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Examining Pre-service Teacher Belief in Technological for Teaching Mathematics

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Abstract. Technology is an effective learning tool. However, the existence of technology is an anxiety for teachers because it is difficult to follow. Therefore, this research intends to analyze teacher beliefs and teacher awareness of the role of technology, as well as the relationship between beliefs and teachers' pedagogical abilities regarding the use of technology in mathematics learning. This research was designed using a qualitative approach with a multiple case study design. Seven candidate elementary school teachers were involved in the research. Data collection was carried out through observation, interviews, and field notes. Data analysis was carried out using inductive and deductive analysis methods. The results of research studies showed that (1) teachers believe that technology can help maximum mathematics learning in the form of audio and visual words; (2) teachers realize that technology is an appropriate visualization tool in mathematics learning by adapting the form of visualization to be more detailed and appropriate to the child's character; (3) there is a relationship between teacher beliefs and candidate teachers' pedagogical abilities regarding the use of technology in mathematics learning. So, it can be concluded that teachers are confident and aware that technology has broad benefits in mathematics learning through its visualization form and there is a relationship between beliefs and teachers' pedagogical abilities in using technology.

Keywords: Digital Technology, Learning, Mathematics, Pre-Service Primary Teachers, Teacher Confidence.

1. Introduction

The world is intensively bringing the Sustainable Development Goals (SDGs) program into life. One of them is in the field of education. The SDGs program seeks to advance and improve the quality of education (Nazar et al., 2018). There are at least 17 SDGs program goals, one of which focuses on quality, fair, equal education and learning opportunities for all ages throughout life (Camilleri & Camilleri, 2020). In the current era of industrial revolution 4.0, education is a challenge in all parts of the world so that a quality education system is upheld (Kayembe & Nel, 2019). Unfortunately, nowadays, there are people who do not get their right to education and a decent life (Rao & Baer, 2012). The decline in people's rights is also caused by the lack of educational facilities from the state, lack of government intervention in handling education and the orientation of education which focuses only on services. This has an impact on weak human resources. Human resources are an essential factor that must be considered and addressed immediately (Fox & Cowan, 2015). These improvements must be adapted to current developments.

Technology is something that is developing rapidly and has penetrated all areas of life (Litvinenko, 2020). Technology must be optimized precisely and wisely. The use of technology becomes a human bridge to help with daily activities. The education sector is one that benefits from technological developments. In education, technology plays a role as a means of distributing material in various forms (Zhou et al., 2020). The involvement of technology in learning helps teachers in delivering material and increases students' learning motivation (Beardsley et al., 2021). Currently, teachers are required to utilize technology in learning. These demands are packaged in an educational regulation and curriculum. Teachers must master all the features available in learning technology, such as in mathematics learning. Teachers

can use Maple, Matlab, GeoGebra, Scaffolding, and many others in the context of mathematics teaching.

Learning mathematics is always considered a difficult subject because students have to do a lot of calculations. Students become quickly tired of the continuous practice method. Therefore, the presence of technology is really needed to represent mathematical numbers in a tool that is of interest to students. Teachers must be confident and aware that the function of technology is very large in teaching mathematics or other subjects. Pedagogical skills regarding the utilization of technology are needed by teachers with immediate implementation.

1.1. Problem Statement

In the current era of the industrial revolution, technology has become something that is considered important. Technological developments are very rapid and have an impact on various aspects of human life (Litvinenko, 2020). Technology is able to bring humans to an era without geographical barriers. Everyone can work, communicate, interact with other people through technology. The impact of technology has penetrated every area of life, including education. Technology has been widely used by teachers to help deliver lesson material or simply attract students' attention and interest in learning (Winarto et al., 2020). Technology models are also very diverse, such as e-learning (electronic learning), Computer Assisted Instruction (CAI), Computer Based Instruction (CBI), and e-teaching (electronic teaching) (Fatimah, 2023). These models allow teachers and students to search for learning materials independently from the internet via computers as a means of learning. By understanding how to use a computer, teachers and students can access learning materials via intranet and internet networks, and through CDs they can study learning materials interactively and interestingly, without having to be accompanied by a teacher directly.

In fact, advances in technology are not accompanied by teacher competence in using it. There are obstacles to integrating technology in learning, both physical and non-physical. From a physical perspective, the problems that occur are inadequate facilities and infrastructure, especially in 3T schools (Frontier, Outermost and Underdeveloped), as well as inadequate multimedia equipment in educational institutions (Sarlin et al., 2023). From a non-physical perspective, the problems that arise are teachers' low confidence in using technology during the teaching and learning process, teachers' lack of competence to integrate technology with pedagogical practice, teachers' attitudes and inherent resistance to change (Hamlaoui, 2021; Wang, 2021). The literature review states that teachers are afraid of teaching failure if they use technology even though the use of ICT is highly recommended (Al-Maroof et al., 2023). Teachers' competence is also doubtful in using computers. Moreover, if the teacher is an elderly teacher. They tend to be unenthusiastic about changes and integration with computerized learning in their classes. Some teachers consider that the utilization of ICT in PBM does not have clear advantages (Lie et al., 2022).

