1. Research must be conducted according to the approved proposal
2. Report in a timely manner anything that might warrant review of ethical approval of the project including:
   - proposed changes to the approved proposal or conduct of the study
   - unanticipated problems that might affect continued ethical acceptability of the project
   - major deviations from the approved proposal and/or regulatory guidelines
   - serious adverse events
3. Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an amendment is undertaken to eliminate an immediate risk to participants)
4. An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion

report submitted on completion of the project

5. Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
6. Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
7. Changes to personnel working on this project must be reported to the Human Research Ethics Office
8. Data and primary materials must be retained and stored in accordance with the Western Australian University Sector Disposal Authority (WAUSDA) and the Curtin University Research Data and Primary Materials policy
9. Where practicable, results of the research should be made available to the research participants in a timely and clear manner
10. Unless prohibited by contractual obligations, results of the research should be disseminated in a manner that will allow public scrutiny; the Human Research Ethics Office must be informed of any constraints on publication
11. Approval is dependent upon ongoing compliance of the research with the Australian Code for the Responsible Conduct of Research, the National Statement on Ethical Conduct in Human Research, applicable legal requirements, and with Curtin University policies, procedures and governance requirements
12. The Human Research Ethics Office may conduct audits on a portion of approved projects.

Special Conditions of Approval

It is the responsibility of the Chief Investigator to ensure that any activity undertaken under this project adheres to the latest available advice from the Government or the University regarding COVID-19.

This letter constitutes low risk/negligible risk approval only. This project may not proceed until you have met all of the Curtin University research governance requirements.

Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at hrec@curtin.edu.au or on 9266 2784.

Yours sincerely

Amy Bowater
Ethics, Team Lead

Appendix B

Fieldwork and Work Integrated Learning

Fieldwork and Work Integrated Learning (WIL) Risk Assessment Summary (FRA20002060)

Curtin ID	**19890928**
Applicant Name	Asrofi
Participant Name	Asrofi
Supervisor Name	Martin Cooper
Supervisor Contact	08 9266 75
Fieldwork Type	Research Project – Thesis
Fieldwork Description	This fieldwork is conducted for my Thesis project entitled "The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge". The fieldwork is carried out in my hometown, Pekanbaru, Riau Province, Indonesia. Currently am already here in Pekanbaru, my hometown. During the fieldwork, I am going to collect the data by visiting some schools, distributing a paper based survey to teachers of senior high schools (approximately 450 teachers). Following that, a face to face semi structured interview and Classroom observation (12 teachers will be selected based on the survey response). The curriculum document analysis will also take place. During Covid-19, schools are still open, but without students. All fieldwork activities will follow the latest advice of Indonesian government regarding the Covid-19 health and safety protocol.
Fieldwork Dates	1/02/2021 – 31/12/2021
Risk Rating	High

Planning and Preparedness

Prior to commencement of fieldwork, participant(s) will be adequately prepared as follows:

Pre-briefing sessions conducted for fieldwork participant(s). Additional information for Staff or Students.*	Yes
On-site induction conducted before fieldwork commences	No
Contingency plans are in place should the fieldwork not be able to proceed*	Yes
Specific threats to the safety and health of participant(s) are identified and addressed*	Yes
Student Curtin Access Plan on Blackboard or Student One reviewed (Staff Only)	No
Relevant Fieldwork checklist consulted*	Yes

Location

Is International Travel required?	**Yes**

Destination	**DFAT Level**
Indonesia	4

Risk Mitigants

(1) Situational Awareness Guidelines will be followed*	Yes
(2) Downloaded the International SOS App, read and understood medical and security information for destination, and will check-in via App*	Yes
(3) Registered for travel updates with Smartraveller (Australian Citizens/Residents Only)	No

Is the destination subject to Australian Autonomous Sanctions?	**No**
Is the destination subject to the Defence Trade Control Act?	**No**

Does the location have known security, political issues, or significant differences in culture or the laws of the land compared to Australia?	**No**
Will participant(s) be travelling with Third Party or Curtin information?	**No**
Will participant(s) be accessing Third Party or Curtin information?	**No**
Will participant(s) be travelling to a remote, rural or regional location?	**No**
Does the fieldwork location experience extreme weather or environmental conditions?	**No**

Health and Safety

Does the location experience issues with hygiene or quality concerns when accessing food and/or water?	**No**
Have any pre-existing well-being, medical conditions or disabilities been identified?	**No**
Are there required and/or recommended immunisations and vaccinations for the fieldwork activity or location?	**No**
Will participant(s) be staying in accommodation other than a hotel?	**Yes**
Will participant(s) be staying with family and/or friends?	**Yes**
Does the fieldwork involve working with hazardous materials e.g. chemicals, biological materials, or a hazardous activity?	**No**
Will participant(s) be using plant and equipment as a part of their fieldwork?	**No**
Does the fieldwork involve working alone or in isolation?	**No**
Does the fieldwork involve working in confined spaces?	**No**
Will participant(s) be travelling in a car more than 50km outside an urban area?	**No**
Will participant(s) be undertaking any of the following: travelling on unsealed roads; or using a mode of transport other than a car (e.g. boat, motorcycle, scooter, helicopter, charter flight etc)?	**No**

Compliance

Will an external organisation be hosting participants? (e.g. industry/government/ community)	**No**
Does the fieldwork require ethics approval?	**No**
Will participant(s) be required to gain external permissions, permits or licences for the fieldwork?	**No**

Your Fieldwork and WIL Risk Level Profile:

Overall Risk Status	High

Revised Risk Status
Comment

Appendix C

Research Recommandation from Riau Integrated Services Agency

PEMERINTAH PROVINSI RIAU
DINAS PENANAMAN MODAL DAN PELAYANAN TERPADU SATU PINTU
Gedung Menara Lancang Kuning Lantai I dan II Komp. Kantor Gubernur Riau
Jl. Jend. Sudirman No. 460 Telp. (0761) 39064 Fax. (0761) 39117 **P E K A N B A R U**
Email : dpmptsp@riau.go.id

REKOMENDASI
Nomor : 503/DPMPTSP/NON IZIN-RISET/38362
T E N T A N G

PELAKSANAAN KEGIATAN PENELITIAN

1.04.02.01

Kepala Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu Provinsi Riau, setelah membaca Surat Permohonan Penelitian dari : **Asrofi, Nomor : - Tanggal 2 Februari 2021**, dengan ini memberikan rekomendasi kepada:

1. Nama	:	**ASROFI**
2. Alamat	:	MINAS TIMUR
3. Pekerjaan	:	PENELITI
4. Kebangsaan	:	INDONESIA
5. Judul Penelitian	:	**The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge**
6. Lokasi Penelitian	:	SEKOLAH MENENGAH ATAS SE-KOTA PEKANBARU
7. Penanggung Jawab	:	ASROFI
8. Pengikut	:	-

Dengan Ketentuan sebagai berikut:

1. Tidak melakukan kegiatan yang menyimpang dari ketentuan yang telah ditetapkan yang tidak ada hubungan dengan kegiatan ini.
2. Pelaksanaan Kegiatan Penelitian ini berlangsung selama 6 (enam) bulan terhitung mulai tanggal rekomendasi ini dibuat.
3. Kepada pihak yang terkait diharapkan untuk dapat memberikan kemudahan serta membantu kelancaran kegiatan Penelitian dan Pengumpulan Data dimaksud.

Demikian Rekomendasi ini dibuat untuk dipergunakan seperlunya.