These problems have the potential to impact other aspects if left unchecked. The impacts that arise if teachers do not involve technology in learning include teachers being left behind in educational information (Fernández-Batanero et al., 2021); teachers are less developed in terms of e-learning (Dhillon & Murray, 2021); and teachers will be hampered in the administration system at educational institutions (Naik et al., 2021). Another impact can also lead to self-labeling (teacher) being considered conventional. Teachers will be increasingly left behind by all technology-based education systems. The conveniences of technology will be considered a big difficulty because they have labeled technology as an obstacle. This will actually make it even more difficult for teachers in the future.

Based on the possible impacts, solutions are considered a priority. The main thing is to bring teachers closer to various technologies naturally. For example, including technological media as a mandatory means of learning which is packaged in the form of a curriculum. Through this, technology becomes the only option in carrying out learning. Several subsequent studies have stated that it is required to regard the involvement of technology in learning. However, it does not aim to replace teachers' roles (Varol, 2013; Zakrajšek, 2019). The knowledge needed by candidate teachers and teachers to promote effective learning includes mathematical

content knowledge, mathematical pedagogical knowledge, technological knowledge, pedagogical technology knowledge, and knowledge of curriculum (Hollebrands & Okumuş, 2018; Koehler, M. J., Mishra, 2008; Koehler et al., 2013; Rocha, 2013; Sacristán, 2019).

The involvement of technology allows candidate teachers to explore basic knowledge of technology. It includes the capacity to operate certain technologies and to decide whether certain technology is suitable to be used in designing learning and conducting learning. There are 3 relationships involving technology in learning, namely: teacher-student-technology, teacher-mathematics-technology, and student-mathematics-technology (Hollebrands & Okumuş, 2018). The construct of knowledge in learning mathematics does not only involve mathematical content knowledge and pedagogical content knowledge (Loewenberg Ball et al., 2008; Maryono et al., 2017) but also pedagogical technology knowledge.

Candidate teachers of elementary schools need to perfect their knowledge of content and knowledge of teaching mathematics because mathematical content knowledge and pedagogical content knowledge are inseparable parts of effective mathematics learning (Shulman, 1986). The need for knowledge can assist teachers in connecting what candidate teachers know concerning learning materials and the effective ways to teach the learning materials. Thus, it is not only content and pedagogical knowledge but also both content and pedagogical knowledge which become the center of knowledge needed for teaching, so that teachers know their students' mathematical ideas and thinking (Linder, 2017; Loewenberg Ball et al., 2008).

1.2. Related Research

Many similar studies have been carried out previously by previous researchers. Like Omar (2016) researched the incorporation of technology in teaching by considering teacher beliefs. The results of his research have proven that teachers need to have the ability to utilize technology in teaching immediately in order to realize the wishes of the Malaysian Ministry of Education in achieving the potential of IT in academics. His research recommends that future researchers study the incorporation of ICT in today's education system. Besides, there is research that reports exploratory and longitudinal studies of teachers' beliefs in technology teaching and learning, as well as their teaching application at the fourth to sixth grade level of elementary school (Levin & Wadmany, 2014). Findings revealed that teachers' beliefs about education have changed significantly after they have had years of experience in technology-based classrooms. The study recommends that future researchers explore technology practices in the classroom in terms of teachers' beliefs.

Furthermore, there was research investigating the conclusiveness of professional development programs in learning mathematics through technology (Thurm & Barzel, 2020). The results of the research exposed that there was no effect of professional development programs on teachers' confidence and self-efficacy to use technology in learning. They also recommend that future researchers design professional development programs connected to teach with technology. Previous research has explored teachers' beliefs and experiences to develop learning creativity through technology (Bereczki & Kárpáti, 2021). The results of the analysis reveal that teachers' beliefs about creativity influence technology-based creativity development practices. Teachers experience difficulties in implementing technology-based teaching. With these results, it is recommended to expand the findings regarding teacher beliefs regarding technology use practices with qualitative methodology.

Other research investigates teachers' beliefs about teaching with technology (Thurm & Barzel, 2022). The research results show that teachers are less confident about the utilization of technology in learning because they consider there is a risk of using technology compared to its benefits. Their research encourages future researchers to investigate teachers' beliefs in applying technology with a multidimensional approach in mathematics classrooms. Research on teachers' beliefs and practices of technology merger has also been conducted (Ertmer et al., 2012). This research has concluded that teachers' beliefs about technology practices in the classroom align with their held beliefs even though teachers experience obstacles in the form of technological, administrative and assessment features. Teachers' beliefs about technology in learning have a big impact on student success accompanied by a firm attitude.

Recommendations are made that future researchers focus professional development efforts on the utilization of technology to facilitate changes in teacher attitudes and beliefs. Further research explains teachers' perspectives on implementing technology in the classroom (Shifflet & Weilbacher, 2015). The findings illustrate that teachers' beliefs and practices are consistent with their views on the utilization of technology in the classroom. The findings promote the existence of in-depth literature on teachers' beliefs about the benefits of technology in learning.

Several previous studies with a similar focus have been conducted. Previous researchers also recommended future researchers to conduct analytical studies on teachers' beliefs regarding the utilization of technology in learning. Therefore, it is very relevant to the studies carried out in the research. This research qualitatively analyzes teachers' beliefs about involving digital technology in learning based on different mathematical abilities and technological adaptation. So, it can be said to be in accordance with previous suggestions by adding components to make this research unique.