Dibuat di : Pekanbaru
Pada Tanggal : 3 Februari 2021

Ditandatangani Secara Elektronik Melalui :
Sistem Informasi Manajemen Pelayanan (SIMPEL)

DPM PTSP PROVINSI RIAU

DINAS PENANAMAN MODAL DAN PELAYANAN TERPADU SATU PINTU PROVINSI RIAU

Tembusan :
Disampaikan Kepada Yth :
1. Kepala Badan Kesatuan Bangsa dan Politik Provinsi Riau di Pekanbaru
2. Kepala Dinas Pendidikan Provinsi Riau di Pekanbaru
3. Asrofi di Pekanbaru
4. Yang Bersangkutan

Appendix D

Research Recommendation from Riau Province Educational Agency

PEMERINTAH PROVINSI RIAU

DINAS PENDIDIKAN

JALAN CUT NYAK DIEN NO. 3 TELP. 22552/21553
PEKANBARU

Pekanbaru, 24 MAY 2021

Nomor : 071/Disdik/1.3/2021/7014
Sifat : Biasa
Lampiran :
Hal : **Izin Riset / Penelitian**

Kepada
Yth. Kepala SMA Se-Kota Pekanbaru
di-
Tempat

Berkenaan dengan Surat Rekomendasi dari Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu Provinsi Riau Nomor : 503/DPMPTSP/NON IZIN-RISET/38362 Tanggal 3 Februari 2021 Perihal Pelaksanaan Izin Riset, dengan ini disampaikan bahwa:

Nama	: **ASROFI**
Alamat	: MINAS TIMUR
Pekerjaan	: PENELITI
Kebangsaan	: INDONESIA
Judul Penelitian	: **THE INFLUENCE OF SELF-EFFICACY AND ATTITUDE TOWARDS DIGITAL TECHNOLOGIES ON TEACHERS' TECHNOLOGY, PEDAGOGY AND CONTENT KNOWLEDGE**
Lokasi Penelitian	: SMA SE-KOTA PEKANBARU
Penanggung Jawab	: ASROFI

Dengan ini disampaikan hal-hal sebagai berikut :

1. Untuk dapat memberikan yang bersangkutan berbagai informasi dan data yang diperlukan untuk penelitian.
2. Tidak melakukan kegiatan yang menyimpang dari ketentuan yang telah ditetapkan dan memaksakan kehendak yang tidak ada hubungan dengan kegiatan ini.
3. Adapun Surat Izin Penelitian ini berlangsung selama 6 (enam) bulan terhitung mulai tanggal rekomendasi ini dibuat.

Demikian disampaikan, atas perhatian diucapkan terima kasih.

An. KEPALA DINAS PENDIDIKAN
PROVINSI RIAU
SEKRETARIS

Dr. Eng. YUSRI, S.Pd.,S.T,M.T
Pembina Tingkat I
NIP. 19661231 199102 1 007

Tembusan:
Asrofi di Pekanbaru

Appendix E

Research Permission for schools

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge

Dear School's Principle

City of Pekanbaru, Riau Province

My name is Asrofi, and I'm a Ph.D candidate in the School of Education at Curtin University Australia. I am currently conducting my Ph.D research project titled "*The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge*" under the guidance of Dr. Martin Cooper and Dr. Kathryn Dixon. This project has received a permit from the Regional Office of Education and Culture of Riau Province (Reference No: 52020788019075). There are two parts of data collection in this research. Phase one of this project refers to a questionnaire survey understanding the views of teachers towards self-efficacy and attitudes on the use of digital technology in the classroom. The second phase of this project will include an interview and classroom observation for a few number of teachers.

I am wondering whether you may give permission to collect the data in your school. The survey may take 25-30 mins of participants' time. After completing the survey, each participant will be given a lunch box. Participation in this study is completely voluntary and will not affect any teaching performance scores. All information will be kept confidential and no individual will be identified able from the final report. Any information obtained and published in a scholarly journal; confidentiality will be protected.

I would like to thank you for considering my request.

Yours sincerely,

Asrofi

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number: HRE2020-0761). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au.

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge

Pekanbaru, 20 Mei 2021

Hal : Permohonan Izin Penelitian
Lamp : 3 Berkas

Kepada Yth. Bapak/Ibu Kepala Sekolah SMAN 12 Kota Pekanbaru

Di Pekanbaru

Perkenalkan, nama saya Asrofi. Saya adalah peneliti di Lembaga Penjaminan Mutu Pendidikan Provinsi Riau (LPMP), Direktorat Jenderal Pendidikan Dasar dan Menengah, Kementerian Pendidikan dan Kebudayaan yang sedang dalam tugas belajar di School of Education, Faculty of Humanities, Curtin University Australia. Saat ini saya sedang melaksanakan proyek penelitian S3 (Doctor of Philosophy) saya yang berjudul "*The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge*" di bawah bimbingan Prof. Dr. Martin Cooper dan Dr. Kathryn Dixon.

Melalui surat ini, saya berharap agar Bapak/Ibu Kepala sekolah memberikan izin kepada saya untuk melakukan Penelitian di sekolah Bapak/Ibu. Penelitian ini telah mendapatkan izin dari Curtin University Human Research Ethics Committee (HREC) nomor: HRE2020-076, rekomendasi penelitian dari Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu Provinsi Riau nomor: 503/ DPMPTSP/NON IZIN-RISET/38362, dan izin penelitian dari Disdik Provinsi Riau nomor: 071/Disdik/1.3/2021/7014. Penelitian ini sepenuhnya akan mengikuti protocol kesehatan terkini dari Kementerian Kesehatan Repubilk Indonesia terkait dengan penekanan penyebaran COVID-19. Partisipasi dalam penelitian ini sepenuhnya bersifat sukarela. Hasil akhir dari penelitian ini digunakan untuk keperluan mendapatkan gelar Doctor of Philosophy in Education dari Curtin University Australia. Semua informasi akan dijaga kerahasiaannya dan nama guru dan sekolah akan dirahasiakan dalam laporan akhir. Setiap informasi yang diperoleh dan diterbitkan dalam jurnal ilmiah; kerahasiaannya akan dilindungi.

Saya ingin mengucapkan terima kasih, besar harapan saya agar permohonan saya ini dipertimbangkan.

Dengan hormat,

Asrofi, M.Ed

Curtin University Human Research Ethics Committee (HREC) telah menyetujui penelitian ini (HREC nomor: HRE2020-0761). Jika Anda ingin bertanya terkait dengan pelaksanaan penelitian ini atau informasi terkait hak anda sebagai peserta, atau anda ingin mengajukan keluhan bersifat rahasia, anda dapat menghubungi Office of Research Integrity di (08) 9266 9223 atau (08) 9266 7093 atau email hrec@curtin.edu.au.

Appendix F

Research invitation for teachers

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge

Baak/Ibu Guru yang Terhormat

Pekanbaru, 2 April 2020

Sekolah Menengah Atas 12

Hal: Undangan Partisipasi Penelitian

Perkenalkan, nama saya Asrofi, saya adalah kandidat Ph.D di School of Education di Curtin University Australia. Saat ini saya sedang melaksanakan proyek penelitian Ph.D saya yang berjudul "*The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge*". Penelitian ini terdiri dri dua tahap pengumpulan data. Tahap pertama adalah pengumpulan data melalui survei kuesioner yang bertujuan untuk memahami pandangan guru terhadap efikasi diri dan sikap tentang penggunaan teknologi digital di kelas. Tahap lanjutan dari proyek ini adalah pengumpulan data yang akan melibatkan beberapa orang guru untuk dalam wawancara dan observasi kelas.

Saya berharap Bapa/Ibu dapat membantu saya dengan berpartisipasi dalam survei ini. Survei ini lebih kurang memerlukan waktu penyelesaian sekitar 25-30 menit. Bagi Bapak/Ibu yang telah berpartisipasi dalam penelitian tahap pertama ini, kami menyiapkan makan siang sebagai ungkapan terimakasih kami. Partisipasi Bapa/Ibu dalam penelitian ini sepenuhnya bersifat sukarela dan tidak akan memengaruhi nilai evaluasi kinerja atau apapun. Semua informasi akan dijaga kerahasiaannya dan nama setiap individu akan dirahasiakan dalam laporan akhir. Setiap informasi yang diperoleh dan diterbitkan dalam jurnal ilmiah; kerahasiaanny akan dilindungi.

Saya ingin mengucapkan terima kasih karena telah mempertimbangkan permintaan saya.

Dengan hormat,

Asrofi

Curtin University Human Research Ethics Committee (HREC) telah menyetujui penelitian ini (HREC nomor XX / XXXX). Jika Anda ingin bertanya tentang studi ini dengan seseorang yang tidak terlibat langsung, berkaitan dengan pelaksanaan studi ini atau informasi terkait hak Anda sebagai peserta, atau Anda ingin mengajukan keluhan bersifat rahasia, Anda dapat menghubungi pegawai kami di (08) 9266 9223 atau Manajer, Research Integrity di (08) 9266 7093 atau email hrec@curtin.edu.au.

Appendix G

Participant Consent Form

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

LEMBAR PERSETUJUAN

HREC Nomor Penelitian:	HRE2020-0761
Judul Penelitian:	Pengaruh efikasi diri dan sikap guru terhadap teknologi digital serta pengaruhnya terhadap kemampuan guru dalam teknologi, pedagogi dan pengetahuan terhadap konten (TPACK)
Ketua Tim:	Dr. Martin Cooper Senior Lecturer/Course Coordinator, Secondary Education School of Education
Mahasiswa:	Asrofi
Nomor Versi:	1
Tanggal Versi:	10/30/2020

- Saya telah membaca pernyataan informasi yang tercantum di atas dan saya memahami isinya.
- Saya yakin saya memahami tujuan, tingkat, dan kemungkinan risiko keterlibatan saya dalam proyek ini.
- Saya secara sukarela menyetujui untuk mengambil bagian dalam proyek penelitian ini.
- Saya memiliki kesempatan untuk mengajukan pertanyaan dan saya puas dengan jawaban yang saya terima.
- Saya mengerti bahwa interview akan di rekam secara audio untuk tujuan proyek ini.
- Saya mengeti bahwa proyek ini telah disetujui oleh Komite Etika Penelitian Manusia Curtin University dan akan dilaksanakan sejalan dengan Pernyataan Nasional tentang Perilaku Etis dalam Penelitian Manusia (2007).
- Saya mengerti bahwa saya akan menerima salinan Pernyataan Informasi dan Formulir Persetujuan ini.

Nama Peserta	M.Rezki Maulana
Tanda Tangan	
Tanggal	11 May 2022

- Pernyataan peneliti: Saya telah memberikan Pernyataan Informasi dan Formulir Persetujuan kepada peserta yang telah menandatangani di atas.

Nama Peneliti	Asrofi
Tanda Tangan	
Tanggal	11 May 2022

Participant Consent Form Version 2, 11/30/2020

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

CONSENT FORM

HRE2020-0761	HRE2020-0761
Project Title:	The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge
Chief Investigator:	Dr. Martin Cooper Senior Lecturer/Course Coordinator, Secondary Education School of Education
Student researcher:	Asrofi
Version Number:	1
Version Date:	10/30/2020

- I have read, the information statement version listed above and I understand its contents.
- I believe I understand the purpose, extent and possible risks of my involvement in this project.
- I voluntarily consent to take part in this research project.
- I have had an opportunity to ask questions and I am satisfied with the answers I have received.
- I understand that the interview will be audio recorded for the purpose of this project.
- I understand that this project has been approved by Curtin University Human Research Ethics Committee and will be carried out in line with the National Statement on Ethical Conduct in Human Research (2007).
- I understand I will receive a copy of this Information Statement and Consent Form.

Participant Name	
Participant Signature	
Date	

- <u>A declaration by researcher:</u> I have supplied an Information Letter and Consent Form to the participant who has signed above.

Researcher Name	
Researcher Signature	
Date	

Participant Consent Form Version 2, 11/30/2020

CRICOS Provider Code 00301J

Appendix H

Participant Information Form

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

PARTICIPANT INFORMATION STATEMENT

HREC Project Number:	HRE2020-0761
Project Title:	The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge
Chief Investigator:	Dr. Martin Cooper Senior Lecturer/Course Coordinator, Secondary Education School of Education
Student researcher:	Asrofi
Version Number:	1
Version Date:	01/30/2022

What is the Project About?

- The background to the research project (what you already know).
- The massive development of digital technologies has impacted education, providing many benefits to classroom activities meaning a teacher's knowledge and skills is critical in digital technology integration. In addition, teacher self-efficacy and attitudes towards digital technologies also have been identified as important variables in this scenario. However, teachers' self-perception of self-efficacy and attitude towards digital technologies and their relationship to teachers' self-perception of TPACK, particularly in the Indonesian context has not been thoroughly explored. Teachers' self-efficacy is identified as a teacher's belief with regard to their ICT skills and their ability to integrate digital technology into the learning environment. Accordingly, attitude indicates to what extent teachers agree or disagree with digital technology integration in the classroom and what they think and feel with regard to classroom digital technology integration.
- This research aims to investigate Indonesian teachers' perception of self-efficacy and attitudes towards digital technologies as well as to better understand the ways in which self-efficacy and attitudes towards digital technologies is reflected in the application of a teachers' technological, pedagogical and content knowledge (TPACK) in teaching. It also intends to investigate factors that positively or negatively affect digital technology integration into the Indonesian classrooms setting as well as the factors that impinge on teachers' capacity to use digital technologies in their practice.
- If we identify that teachers' self-efficacy and attitudes towards digital technologies influence teachers' technological, pedagogical and content knowledge (TPACK) in teaching, it may help to inform government (ministry of education), college and professional development programs to address these issues.
- All of the teachers across six senior high schools in Pekanbaru, Riau, Indonesia will be invited to participate.
- This is a pilot study

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

Who is doing the Research?

- The project is being conducted by Asrofi
- The results of this research project will be used by Asrofi to obtain a Doctor of Philosophy at Curtin University and is funded by the University.
- There will be no costs to you and you will not be paid for participating in this project.

Why am I being asked to take part and what will I have to do?

- You have been asked to take part because you are a teacher in Pekanbaru.
- Your participation will consist of completing a printed questionnaire. 12 teachers will be selected (based on survey responses) to participate in interviews and class observation. Lesson plans and teaching programs will also be collected from these selected teachers. We will make a digital audio recording so we can concentrate on what you have to say and not distract ourselves with taking notes. After the interview we will make a full written copy of the recording.
- Participation in a printed questionnaire, interview, and classroom observation will take place in a classroom at your schools and at a convenient time. The questionnaire will take approximately 30 minutes, the interviews will take about 60 minutes, and the class observation will take about 90 minutes.
- We will ask you questions about how you feel and what you believe about integrating digital technology in teaching. Once you have completed the questionnaire, a school's staff will collect it from you by the hand.
- There will be no cost to you for taking part in this research and you will not be paid for taking part. We will give you a free lunch while you attend appointments.

Are there any benefits' to being in the research project?

- There may be no direct benefit to you from participating in this research, however, sometimes, people appreciate the opportunity to discuss their opinions and feelings.
- We hope the results of this research will allow us to:
  - develop professional development programs for teachers
  - add to the knowledge we have about this condition

Are there any risks, side-effects, discomforts or inconveniences from being in the research project?

- There are no foreseeable risks of this research project.
- Apart from giving up your time, we do not expect that there will be any risks or inconveniences associated with taking part in this study.

Who will have access to my information?

- The information collected in this research will be non-identifiable (anonymous). This means that we do not need to collect individual names. No one, not even the research team will be able to identify your information. Any information we collect and use during this research will be treated as confidential. The following people will have access to the information we collect in this research: the research team and the Curtin University Ethics Committee.

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

- Electronic data will be password-protected and hard copy data will be in locked storage.
- The information we collect in this study will be kept under secure conditions at Curtin University for 7 years after the research has ended and then it will be destroyed.
- The results of this research may be presented at conferences or published in professional journals. You will not be identified in any results that are published or presented.

Will you tell me the results of the research?