1.3. Research Objectives

This research focuses on pre-service teachers' beliefs and awareness of the involvement of digital technology in mathematics learning, as well as the relationship between teacher beliefs and teachers' pedagogical abilities regarding the use of technology in mathematics learning. Research examining teachers' beliefs and awareness of technology has never been conducted by other researchers. Therefore, the formulation of this research problem is (1) What are teachers' beliefs about the involvement of technology in mathematics learning? (2) What is the teacher's awareness of the role of technology in mathematics learning? and (3) Is there a relationship between teacher beliefs and teachers' pedagogical abilities regarding the use of technology in mathematics learning? The aims of this research are (1) to analyze teachers' beliefs about technology, (2) to analyze teachers' awareness of the role of technology, and (3) to analyze the relationship between teachers' beliefs and teachers' pedagogical abilities regarding the use of technology in mathematics learning.

2. Theoretical Framework

2.1. Examining Pre-service Teacher

The confidence of candidate teachers and teachers in teaching becomes one of the things that needs to be built in learning (Ciascai & Zsoldos-Marchis, 2016; Voss et al., 2013). Mathematics candidate teachers' and teachers' belief regarding beliefs concerning the essence of mathematics, beliefs in learning, beliefs in teaching (Ernest, 1989; Ferguson & Bråten, 2018), beliefs in the science of teaching mathematics (Mosvold & Fauskanger, 2013), and beliefs in knowledge concerning technology support learning (Webb & Cox, 2004). Teachers' beliefs arise from their experiences related to themselves, instructions, and knowledge of mathematics (Mosvold & Fauskanger, 2013). Furthermore, candidate teachers tend to have limited and strong teaching beliefs in mathematics, but these beliefs may change (Jääskelä et al., 2017; White et al., 2006) On the other hand, candidate teachers assume that when they become teachers they will teach mathematics in the same way as they did before. Teacher beliefs can be influenced by personal issues (teacher's perception of oneself), management issues (classroom management and student learning, and technical issues (how technology works effectively) (Tyminski et al., 2013).

2.2. Technological

Technology plays a central role in the learning process in any learning condition. Technology in learning is known as TPACK (Technology, Pedagogy and Content Knowledge). The term has been deployed to analyze teachers' knowledge of pedagogical content in the field of education (T. C. Lin et al., 2013). TPACK is described with three interdependent dimensions, namely Content Knowledge (CK), Pedagogical Knowledge, and Technological Knowledge (TK) (Baram & Uygun, 2016). Technological knowledge refers to knowledge of various kinds of digital technologies, such as the internet, software, etc (M, 2017). Knowledge factors guide

teachers' application of ICT in teaching (bjet). ICT specifically provides learning strategies to enhance learning

In general, technology has been widely discussed to maintain learning approaches such as collaborative, problem-based, contextual, cooperative, and situated learning (Benson & Ward, 2013). Therefore, teacher professional development programs mainly facilitate the creation of TPACK through media, such as: Maple software, Matlab, GeoGebra, Scaffolding, etc. Based on opinion Nurzannah et al. (2021) said that GeoGebra. GeoGebra is defined as mathematical software to help handle numbers, vectors, up to finding derivatives and integrals. Besides, GeoGebra software was built specifically for mathematics lessons with three functions, namely as a mathematics learning medium, a tool for preparing mathematics teaching materials, and a tool for solving mathematics problems (Nurzannah et al., 2021; Saputra & Fahrizal, 2019). GeoGebra makes it easier for students to visualize images of mathematical equations (algebra)(Saha et al., 2010). Geometry material can be delivered using the GeoGebra application so that students show a positive attitude when solving math problems (Septian et al., 2020). GeoGebra guides students so that they understand geometry concepts easily. This is a consideration rather than students learning with other tools (Jelatu et al., 2018).

2.3. Teaching Mathematics

The concept of pre-algebra does not have a widely agreed definition, in articles suggest that pre-algebraic operations deal with equivalence and solving problems of unknown numbers. Active understanding of adaptive numbers demonstrates competence in manipulating arithmetic relationships comprehensively and applying inverse and multi-step relationships. Taking the relationship between 12 and 3 as an example, If students' understanding of adaptive numbers is maximum, then students can recognize the relationship between these adaptive numbers and each other (McMullen et al., 2017).

The transition from arithmetic to algebra requires a similar thought process than transitions from other mathematical materials (Carraher et al., 2001). This transition creates a cognitive gap that makes it difficult to understand algebra. This is because understanding algebra requires not only quantities but also consideration of relationships (Nunes, T., Bryant, P., & Watson, 2006). Numerical and operational relationships can unify adaptive number knowledge and algebraic reasoning. Therefore, understanding adaptive numbers should be linked to pre-algebra material. Mainly to solve problems. Also, further understanding of arithmetic operations is required. This understanding leads to a relational view of equality (McNeil et al., 2010).

3. Method

3.1. Research Method

This research was designed with qualitative research. A case study design was used in this research. A case study is defined as intensive research on a person or group of people with the intention of generalizing data from several variables in depth (Gustafsson, 2017; Woods & Calanzaro, 1980). Case studies investigate a phenomenon broadly in order to understand the reader about the phenomenon (Hamel, 1993; Yin, 2009). This design was used because this research answers pre-service teachers' beliefs regarding the involvement of technology in mathematics learning (Hani et al., 2021; Yin, 2009). The case study design used is more than one issue or case in one study (Creswell & Creswell, 2022), so when the researchers want to test similar conditions or findings, the case can be replicated (Prihatsanti et al., 2018). Multiple case studies are used in research to answer the research problem formulation in depth.

3.2. Participants

This study involved 7 candidate elementary school teachers who had taken digital literacy lectures and ICT (Information and Communication Technology) literacy lectures. Furthermore, the participants had taken a deepening understanding of mathematics learning material and mathematics learning development courses in the final year of the third year and the beginning of the fourth year. The researchers observe the participants' activities when they are

taking part in practical field learning activities. The participants are treated as different cases based on the results of the lectures they have taken. The researchers try to get a pattern with the help of semi-structured interviews. The candidate teachers know their participation and know the goal of this research.

Table 1. Pre-Service Teachers' Level of Mathematical Content Knowledge (MK), Mathematics Pedagogical Content Knowledge (MPCK), and Technological Knowledge (TK).

Participants	MCK	PCK	TK
S1	High	high	high
S2	High	high	Moderate
S3	High	Moderate	high
S4	Moderate	high	high
S5	Moderate	Moderate	high
S6	Moderate	Moderate	Moderate
S7	Moderate	high	Moderate

3.3. Data Collection

Research data was obtained from observation techniques, interviews and field notes. Observations were carried out to photograph learning activities using technology, accompanied by the use of field notes. Researchers observed seven candidate elementary school teachers as research subjects. The observation process took place from the beginning of the research permit. Question and answer activities through interviews are addressed to the teacher and carried out at the end of the lesson. Researchers interviewed seven candidate elementary school teachers. The things interviewed related to teachers' knowledge about how teachers involve technology in learning, views on the involvement of technology in learning, knowledge about technology, and knowledge about teaching mathematics with technology. Interviews are intended to evaluate teacher learning practices. The field notes are intended to capture the difficulties of candidate teachers during learning practice. The field note process took place from the beginning of the research permit, both during observations and interviews. The data collection process was carried out for 11 months from August 2022 to July 2023. The data collection process can be illustrated in the figure 1.

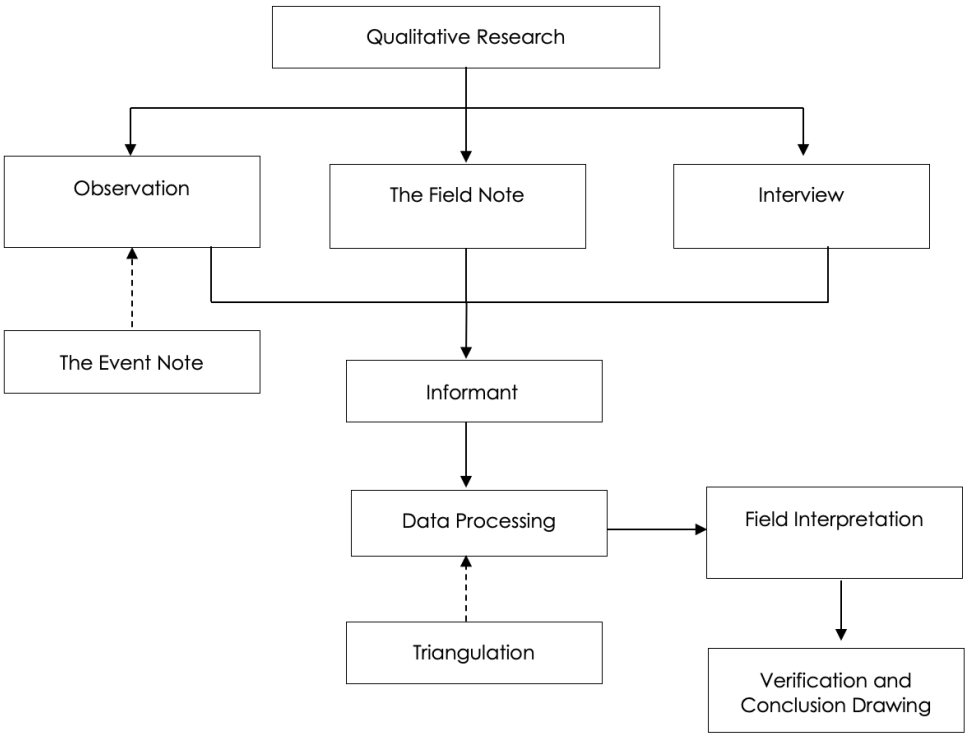

Figure 1. Qualitative Data Collection Process Chart

3.4. Data Analysis

Data analysis was obtained from inductive and deductive analysis methods. Before being analyzed, the data was first tested for validity using technical triangulation (Bengtsson, 2016). The researchers determined the components that were studied theoretically, including the MKT components and the technology adoption component in learning. The two components were divided into several subcomponents which among others were given code analysis for analysis purposes and listed in Table 2.

Table 2. Component of Knowledge

Knowledge components	Descriptions
The conception concerning the purpose of involving technology in learning	The technology roles How technology supports students' learning ideas (visualizing teacher ideas)
Specialized content knowledge	Knowledge to select a technology for the representation of a particular concept Knowledge to analyze and correct inaccuracies in existing learning resources with the help of technology
Knowledge of content and teaching with technology	Views on the involvement of technology in learning Knowledge of representation to teach mathematics
Knowledge of content and students with technology	Views related to ways students learn mathematics with technology Candidate teachers' view as students

4. Findings

4.1. The Beliefs of Pre-service Primary Teachers' concerning the Digital Technology in Learning

The first component is related to the conception of candidate teachers about the purpose of involving technology in learning. This refers to teachers' belief in utilizing technology effectively as shown in Table 3.