- If you are interested in obtaining a summary of the results, please contact the researchers after February 2024
- The results will be available in my Ph.D. dissertation and may be presented at conferences or published in professional journals.

Do I have to take part in the research project?

- Taking part in a research project is voluntary. It is your choice to take part or not. You do not have to agree if you do not want to. If you decide to take part and then change your mind, that is okay, you can withdraw from the project. You do not have to give us a reason; just tell us that you want to stop. Please let us know you want to stop so we can make sure you are aware of anything that needs to be done so you can withdraw safely. If you chose not to take part or start and then stop the study, it will not affect your relationship with the University, staff or colleagues.
- If you chose to leave the study, we will be unable to destroy your information because it has been collected in an anonymous way.

What happens next and who can I contact about the research?

- To obtain further information or answer questions, please contact Asrofi on +9712 206 2572 or asrofi@postgrad.curtin.edu.au OR Dr. Martin Cooper on 08 9266 7526 or Martin.Cooper@curtin.edu.au
- At the start of the questionnaire, there is a consent form to indicate you have understood the information provided here on the information sheet and that you agree to be in the research project.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HRE2020-0761). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au.

Participant Information Form Version 1, 10/20/2020

CRICOS Provider Code 00301J

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

PERNYATAAN INFORMASI PESERTA

HREC Nomor Penelitian:	HRE2020-0761
Judul Penelitian:	Pengaruh efikasi diri dan sikap guru terhadap teknologi digital serta pengaruhnya terhadap kemampuan guru dalam teknologi, pedagogi dan pengetahuan terhadap konten (TPACK)
Ketua Tim:	Dr. Martin Cooper Senior Lecturer/Course Coordinator, Secondary Education School of Education
Mahasiswa:	Asrofi
Nomor Versi:	1
Tanggal Versi:	10/30/2020

Penelitian ini tentang apa?

- Perkembangan besar-besaran teknologi digital telah memengaruhi pendidikan, memberikan banyak manfaat bagi kegiatan pembelajaran di kelas yang berarti pengetahuan dan keterampilan guru sangat penting dalam integrasi teknologi digital. Selain itu, self-efficacy dan sikap guru terhadap teknologi digital juga telah diidentifikasi sebagai variabel penting dalam skenario ini. Namun, persepsi diri guru tentang efikasi diri dan sikap terhadap teknologi digital dan hubungannya dengan persepsi diri guru terhadap TPACK, khususnya dalam konteks Indonesia belum dieksplorasi secara menyeluruh. Efikasi diri guru diidentifikasi sebagai keyakinan guru terkait dengan keterampilan TIK mereka dan kemampuan mereka untuk mengintegrasikan teknologi digital ke dalam lingkungan belajar. Dengan demikian, sikap menunjukkan sejauh mana guru setuju atau tidak setuju dengan integrasi teknologi digital di kelas dan apa yang mereka pikirkan dan rasakan terkait integrasi teknologi digital di kelas.
- Penelitian ini bertujuan untuk menyelidiki persepsi guru Indonesia tentang efikasi diri dan sikap terhadap teknologi digital serta untuk lebih memahami bagaimana efikasi diri dan sikap terhadap teknologi digital tercermin dalam penerapan pengetahuan guru tentang teknologi, pedagogis dan konten materi (TPACK) (TPACK) dalam mengajar. Penelitian juga bermaksud untuk menyelidiki faktor-faktor yang secara positif atau negatif mempengaruhi integrasi teknologi digital ke dalam kegiatan belajar dan mengajar di Indonesia serta faktor-faktor yang mempengaruhi kapasitas guru dalam menggunakan teknologi digital dalam mengajar.
- Jika kami berhasil mengidentifikasikan bahwa self-efficacy dan sikap guru terhadap teknologi digital mempengaruhi pengetahuan mereka dalam teknologi, pedagogis dan konten materi dalam mengajar, maka ini akan membantu untuk menginformasikan pemerintah (kementerian pendidikan), perguruan tinggi dan program pengembangan profesional untuk mengatasi masalah ini.
- Semua guru di enam sekolah menengah atas di Pekanbaru, Riau, Indonesia akan diundang untuk berpartisipasi.

Participant Information Form Version 1, 10/20/2020

CRICOS Provider Code 00301J

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

Siapa yang melakukan penelitian ini?

- Proyek ini dilakukan oleh Asrofi
- Hasil proyek penelitian ini akan digunakan Asrofi untuk memperoleh gelar Doctor of Philosophy di Curtin University dan didanai oleh Universitas.
- Tidak akan ada biaya bagi Anda dan Anda tidak akan dibayar untuk berpartisipasi dalam proyek ini.

Mengapa saya diminta untuk ikut serta dan apa yang akan saya lakukan?

- Anda diminta untuk ambil bagian karena Anda seorang guru di Pekanbaru.
- Anda akan berpartisipasi dalam mengisi kuesioner. Setelah itu, 12 orang guru akan dipilih (berdasarkan hasil survei) untuk berpartisipasi dalam sesi wawancara dan observasi kelas. Rencana pembelajaran dan program pengajaran juga akan dikumpulkan dari guru-guru terpilih ini. Kami akan membuat rekaman audio / video digital sehingga kami dapat berkonsentrasi pada apa yang Anda katakan dan tidak mengalihkan perhatian dengan membuat catatan. Setelah wawancara kami akan membuat salinan tertulis lengkap dari rekaman tersebut.
- Partisipasi dalam kuesioner, wawancara, dan observasi kelas akan dilakukan di ruang kelas di sekolah Anda dan pada waktu yang tepat. Kuesioner akan memakan waktu kurang lebih 30 menit, wawancara akan memakan waktu sekitar 60 menit, dan observasi kelas akan memakan waktu sekitar 90 menit.
- Kami akan mengajukan pertanyaan tentang apa yang Anda rasakan dan apa yang Anda yakini tentang integrasi teknologi digital dalam pengajaran. Setelah Anda menyelesaikan kuesioner, staf sekolah akan mengambilnya dari Anda secara langsung.
- Tidak ada biaya bagi Anda untuk ikut serta dalam penelitian ini dan Anda tidak akan dibayar untuk ikut serta. Kami akan memberi Anda makan siang gratis saat Anda mengikuti penelitian ini.

Apakah manfaat proyek penelitian ini bagi saya?

- Mungkin tidak ada manfaat langsung bagi Anda dari berpartisipasi dalam penelitian ini, namun, terkadang, beberapa orang menghargai kesempatan untuk mendiskusikan pendapat dan perasaan mereka.
- Kami berharap hasil penelitian ini dapat memungkinkan kami untuk:
    - mengembangkan program pengembangan profesional untuk guru
    - menambah pengetahuan yang kita miliki tentang kondisi ini

Adakah resiko, efek samping, atau ketidaknyamanan lainnya ketika ikut serta dalam penelitian ini?

- Tidak ada risiko yang dapat diperkirakan dari proyek penelitian ini.
- Selain waktu anda yang tersita, kami tidak berharap akan ada risiko atau ketidaknyamanan yang terkait dengan mengambil bagian dalam studi ini.

Siapa yang akan memiliki akses ke informasi saya dalam penelitian ini?

- Informasi yang dikumpulkan dalam penelitian ini tidak akan dapat diidentifikasi (anonim). Artinya, kami tidak perlu mengumpulkan nama individu. Tidak seorang pun, bahkan tim peneliti pun tidak akan dapat mengidentifikasi informasi Anda. Setiap informasi yang kami kumpulkan dan gunakan selama penelitian ini akan diperlakukan sebagai rahasia. Orang-orang berikut akan memiliki akses ke informasi

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

yang kami kumpulkan dalam penelitian ini: tim peneliti dan Komite Etik Universitas Curtin.