Table 3. The beliefs of candidate teachers concerning the conception of technology involvement in learning.

Level		
	High	Medium
The role of technology	Visual representation with audio	Visual representation in words
How technology supports students' learning ideas (visualizing teacher ideas).	The visualization aims to motivate students and prevent student misunderstandings as well	Technology is difficult to be implemented in some topics.

Table 3 shows that candidate teachers consider technology as a visual representation with audio and words. Teachers believe technology can support learning, motivate students, and prevent student misunderstandings. On the other hand, technology is also difficult to apply to some topics. Thus, it can be concluded that candidate teachers' beliefs regarding the involvement of technology lead to the role of technology in supporting the learning process and students' interest in learning even though there are several topics that are difficult to apply.

The second component is related to specialized content knowledge concerning the knowledge to choose technology for the representation of certain concepts as well as the knowledge to analyze and correct inaccuracies in existing learning resources with the help of technology shown in Table 4.

Table 4. The Beliefs of Candidate Teachers Regarding the Selection of Representations and Inaccuracies in Learning Resources

Level		
	High	Medium
Knowledge to select a technology for the representation of a particular concept	Contextual learning and thinking in more detail	Contextual learning
Knowledge to analyze and correct inaccuracies in existing learning resources with the help of technology	Using certain ideas to prepare the anticipation of misunderstandings, especially in the lower grades	The implemented ideas make learning meaningful

Table 4 shows the results that teachers choose technology so that concepts or lesson material can be represented in detail. In addition, teachers use certain ideas to prepare students for misunderstandings from the learning resources used. In summary, candidate teachers' confidence in choosing learning resources is based on their knowledge in choosing technology that is appropriate to current learning.

The third component is related to knowledge of content and teaching with technology shown in Table 5.

Table 5. Candidate Teachers' Beliefs about Learning and Curriculum

Level		
	High	Medium
Views on the involvement of technology in learning	It is very helpful in learning.	For some concepts, it is very helpful.
Knowledge of representation to teach mathematics	Illustrating a concept, especially geometry, will be easier if technology is involved.	Technology is still difficult to be implemented in some learning concepts.

Table 5 shows the results that teachers believe technology really helps the learning process and curriculum implementation. Technology is also believed to be an appropriate tool for illustrating geometric concepts in mathematics. However, there are difficulties experienced by teachers when implementing this technology in other concepts. Thus, it can be concluded that teachers view the involvement of technology as very appropriate and useful in representing mathematics learning materials.

The fourth component is related to knowledge of content and students with technology shown in Table 6.

Table 6. The Beliefs of Candidate Teachers about Learning and Curriculum

Level		
	High	Medium
Views related to how students learn mathematics with technology The view of candidate teachers as students	Students learn to think in more detail by trying something. With interesting visualization, students feel happier.	The questions given can be designed by the students themselves. It is interesting.

Table 6 displays the results that students gain more detailed learning experiences when using technology in mathematics learning. Apart from that, candidate teachers (from a student's perspective) view technology as a tool that displays interesting visualizations of images and videos so that students feel happier. Therefore, it can be concluded that candidate teachers' beliefs about technology from the students' perspective are in line with their expectations with many assumptions about the attractiveness of visualization and other benefits of technology.

4.2. Pre-service Elementary School Teachers' Awareness of the Role of Digital Technology in Learning

The first component is related to the conception of candidate teachers about the purpose of involving technology in learning. This component is reviewed in terms of how technology plays a role and how technology supports students in learning ideas (visualizing teacher ideas).

Candidate teachers realize the role of technology as a visualization tool. Even though they have realized that technology is a visualization tool, some candidate teachers feel that visualization still needs to be strengthened by words. However, some candidate teachers feel that visualization is enough and can be understood well. Overall, participants realize that visualization can support student learning, especially when students are in the iconic and symbolic stages. However, some participants felt that it was difficult to visualize certain materials with the help of technology.

S6 stated "I had difficulty visualizing the topic of decimal numbers. In what way can I visualize it? Finally, I thought that some topics were difficult to be visualized, whereas, I should be able to simplify them to help students understand them more easily.

On the other hand, S1 responded, "For the learning materials, I used Geogebra to help students understand decimal numbers. For example, when students drag the cursor so that the area looked like this and the decimal number value was 2.44.

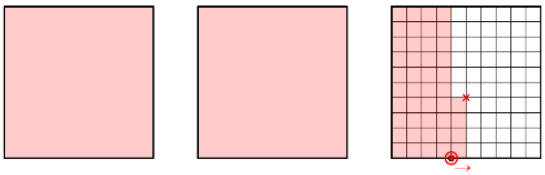

Figure 2. An Illustration Adapted from GeoGebra 2.44.

Furthermore, participants realized that technology played a very important role in a learning process such as when the learning situation required distance learning. Participants believed that technology provided interesting examples for students. In addition, technology could make lessons more fun. As a result, it would ultimately motivate students. This motivation was

related to an opportunity for students to try themselves so that they display different forms of visualization. Participants also realized that learning time was more effective. Several participants tried to make some visualizations as follows.

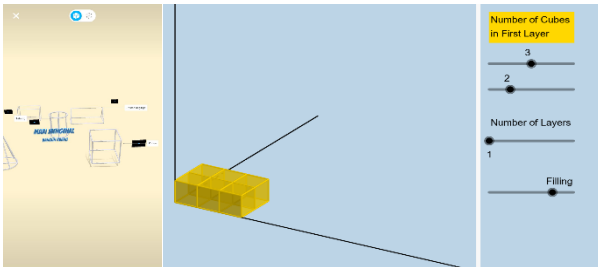

Figure 3. S3 A Visualization using Assemblrworld (1) and Geogebra (2)

The second component is related to specialized content knowledge concerning the knowledge to choose technology for the representation of certain concepts as well as the knowledge to analyze and correct inaccuracies in existing learning resources with the help of technology. At first, this component starts by providing excerpts of existing teaching materials as follows:

Figure 4. A Snippet of Questions on The Teaching Materials

Participants of S1 and S2 argue that this confuses students and make them think that they can add up different objects later. The analysis showed that the participants understood the pre-algebraic concepts. The participants were asked to be able to think of a visual representation or manipulative form that could lead students to understand a concept. The results designed by the participants are as follows:

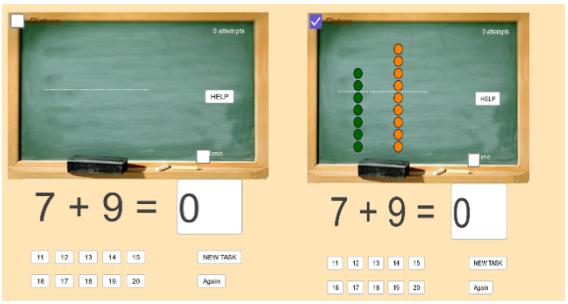

Figure 5. An Illustration of Participant S1

Figure 6. A Snippet of the Participant S2 Illustration

From the text snippet of the teaching materials used, the participants designed an illustration considered capable of overcoming the existing inaccuracies of the learning materials. The participant stated that such illustrations can help students understand a concept more easily and make students like mathematics more.

S2: by making more attractive visual representations, students feel more interested in learning mathematics. Besides, by implementing technology in learning, I feel that I am capable of helping students with more meaningful learning.

However, the participants were also worried about whether all students can access it later. On the other hand, candidate teachers continued to have the knowledge to develop learning with technology utilization. Another concern that emerged from S5 was whether the technology would replace the teacher's role and students' thinking processes even though in limited practice the participants did not feel this way because there was still guidance in the learning process.

The third component is related to knowledge of content and teaching with technology. This is connected to views on the involvement of technology in learning and knowledge about representation for teaching mathematics (aspects related to curriculum).

After taking lectures on digital learning and ICT literacy, participants thought that "technology can help teachers visualize various topics in learning".

In line with the experience expressed by S7 who stated, “Regarding the concept of conical nets, students will understand more and be sure that it is not a triangle and a circle. Students will believe in and understand more, and I am more confident in helping students. The participants realize that they can make illustrations or drawings faster with the help of technology, for example, in the case of geometry, participants take advantage of what is in GeoGebra, one of which is as follows:

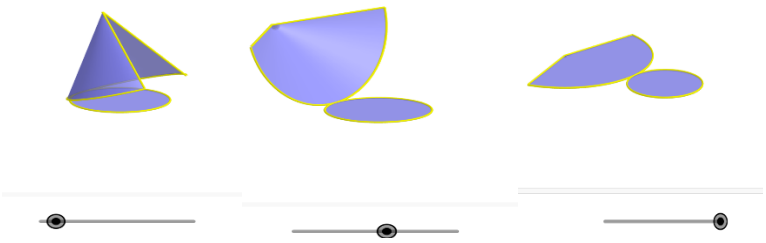

Figure 7. A Snippet from S7

The fourth component is related to knowledge of content and students with technology. This is related to views regarding how students learn mathematics with technology and views of candidate teachers as students.

Some participants realized that at the beginning, participants felt difficulties and were unable to involve technology in learning, but in the end, after what was done, participants felt capable and confident that they could do it. The confidence of participants was also shown by the reactions of students who feel happy during learning.

S3: students felt very challenged and happy when learning about the perimeter of flat shapes (rectangles). Students discovered concepts and study in more detail for the circumference materials. Students keep trying and finally, they can conclude what circumference is.