- Data elektronik akan dilindungi sandi dan data hard copy akan berada dalam penyimpanan terkunci.
- Informasi yang kami kumpulkan dalam penelitian ini akan disimpan dalam kondisi aman di Curtin University selama 7 tahun setelah penelitian berakhir dan kemudian akan dimusnahkan.
- Hasil penelitian ini dapat dipresentasikan di konferensi atau dipublikasikan di jurnal profesional. Anda tidak akan diidentifikasi dalam hasil apa pun yang dipublikasikan atau disajikan.

Apakah hasil penelitian ini akan diberikan kepada saya?

- Jika Anda tertarik untuk mendapatkan ringkasan hasil, silakan hubungi kami setelah Februari 2023
- Hasilnya akan tersedia di Ph.D. disertasi dan dapat dipresentasikan di konferensi atau diterbitkan dalam jurnal profesional.

Apakah keikutsertaan dalam penelitian ini wajib?

- Mengambil bagian dalam proyek penelitian adalah sukarela. Terserah Anda untuk ambil bagian atau tidak. Anda tidak harus setuju jika Anda tidak mau. Jika Anda memutuskan untuk ambil bagian dan kemudian berubah pikiran, tidak apa-apa, Anda bisa mundur dari proyek. Anda tidak harus memberi kami alasan; cukup beri tahu kami bahwa Anda ingin berhenti. Beri tahu kami bahwa Anda ingin berhenti sehingga kami dapat memastikan Anda mengetahui apa pun yang perlu dilakukan agar Anda dapat menarik dana dengan aman. Jika Anda memilih untuk tidak mengambil bagian atau memulai dan kemudian menghentikan studi, hal itu tidak akan memengaruhi hubungan Anda dengan Universitas, staf, atau kolega.
- Jika Anda memilih untuk keluar dari studi, kami tidak akan dapat memusnahkan informasi Anda karena dikumpulkan dengan cara anonim.

Jika saya memiliki pertanyaan tentang penelitian ini, siapa yang dapat saya hubungi?

- Untuk mendapatkan informasi lebih lanjut atau untuk menjawab pertanyaan anda, silakan hubungi Asrofi di +9712 206 2572 atau asrofi@postgrad.curtin.edu.au ATAU Dr. Martin Cooper di 08 9266 7526 atau Martin.Cooper@curtin.edu.au
- Di awal kuesioner, ada formulir persetujuan untuk menunjukkan bahwa Anda telah memahami informasi yang diberikan di sini di lembar informasi dan bahwa Anda setuju untuk ikut serta dalam proyek penelitian, siakan di tanda tangani.

Curtin University Human Research Ethics Committee (HREC) telah menyetujui penelitian ini (HRE2020-0761). Jika Anda ingin mendiskusikan studi ini dengan seseorang yang tidak terlibat langsung, khususnya, terkait hal apa pun yang berkaitan dengan pelaksanaan studi atau hak Anda sebagai peserta, atau Anda ingin mengajukan keluhan yang bersifat rahasia, Anda dapat menghubungi Ethics Office di (08) 9266 9223 atau Manajer, Research Integrity di (08) 9266 7093 atau email hrec@curtin.edu.au.

Participant Information Form Version 1, 10/20/2020

CRICOS Provider Code 00301J

Appendix I

Survey (English Version)

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

1
Name :

☐ I have received information regarding this research and had an opportunity to ask questions. I believe I understand the purpose, extent and possible risks of my involvement in this project and I voluntarily consent to take part.

Direction:

This survey takes approximately 30 minutes to complete.

Digital technologies mentioned in this survey include devices such as desktop/laptop, tablet devices, smartphone, online/offline digital technologies, and software/programs. Please answer each question to the best of your knowledge. Your responses will be kept completely confidential and will not influence your performance evaluation scores.

Part 1. Demographic Information

Direction: Please answer or tick (√) the appropriate response for each item

1. Gender:

☐ Male ☐ Female

2. What is your age?

……………

3. Academic Degree Level

☐ Diploma ☐ Bachelor ☐ Master

☐ Pursuing Bachelor ☐ Pursuing Master ☐ Pursuing Ph.D

4. Year of Completion

…………….

5. From which university did you graduate?

…………….

6. What subject do you teach?

……………..

7. Have you completed a program of "Profesi Pendidikan Guru"? Please specify the year.

☐ Yes ☐ No Year:……………….

Survey, Version 1, 11/30/2020

CRICOS Provider Code 00301J

8. Including the current school year, how many years of teaching experience do you have?

……………..

9. Did you ever take any Information Communication and Technology (ICT) courses during your pre-service teacher training?

☐ Yes ☐ No

If yes, please list them:
a……………….
b……………….
c……………….

10. Did you ever receive any ICT trainings during your in-service?

☐ Yes ☐ No

If yes, please list them:
a……………….
b……………….
c……………….

11. How many hours per day do you spend your time using the internet to prepare the teaching material?

……………..

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledgea

12. Please tick (√) to the appropriate column:

Do you use these following digital technologies in the classroom?			If "yes", how often do you use the them?					
	Yes	**No**	**Daily**	**Biweekly**	**Weekly**	**Fortnightly**	**Monthly**	**Bimonthly**
Desktop computer								
Laptop								
Tablet								
Smartphone								
Projector								
Microsoft Offices								
Social media Platforms								
YouTube								
Video/audio downloader								
Cloud Storage								
E-mail								

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

Do you use these following digital technologies in the classroom?			If "yes", how often do you use the them?					
	Yes	**No**	**Daily**	**Biweekly**	**Weekly**	**Fortnightly**	**Monthly**	**Bimonthly**
Online / offline learning tools that provide interactive learning resources for teachers and students (example: Rumah Belajar, Khan Academy…) If you use the tool, please name it……….								
Online / offline tool for mind mapping / brainstorming activities (example: Spiderscrab, Coogle…) If you use the tool, please name it……….								
online/offline tools for classroom game and quize (example: Kahoot, Quizlet…) If you use the tool, please name it……….								
Online/offline tools for teacher's productivity in designing lesson plans, evaluating student's works, and organizing others' teache's works (example: Trello, Eduflow..) If you use the tool, please name it……….								
Online/offline tools for survey and learning feedback (example: survey monkey, Doodle…) If you use the tool, please name it……….								
Online/Offline tools for collaborative learning (example: Pedlet, conceptborad..) If you use the tool, please name it……….								

Survey, Version 1, 11/30/2020

CRICOS Provider Code 00301J

online/offline tools for video confrence (example zoom meeting, google meeting..) If you use the tool, please name it………..								

13. Please tick (V) the following barriers which fit your situation, making you difficult to use digital technology in the classroom.

V	Barriers
	Lack of ICT training
	Lack of ICT facilities
	Lack of ICT knowledge and skills
	Lack of ICT access
	Lack of technical support
	Poor internet connection
	Scarcity of time
	Uninformed principles about digital technologies
	Inflexible school time-tabling structure
	School's uncomprehensive technology plans

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledge

	Teacher's low attitude towards digital technology use
	Teacher's self-efficacy towards digital technology use
	Subject culture

Survey, Version 1, 11/30/2020

CRICOS Provider Code 00301J

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

Part 2. Survey on Self-Efficacy, Attitude, and TPACK

Answer all of the questions that are true for you. Please tick (√) to the appropriate scale.

Self-Efficacy

A. Digital Technology self-efficacy

		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
1.	I feel confident that I can use digital technology efficiently					
2.	I feel confident that I can learn to use new digital technology independently					
3.	I feel confident that when I use digital technology I can solve technical problems if I face them					
4.	I feel confident that I am able to find a useful digital technology on the Internet if I need to find one					
5.	I feel confident that I am able to download and install the digital technology apps or programs on my devices					

B. Teacher self-efficacy

		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
6.	I feel confident that I can apply different kinds of teaching methods to enhance my students' learning					
7.	I feel confident that I can create meaningful learning experiences for my students					
8.	I feel confident that I can motivate my students to be actively involved in their learning					
9.	I feel confident that I can develop my teaching skills and strategies in the classroom					

Survey, Version 1, 11/30/2020

CRICOS Provider Code 00301J

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

C. Self-efficacy towards digital technology integration						
		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
10.	I feel confident that I can find digital technology which are suitable for my classroom activities					
11.	I feel confident that I can integrate digital technology to develop my classroom activities					
12.	I feel confident that I can increase student engagement to use online technology in their learning					
13.	I feel confident that I can increase student achievement in the classroom with digital technology					
14.	I feel confident that I can evaluate the strengths and weaknesses of digital technology to improve my classroom activities					
Attitude **A. I believe digital technology Use in Education**						
		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
15.	Digital technology plays a critical role in contemporary education					
16.	Digital technology is a useful means to attain educational goals					
17.	Digital technology helps the teacher to manage his classroom efficiently					
18.	Digital technology helps teacher to create engaging, interesting and well-designed classroom activities					
19.	Digital technology enhances interaction and increase student engagement					
20.	Digital technology improves student knowledge retention					
21.	Digital technology encourages student collaborations in the classroom					
22.	Digital technology encourages students' different learning styles and abilities					

Survey, Version 1, 11/30/2020

CRICOS Provider Code 00301J

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

B. I am afraid that digital technology use in education						
		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
23.	Digital technology causes a less respect of the teachers' role and responsibility in the classroom					
24.	Students are more sophisticated in their use of digital technology than teachers					
25.	Digital technology turns teaching into a monotonous and mechanical process					
26.	Teaching with digital technology are more complicated and takes more time					
27.	Digital technology requires implementing devices (computers/laptop/tablet/phone) and the internet that takes more money					
28.	Digital technology increases the risk of cyber attacks and hacks					
TPACK **A. TK (Technology Knowledge)**						
		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
30.	I can solve digital technology related problems					
31.	I am familiar with new digital technologies and their features which benefit teaching and learning					
32.	I can use new digital technologies in teaching					
33.	I know several digital technologies which benefit teaching and learning					
B. CK (Content Knowledge)						
		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
34.	I have sufficient knowledge in developing contents in the subject I teach					
35.	I know the basic theories and concepts of the subject I teach					
36.	I know the history and development of important theories in the subject I teach					
37.	I am familiar with recent research on the subject I teach					

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

C. PK (Pedagogical Knowledge)

		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
38.	I know the teaching methods to support students' critical thinking					
39.	I know the teaching methods to support students' creative thinking					
40.	I know the teaching methods to guide students working collaboratively					
41.	I know the teaching methods to encourage students communicating effectively					
42.	I know the teaching methods to guide students planning their own learning					
43.	I know the teaching methods to support students' problem-solving skills					

D. PCK (Pedagogical Content Knowledge)

		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
44	I know how to support students' critical thinking in the subject I teach					
45.	I know how to support students' creative thinking in the subject I teach					
46.	I know how to guide students to work collaboratively on the subject I teach					
47.	I know how to encourage students to communicate effectively in my classroom					
48.	I know how to guide students to plan their own learning in my classroom					
49.	I know how to support students' problem-solving skills in the subject I teach					

E. TCK (Technological Content Knowledge)

		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
50.	I know websites with materials suitable for studying the subject I teach					
51.	I know digital technology which can enable me self-learning in the subject I teach					
52.	I know digital technologies which are used by professionals in the subject I teach					
53.	I know digital technologies which I can use to illustrate difficult contents in the subject I teach					

Survey, Version 1, 11/30/2020

CRICOS Provider Code 00301J

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

F. TPK (Technological Pedagogical Knowledge)

		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
54.	I know how to use digital technology as a tool for students' critical thinking					
55.	I know how to use digital technology as a tool for students' creative thinking					
56.	I know how to use digital technology as a tool for sharing ideas and working collaboratively					
57.	I know how to use digital technology as an effective tool for student communication					
59.	I know how to use digital technology as a tool for students to plan their own learning					
60.	I know how to use digital technology as a tool for support students' problem-solving					

G. TPACK (Technology, Pedagogy and Content Knowledge)

		Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
60.	I know how to use digital technology to deliver specific subject content as a tool for students' critical thinking					
61.	I know how to use digital technology to deliver specific subject content as a tool for students' creative thinking					
62.	I know how to use digital technology to deliver specific subject content as a tool for sharing ideas and working collaboratively					
63.	I know how to use digital technology to deliver specific subject content as a tool for student communication					
64.	I know how to use digital technology to deliver specific subject content as a tool for students to plan their own learning					
65.	I know how to use digital technology to deliver specific subject content as a tool for students' problem-solving					

Survey, Version 1, 11/30/2020

CRICOS Provider Code 00301J

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

SEMI-STRUCTURED INTERVIEW

1. a. With this topic (the lesson plan), describe the subject content you will teach
   b. How would you develop your knowledge on the subject content before teaching?
   c. Describe what pedagogical strategy/classroom activity you will choose for that subject content
   d. What considerations do you take in choosing that particular pedagogical strategy/classroom activity?
   e. How effective are that pedagogical strategy to teach the subject content?
   f. Describe what particular digital technology you will use to teach the subject content
   g. How will you evaluate your classroom?
2. a. Is ICT important in teaching and learning?
   b. What are your ICT skills?
   c. Do you think that you are able to use any new digital technology in teaching?
   d. What benefits do you get from your ICT skills in teaching?
   e. How do you use digital technologies in your daily tasks?
   f Are there any aspects of digital technologies which you believe negatively affect your teaching?
3. a. What digital technology do you often use in the classroom?
   b. How do you develop your skills to use that/those digital technologies?
   c. What considerations do you take when choosing one particular digital technology to support the pedagogical approaches?
   d. What digital technologies do you often use to develop your knowledge on the subject content?
4. a. What are the challenges you face in integrating digital technologies in the classroom?
   b. What support should be provided by the school or authority helping you integrate digital technologies?
5. a. I the near future, will you use any new digital technology in the classroom?
   b. Why do you want to use it?
6. a. What digital technologies do you often use in the classroom
   b. How do you use them?

Interview, Version 1, 11/30/2020

CRICOS Provider Code 00301J

Appendix J

Survey (Indonesian Version)

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

1
Nama :

☐ Saya sudah mendapatkan informasi yang cukup terkait dengan penelitian ini dan telah mendapatkan kesempatan untuk menanyakan hal-hal terkait. Saya percaya bahwa saya mengerti tujuan, tingkat, dan kemungkinan resiko atas keikutsertaan saya dalam proyek ini dan saya secara sukarela setuju untuk ikut serta didalamnya.

Petunjuk:

Survey ini membutuhkan waktu sekitar 20 hingga 30 menit untuk diselesaikan.

Teknologi digital yang disebutkan dalam survei ini meliputi setiap perangkat seperti computer desktop/laptop, perangkat tablet, smartphone, teknologi digital online/offline, dan software/program. Mohon untuk mejawab setiap pertanyaan sebaik mungkin. Tanggapan jujur anda sangat kami hargai. Nama guru, sekolah, serta tanggapan anda akan dijaga kerahasiaannya dan tidak akan memengaruhi nilai evaluasi kinerja ataupun evaluasi lainnya.

Bagian 1. Informasi Demografi

Petunjuk: Harap jawab atau centang (√) jawaban yang sesuai untuk setiap item

1. Jenis Kelamin:

☐ Pria ☐ Wanita

2. Umur:

……………

3. Gelar Akademik:

☐ Diploma ☐ S1 ☐ S2

☐ Sedang S1 ☐ Sedang S2 ☐ Sedang S3

4. Tahun selesai pendidikan:

…………….

5. Alumni Universitas:

…………….

6. Mata pelajaran yang diampu:

……………..

7. Apakah anda sudah mengikuti program "Profesi Pendidikan Guru"? Sebutkan tahunnya.

☐ Ya ☐ Belum Tahun:……………….

8. Hingga saat ini, sudah berapa tahunkah pengalaman anda mengajar?

……………..