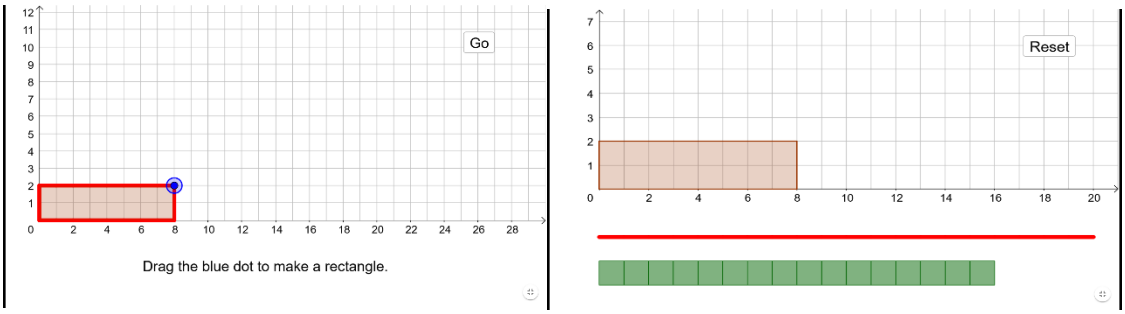

Figure 8. A Snippet from S3

4.3. The Relationship between Confidence in Using Technology and Candidate Teachers' Pedagogical Abilities

From what was realized by the participants during this process and changes in the beliefs of the participants regarding the involvement of technology, the structure of the lecture curriculum became one of the factors that could help candidate teachers build their self-confidence and beliefs. However, this was also the opportunity for possible access to technology. The results of the study showed that there was indeed a correlation between confidence in using technology and the pedagogical ability of candidate teachers, in this context, pedagogical technological knowledge, so that digital technology could be utilized pedagogically to assist learning. In general, it can be seen in Figure 9 below.

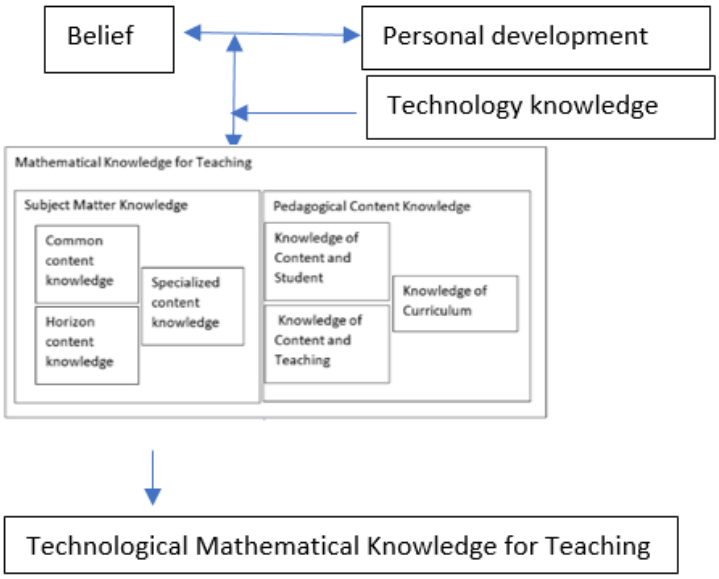

Figure 9. A Tentative Model of Technological Knowledge for Teaching Mathematics

The model depicted in Figure 9 considers the candidate teachers' belief in the knowledge that must be achieved. From the components that are trying to be developed with the involvement of technology, the components in PCK can be proposed to be the knowledge of content and student with technology, knowledge of content and teaching with technology, and knowledge of the curriculum.

5. Discussion

5.1. The Beliefs of Pre-service Primary Teachers' concerning the Digital Technology in Learning

The research results show that teachers believe technology can help learning more effectively. Technology provides maximum function in representing audio and visual forms of words. Teachers also believe that technology provides the knowledge to analyze and correct inaccuracies in learning resources. The involvement of technology in learning is very helpful to the maximum. This is also felt by students. Students learn to think in more detail by trying things. With interesting visualizations, students feel happier. The questions given can be designed by students themselves.

The benefits of technology in learning are not only limited to the visual or audio form it represents, but also the sophistication of the tools or parts of the technology which can penetrate from all directions. The consume of digital technology in learning is interpreted as a digital processing system so that learning becomes active, constructive, inquiry-based and exploratory for students, as well as enabling long-distance communication and data exchange between teachers and students physically in the classroom (Singhal et al., 2021). This is an expanded use of technology from mere information delivery systems and also clarifies its broader role and use in different classrooms, entire schools, and other learning centers.

Students can experience real and meaningful learning, and can interact more widely even though they do not meet in person through the use of digital technology in learning (Singh et al., 2021). The presence of technology has created a radical new era that changes the way people learn (Burbules et al., 2020). The latest step in entering the current era is by utilizing digital technology in the learning process. This step requires courage, innovation, tenacity, creativity and sufficient knowledge to accept the ever-rapid technological developments.

The potential benefits of digital technology in the learning process include: First, its use can encourage students' dialogical and emancipatory practices in learning activities and even encourage them to be proactive in learning. Students have the opportunity to access information about teaching materials earlier rather than having to wait for teacher instructions while technology is utilized. Second, the quality of student learning is maximized by activities that occur outside the classroom through technology (Serrano et al., 2019). Third, students are encouraged to learn actively through technology offerings. However, students' self-confidence sometimes peaks if technology is used excessively. Fourth, students can provide direct feedback to teachers through the use of technology (Muñoz et al., 2022). For teachers, feedback is something to pay attention to in order to reflect on the learning process so that the quality of student learning is more focused and students receive space for mediation on how to improve their learning style and direction.