9. Apakah anda pernah mengambil mata kuliah Teknologi Pembelajaran atau Teknologi Informasi dan Komputer (TIK) ketika kuliah?

☐ Ya ☐ Tidak

Jika ya, sebutkan:
a……………….
b……………….
c……………….

10. Apakah anda pernah mengikuti pelatihan TIK selama masa kerja anda?

☐ Ya ☐ Tidak

Jika ya, sebutkan::
a……………….
b……………….
c……………….

11. Berapa jam per hari anda menghabiskan waktu menggunakan internet untuk mempersiapkan bahan pengajaran?

……………………..

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

12. Silakan centang (√) kedalam kolom yang sesuai:

Apakah anda menggunakan teknologi digital berikut ini dalam proses belajar dan mengajar?			**Jika "ya", seberapa sering anda menggunakannya?**					
	Ya	**Tidak**	**Setiap hari**	**Dua kali seminggu**	**Sekali minggu**	**Dua kali sebulan**	**Sekali sebulan**	**Dua bulan sekali**
Desktop computer								
Laptop								
Tablet								
Smartphone								
Projector								
Microsoft Offices								
Social media Platforms								
YouTube								
Pengunduh Video/audio								
Penyimpanan Cloud								
E-mail								

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

Apakah anda menggunakan teknologi digital berikut ini dalam proses belajar dan mengajar?			**Jika "ya", seberapa sering anda menggunakannya?**					
	Ya	**Tidak**	**Setiap hari**	**Dua kali seminggu**	**Sekali minggu**	**Dua kali sebulan**	**Sekali sebulan**	**Dua bulan sekali**
Perangkat pembelajaran daring/luring yang menyediakan sumber pembelajaran interaktif bagi guru dan siswa (mis: Rumah Belajar, Khan Academy, Edmodo). Jika anda menggunakannya, sebutkan nama perangkatnya…………								
Perangkat daring/luring untuk aktivitas pemetaan fikiran/brainstorming (mis: SpiderScrab, Coogle). Jika anda menggunakannya, sebutkan nama perangkatnya…………								
Perangkat daring/luring untuk membuat quiz dan permainan dikelas (mis: Kahoot, Quizlet, Socrative). Jika anda menggunakannya, sebutkan nama perangkatnya…………								
Perangkat daring/luring untuk meningkatkan produktivitas dan kinerja guru dalam membuat rencana pembelajaran, penilaian tugas siswa, dan pengorganisasian tugas guru lainnya (mis: Trello, Eduflow, Flubaroo, liveBinders). Jika anda menggunakannya, sebutkan nama perangkatnya…………								
Perangkat daring/luring untuk membuat survey dan feedback pembelajaran (Mis: Survey Monkey, Kaizena, Doddle)..Jika anda menggunakannya, sebutkan nama perangkatnya…………								
Perangkat daring/luring pembelajaran ruang bersama untuk kolaborasi dan kerjasama sesama siswa (mis: pedlet, conceptboard, Lino). Jika anda menggunakannya, sebutkan nama perangkatnya…………								
Perangkat daring/luring pembelajaran untuk video konferensi (mis: zoom meeting, google meeting..) .Jika anda menggunakannya, sebutkan nama perangkatnya…………								

Survey, Version 1, 11/30/2020

CRICOS Provider Code 00301J

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

13. Silakan centang faktor-faktor penghalang integrasi ICT didalam kelas berikut (√) kedalam kolom sesuai dengan keadaan yang anda hadapi

V	Faktor
	Terbatasnya pelatihan ICT bagi guru
	Terbatasnya fasilitas ICT yang menunjang proses belajar dan mengajar
	Kurangnya pengetahuan dan skill guru dalam pemanfaatan teknologi digital
	Terbatasnya aksess untuk pemanfaatan teknologi digital di sekolah
	Terbatasnya bantuan dan dukungan teknis dalam pemanfaatan teknologi digital
	Koneksi internet yang buruk
	Waktu yang terbatas untuk mempersiapkan penggunaan teknologi digital dikelas
	Kurangnya dukungan dari kepala sekolah dalam pemanfaatan teknologi digital dikelas
	Rencana Kerja Sekolah yang belum mendukung pemanfaatan digital teknologi
	Sikap guru yang rendah terhadap pentingnya pemanfaatan teknologi digital
	Rasa percaya diri guru yang rendah terhadap kemampuan untuk memanfaataan teknologi digital

Survey, Version 1, 11/30/2020

CRICOS Provider Code 00301J

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

Bagian 2. Survey tentang Efikasi Diri, Sikap, dan TPACK

Jawab semua pertanyaan sesuai dengan keadaan anda. Beri centang (√) ke skala yang sesuai.

Efikasi Diri
A. Efikasi Diri terhadap Teknologi Digital

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
1.	Saya yakin jika saya dapat memanfaatkan teknologi digital secara efektif dan efisien					
2.	Saya yakin jika saya mampu belajar menggunakan teknologi digital baru secara mandiri					
3.	Saya yakin bahwa ketika saya menggunakan teknologi digital saya bisa menyelesaikan setiap masalah teknis yang saya hadapi					
4.	Saya yakin jika saya saya dapat mencari dan menemukan teknologi digital yang bermanfaat di Internet jika saya memerlukannya					
5.	Saya yakin jika saya saya dapat mengunduh dan menginstal aplikasi atau program teknologi digital di perangkat saya					

B. Efikasi Diri dalam Mengajar

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
6.	Saya merasa yakin bahwa saya dapat menerapkan berbagai jenis metode pengajaran untuk meningkatkan pembelajaran siswa saya					
7.	Saya merasa yakin bahwa saya dapat menciptakan pengalaman belajar yang bermakna bagi siswa saya					
8.	Saya merasa yakin bahwa saya dapat memotivasi siswa saya untuk terlibat aktif dalam pembelajaran mereka					
9.	Saya merasa yakin bahwa saya dapat mengembangkan keterampilan dan strategi mengajar saya di kelas					

C. Effikasi diri dalam mengintegrasikan digital technology

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
10.	Saya yakin bisa menemukan teknologi digital yang cocok untuk kegiatan kelas saya					
11.	Saya merasa yakin bahwa saya dapat mengintegrasikan teknologi digital untuk mengembangkan aktivitas kelas saya					

Survey, Version 1, 11/30/2020

CRICOS Provider Code 00301J

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
12.	Saya merasa yakin bahwa saya dapat meningkatkan keterlibatan siswa untuk menggunakan teknologi online dalam pembelajaran mereka					
13.	Saya merasa yakin dapat meningkatkan prestasi siswa di kelas dengan teknologi digital					
14.	Saya merasa yakin bahwa saya dapat mengevaluasi kekuatan dan kelemahan teknologi digital untuk meningkatkan aktivitas kelas saya					

Sikap

A. Saya percaya penggunaan teknologi digital dalam pendidikan

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
15.	Teknologi digital memainkan peran penting dalam pendidikan kontemporer					
16.	Teknologi digital merupakan sarana yang berguna untuk mencapai tujuan pendidikan					
17.	Teknologi digital membantu guru untuk mengelola ruang kelasnya secara efisien					
18.	Teknologi digital membantu guru menciptakan aktivitas kelas yang menarik, menarik, dan dirancang dengan baik					
19.	Teknologi digital meningkatkan interaksi dan meningkatkan keterlibatan siswa					
20.	Teknologi digital meningkatkan retensi pengetahuan siswa					
21.	Teknologi digital mendorong kolaborasi siswa di dalam kelas					
22.	Teknologi digital mendorong gaya dan kemampuan belajar siswa yang berbeda					

B. Saya khawatir dengan penggunaan teknologi digital dalam pendidikan

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
23.	Teknologi digital menyebabkan peran dan tanggung jawab guru di kelas menjadi kurang dihargai					
24.	Siswa lebih canggih dalam menggunakan teknologi digital daripada guru					
25.	Teknologi digital mengubah pengajaran menjadi proses yang monoton dan mekanis					