5.2. Pre-service Elementary School Teachers' Awareness of the Role of Digital Technology in Learning

The second finding concerns teacher awareness of the role of technology as a visualization tool. The results show that teachers are aware that technology is a visualization tool, but some candidate teachers feel that visualization still needs to be reinforced with words. As a visualization tool, the use of technology has limitations that cannot be avoided. Some roles of technology can be lost to the teacher's maximization in explaining learning material. When studying, students not only pay attention to the objects in front of them, but students also need detailed explanations or in language that suits the child's character. There are several teacher roles that cannot be replaced by technology, such as providing motivation, supervisor, and

provider of clarity, and the like. Teachers have five roles in the learning process, namely as controller, director, leader, facilitator, and as a resource (Khairani & Sumarsih, 2021). With the proliferation of information from social media that students receive about learning today, teachers have become a source of information, no longer the only source, but the presence of teachers in education is still and continues to be needed by students as managers and facilitators so that students can study productively.

The results of the analysis show that participants understand pre-algebra concepts. Participants are asked to be able to think of visual representations or manipulative forms that can direct students to understand a concept. The participants also realized that they could create illustrations or drawings more quickly with the help of technology. So, it can be said that the existence of technology ignites students' motivation to understand a concept. This was expressed that technology is a motivation for students in providing resources that help provide contextual knowledge that can be reused, sustainable, and can cover a wider learning group (Dar et al., 2019; Vijayakumar & Ramesh Babu, 2018). However, there is something you need to pay attention to. In a learning process, teacher involvement in guiding students could not be replaced by technology. The emergence of the idea that teaching would not be effective without the involvement of technology underlay the importance of technology to assist meaningful learning (Ertmer & Ottenbreit-Leftwich, 2010; Spector, 2014).

Several participants realized that at first the participants felt difficult and unable to involve technology in learning, but in the end after doing so, the participants felt able and believed that they were capable of doing it. The participants' self-confidence was also shown by the students' reactions who felt happy during the lesson. In line with Vijayakumar & Ramesh Babu (2018) opinion that learning technology helps increase self-esteem and self-confidence. Several previous studies also mentioned similar things, where the presence of technology in learning influenced the self-confidence of teachers and students. Previous research concluded that social TikTok has an influence as an interactive learning media for educators and students in online learning (Khairani & Sumarsih, 2021).

5.3. The Relationship between Confidence in Using Technology and Candidate Teachers' Pedagogical Abilities

The research results show that there is indeed a correlation between self-confidence in using technology and candidate teachers' pedagogical abilities, in this context pedagogical technological knowledge so that digital technology can be used pedagogically to help with learning. Specifically, the involvement of technology in learning, which is often known as TPACK (Shulman, 1986), and the emergence of pedagogical technology knowledge (Thomas & Palmer, 2014) have a general framework, meaning that as it is known, mathematics has its own characteristics. The involvement of technology in learning is related to visualization, accompaniment, and the meaningfulness of learning. Technology also helps provide visualization in learning. In elementary schools, visualization is an effective representation to help students understand a concept (C. Y. Lin & Wu, 2021; Rau, 2017). Through visualization, participants assist students by accompanying students to keep trying new things, which leads to meaningful learning. Students will learn to think in more detail and at the end, with teacher assistance, students can develop a concept optimally. Based on the activities carried out and experienced by participants, beliefs and the desire to develop provide influential factors. What is given in lectures to support technological abilities strengthens this and builds mathematical knowledge for teaching.

The results of this are in line with research produced by (Thomas & Palmer, 2014) stating that the support in the lecture process and personal development affect what can be done in learning practice, in this case, what has been obtained in the learning process theoretically influences the learning practices carried out. Furthermore, learning practices involving technology are considered to be able to increase candidate teachers' confidence in teaching (Abraham & Komattil, 2017; Uluyol & Şahin, 2016).

6. Conclusion

The design of the lecture curriculum structure forms the basis of teaching practice skills. To meet the demands of the 21st century, it is necessary to strengthen the teaching beliefs of candidate teachers. This teaching belief can be prepared by strengthening the mastery of mathematics content, mathematics pedagogy, and technology in mathematics learning. The conclusions of this research consist of three things, namely (1) teachers believe technology can help mathematics learning effectively with its function of representing concepts in the form of words audio and visual; (2) the teacher realizes that technology is an appropriate visualization tool even though a more rigid form of visualization is needed and is appropriate to the child's character; (3) there is a relationship between teacher beliefs and candidate teachers' pedagogical abilities regarding the use of technology.

Limitation

This research only focuses on studying mathematical technological pedagogical knowledge for pre-service primary teachers in designing a lesson.

Recommendation

The research results show that pre-service teachers' beliefs in teaching mathematics require preparation in terms of content components, pedagogy, and mastery of technology. Therefore, researchers recommend teachers to prepare the basic needs for teaching completely. Furthermore, this research concludes that the benefits of using technology in learning are felt by teachers and students, in the form of closeness between teachers and students so that learning becomes more meaningful. Thus, teachers are advised to use technology in learning with more interesting concepts by combining types of digital technology.

Technical constraints and self-confidence to explore technology during learning are things that need to be addressed by future researchers. Learning experiences involving technology bring participants and students to think in more detail so that learning is much more meaningful. However, further studies should be more certain about this. In addition, teachers' belief that traditional teaching is more effective is also a reason for further study because it can be used to see whether teaching beliefs also change learning practices. Future researchers are also advised to conduct further research quantitatively by testing the effectiveness of digital technology on the beliefs of primary school-level pre-service teachers.

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Conflict of Interest

The authors declare no conflicts of interest.

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