Survey, Version 1, 11/30/2020

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
26.	Pengajaran dengan teknologi digital lebih rumit dan membutuhkan lebih banyak waktu					
27.	Teknologi digital membutuhkan perangkat pelaksana (komputer / laptop / tablet / telepon) dan internet yang membutuhkan lebih banyak uang					
28.	Teknologi digital meningkatkan risiko serangan dan peretasan dunia maya					

TPACK
A. TK (Pengetahuan Teknologi)

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
30.	Saya bisa memecahkan masalah-masalah yang terkait dengan teknologi digital					
31.	Saya terbiasa dengan teknologi digital baru dan fitur-fiturnya yang menguntungkan proses belajar mengajar					
32.	Saya bisa menggunakan teknologi digital baru dalam mengajar					
33.	Saya tahu beberapa teknologi digital yang menguntungkan proses belajar mengajar					

B. CK (Pengetahuan Konten)

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
34.	Saya memiliki pengetahuan yang cukup dalam mengembangkan konten dalam mata pelajaran yang saya ajarkan					
35.	Saya tahu teori dan konsep dasar dari mata pelajaran yang saya ajarkan					
36.	Saya tahu sejarah dan perkembangan teori-teori penting dalam mata pelajaran yang saya ajarkan					
37.	Saya terbiasa dengan penelitian terbaru tentang subjek yang saya ajarkan					

C. PK (Pengetahuan Pedagogi)

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
38.	Saya tahu metode pengajaran untuk mendukung pemikiran kritis siswa					
39.	Saya tahu metode pengajaran untuk mendukung pemikiran kreatif siswa					

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
40.	Saya tahu metode pengajaran untuk membimbing siswa bekerja secara kolaboratif					
41.	Saya tahu metode pengajaran untuk mendorong siswa berkomunikasi secara efektif					
42.	Saya tahu metode pengajaran untuk membimbing siswa merencanakan pembelajaran mereka sendiri					
43.	Saya tahu metode pengajaran untuk mendukung keterampilan pemecahan masalah siswa					

D. PCK (Pengetahuan Konten dan Pedagogi)

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
44	Saya tahu bagaimana mendukung pemikiran kritis siswa dalam mata pelajaran yang saya ajarkan					
45.	Saya tahu bagaimana mendukung pemikiran kreatif siswa dalam mata pelajaran yang saya ajarkan					
46.	Saya tahu bagaimana membimbing siswa untuk bekerja secara kolaboratif pada subjek yang saya ajarkan					
47.	Saya tahu bagaimana mendorong siswa untuk berkomunikasi secara efektif di kelas saya					
48.	Saya tahu bagaimana membimbing siswa untuk merencanakan pembelajaran mereka sendiri di kelas saya					
49.	Saya tahu bagaimana mendukung keterampilan pemecahan masalah siswa dalam mata pelajaran yang saya ajarkan					

E. TCK (Pengetahuan Konten dan Teknologi)

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
50.	Saya tahu situs web dengan materi yang sesuai untuk mempelajari subjek yang saya ajarkan					
51.	Saya tahu teknologi digital yang memungkinkan saya belajar mandiri dalam mata pelajaran yang saya ajarkan					
52.	Saya tahu teknologi digital yang digunakan oleh para profesional dalam mata pelajaran yang saya ajarkan					
53.	Saya tahu teknologi digital yang dapat saya gunakan untuk mengilustrasikan konten sulit dalam mata pelajaran yang saya ajarkan					

Curtin University

The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

F. TPK (Pengetahuan Teknologi dan Pedagogi)

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
54.	Saya tahu cara menggunakan teknologi digital sebagai alat untuk berpikir kritis siswa					
55.	Saya tahu bagaimana menggunakan teknologi digital sebagai alat untuk berpikir kreatif siswa					
56.	Saya tahu bagaimana menggunakan teknologi digital sebagai alat untuk berbagi ide dan bekerja secara kolaboratif					
57.	Saya tahu bagaimana menggunakan teknologi digital sebagai alat yang efektif untuk komunikasi siswa					
59.	Saya tahu bagaimana menggunakan teknologi digital sebagai alat bagi siswa untuk merencanakan pembelajaran mereka sendiri					
60.	Saya tahu cara menggunakan teknologi digital sebagai alat untuk mendukung pemecahan masalah siswa					

G. TPACK (Pengetahuan Technologi, Pedagogi and kontent)

		Sangat Tidak Setuju	Tidak Setuju	Netral	Setuju	Sangat Setuju
60.	Saya tahu cara menggunakan teknologi digital untuk menyampaikan konten subjek tertentu sebagai alat untuk berpikir kritis siswa					
61.	Saya tahu cara menggunakan teknologi digital untuk menyampaikan konten subjek tertentu sebagai alat untuk berpikir kreatif siswa					
62.	Saya tahu cara menggunakan teknologi digital untuk menyampaikan konten subjek tertentu sebagai alat untuk berbagi ide dan bekerja secara kolaboratif					
63.	Saya tahu bagaimana menggunakan teknologi digital untuk menyampaikan konten mata pelajaran tertentu sebagai alat komunikasi siswa					
64.	Saya tahu bagaimana menggunakan teknologi digital untuk menyampaikan konten mata pelajaran tertentu sebagai alat bagi siswa untuk merencanakan pembelajaran mereka sendiri					
65.	Saya tahu cara menggunakan teknologi digital untuk menyampaikan konten subjek tertentu sebagai alat untuk pemecahan masalah siswa					

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The Influence of Self-Efficacy and Attitude towards Digital Technologies on Teachers' Technology, Pedagogy and Content Knowledga

SEMI-STRUCTURED INTERVIEW

1. a. Dengan topik ini (RPP), gambarkan konten subjek yang akan Anda ajarkan
   b. Bagaimana Anda akan mengembangkan pengetahuan Anda tentang konten ubjek sebelum mengajar?
   c. Jelaskan strategi pedagogis / kegiatan kelas apa yang akan Anda pilih untuk konten mata pelajaran tersebut
   d. Pertimbangan apa yang Anda ambil dalam memilih strategi pedagogis / kegiatan kelas tertentu?
   e. Seberapa efektif strategi pedagogis itu untuk mengajarkan isi mata pelajaran?
   f. Jelaskan teknologi digital tertentu yang akan Anda gunakan untuk mengajarkan konten subjek
   g. Bagaimana Anda akan mengevaluasi kelas Anda?
2. a. Apakah TIK penting dalam pengajaran dan pembelajaran?
   b. Apa keterampilan TIK Anda?
   c. Apakah Anda berpikir bahwa Anda dapat menggunakan teknologi digital baru dalam mengajar?
   d. Manfaat apa yang Anda dapatkan dari keterampilan TIK Anda dalam mengajar?
   e. Bagaimana Anda menggunakan teknologi digital dalam tugas harian Anda?
   f Apakah ada aspek teknologi digital yang menurut Anda berdampak negatif pada bagi Anda?
3. a. Teknologi digital apa yang sering Anda gunakan di dalam kelas?
   b. Bagaimana Anda mengembangkan keterampilan Anda untuk menggunakan teknologi digital itu?
   c. Pertimbangan apa yang Anda ambil ketika memilih satu teknologi digital tertentu untuk mendukung strategi pedagogis?
   d. Teknologi digital apa yang sering Anda gunakan untuk mengembangkan pengetahuan Anda tentang konten subjek?
4. a. Apa tantangan yang Anda hadapi dalam mengintegrasikan teknologi digital di kelas?
   b. Dukungan apa yang harus diberikan oleh sekolah atau otoritas yang membantu Anda mengintegrasikan teknologi vvv digital?
5. a. Saya dalam waktu dekat, apakah Anda akan menggunakan teknologi digital baru di kelas?
   b. Mengapa Anda ingin menggunakannya?
6. a. Teknologi digital apa yang sering Anda gunakan di dalam kelas
   b. Bagaimana cara anda menggunakannya?