The teachers’ obstacles in implementing technology in mathematics learning classes in the digital era

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Abstract. The use of technology in mathematics teaching-learning has been proven to be successful in increasing students’ motivation, interests, and achievement. However, the use of technology in learning mathematics in answering the challenges of the digital era has not been successfully implemented as a whole with only 19.22% at the junior high school level and even at the senior high school level only 16.23%. Teacher professionalism is not enough to guarantee the implementation of technology in mathematics education. Unequal facilities and infrastructure are also obstacles. This research aims to describe the obstacles of mathematics teachers in applying technology in mathematics teaching-learning. This research is a case study research with the subject of 12 mathematics teachers in South Kalimantan, Indonesia. Data were collected using questionnaires and interviews. Data analysis was done using the Miles & Huberman model, with the step of data reduction, data display, and conclusion. The results showed that the obstacles of mathematics teachers in the digital era in implementing technology in mathematics teaching-learning included: (1) mathematics learning material that was less suitable for the use of technology; (2) facilities, infrastructure, and support provided by schools were inadequate for the use of technology in teaching-learning; (3) the level of teacher skills in using technology in mathematics teaching-learning. Some factors that influenced the emergence of these obstacles include (1) teachers’ assessments and point of views of the effectiveness in using technology in teaching-learning mathematics in the classroom; (2) unequal access to education services between schools in cities and villages; and (3) lack of training and information provided to the teachers about the use of technology in mathematics classes. Those obstacles obtained were common obstacles experienced by the teachers in South Kalimantan, Indonesia, both in urban and rural environments.

1. Introduction

Technology has entered in all aspects of life, including education. The application of technology aims to ease human tasks and help humans in various aspects of life. Shopping, booking tickets, digital payments, and even learning in a class have used technology. The digital era is the beginning of the incorporation of technology into almost all elements in education [1]. Technology is a major booster in increasing innovation in teaching-learning activities, providing different learning experiences and providing broader learning opportunities for students [2]. The use of technology in the classroom can be done in various fields of science, including mathematics.

The use of technology in learning mathematics creates opportunities for students to access mathematics deeper and connect mathematics with real life. Along with the increasing problems and complexity of mathematics material, the digital learning ecosystem becomes an alternative for
students, because mathematics learning becomes interactive, dynamic, investigative, and process-oriented due to technological involvement. In the end, it becomes a capital that can direct students towards discovery-oriented mathematics and strengthen deeper understanding through reflection and critical thinking. Learning mathematics using technology becomes more interesting, motivates, provides opportunities for learning while playing, and encourages students to explore problems, produce guesses, and seek explanations while sharing their findings with their peers and teachers, and increasing opportunities for collaboration [3].

The integration of technology must be done in the classroom to support the teaching-learning process in order to create students’ abilities about mathematical concepts and procedures until the end the students can do it without the help of technology supports [4]. There are various alternatives for teachers in integrating technology in mathematics learning, for example, in the form of presentation slides, graphic calculators, learning videos, or blended learning [5]. The use of technology in the form of videos can provide opportunities for the students to explore mathematical ideas and can be used to introduce new mathematical processes and concepts, linking mathematics with nature, arts, and other contexts in real life by involving students to express mathematics that they understand through the given videos [6]. Fundamentally, the use of technology has a positive impact on students in learning mathematics [7–9]. Technology can improve the concept of understanding, mathematical procedures, motivation, achievement, self-regulated learning, and learning outcomes, and even has a positive impact on students with special needs [10–14].

Integrating technology in a teaching-learning process will be done well if the teacher has a knowledge framework known as Technological Pedagogical Content Knowledge (TPACK). TPACK is a framework that integrates technology into the teaching-learning process that requires interaction between content knowledge, pedagogical knowledge, and technological knowledge. TPACK forms effective learning through technology that plays a role as a representation in understanding the concepts being taught. TPACK includes pedagogical knowledge possessed combined with the use of technology in teaching content, knowledge of what makes a mathematical concept difficult or what makes a concept easy to learn and how technology can help problems faced by students, knowledge of previous student abilities, and knowledge of how technology can be used to build on existing knowledge to develop new knowledge and strengthen old knowledge [15].

In principle, TPACK is an interaction or a combination of 3, namely Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK) as follows: (1) CK is a basic element that must be owned by teachers following their fields. CK is knowledge about learning material that must be learned or taught; (2) PK refers to the methods and processes of learning, class management, assessment and evaluation, development of learning implementation plans; and (3) TK is knowledge refers to various technologies which can be used in teaching and to understand that the use of technology can change the way teachers teach [16]. As a professional, the teachers who have a TPACK framework plays a very important role in determining strategies and evaluating the development of learning, including to implementation of various technologies in the classroom [17].

![Figure 1. TPACK Framework](image-url)
The application of technology in the education sector must be maximized, the potential of digital technology can increase the student learning achievement and have a positive impact on the process of learning and teaching mathematics has been widely recognized [18]. Besides, teachers are also an important part of the implementation of the use of technology. Also, teachers are an important part of the implementation of the use of technology. However, in a survey of 4,014 schools in 34 provinces of Indonesia, only 19.22% at the junior high school level and even lower at the senior high school level 16.23% the use and utilization of information and communication technology in the education sector [19]. This data illustrates the lack of use of technology in education sectors that have an important role in developing human potential. Therefore, this study will illustrate the obstacles and barriers faced by teachers in implementing technology in learning mathematics in the classroom.

2. Methods
The type of research is a case study with a qualitative approach that aims to describe in-depth relating to the obstacles of the teachers in implementing technology in learning mathematics in the classroom. The research subjects in this study were 12 teachers from various regions in South Kalimantan who were selected based on the results of data collection on the obstacles encountered in using technology in mathematics learning and TPACK questionnaires. Each research subject will be given an MT code from 1 to 12. All of the research subjects were high school mathematics teachers with a working period of fewer than three years.

Data collection was done by questionnaire and semi-structured interviews to find out the obstacles of the teachers in integrating technology in mathematics learning in class. Interviews were conducted until the data obtained was saturated. The questionnaire in this research consisted of two, the TPACK questionnaire and the teacher obstacle questionnaire in integrating technology. The data validity test to increase trust in this research was done by triangulation. Triangulation is a technique to increase trust by checking the data from various sources using various methods and times. The type of triangulation used in this research was sourced triangulation by linking related statements from a minimum of three research subjects. Data analysis techniques in this research used the data analysis techniques of the Miles and Huberman models, which consisted of: (1) data reduction, (2) data presentation, and (3) concluding [20].

3. Results and Discussion
Twelve teachers with high and very high TPACK categories (Cronbach-alpha reliability 0.7 (minimal reliability [21]) and corrected item-total correlation higher than r-table) were selected as the subject. They followed the interviews to obtain and find teacher constraints in integrating technology. The results of the interviews were grouped according to the similarity of answers from the research subjects and then reduced until the saturated data was obtained. After that, the reduction results were linked to getting a conclusion with source triangulation as a form of acknowledgment of the data obtained. In this research, three major ideas were found in understanding the obstacles of mathematics teachers in implementing technology in classroom, (1) mathematics learning material that was less suitable for the use of technology; (2) facilities, infrastructure, and support provided by schools were inadequate for the use of technology in learning; (3) the level of teacher skills in using technology in mathematics learning. The teachers' obstacles from each theme were developed by searching in-depth data until saturated, which obtained through interviews with research subjects. Details of the results of teachers' obstacles in using technology in mathematics learning are presented as follows.

3.1. Mathematics Learning Material that is Less Suitable for the Use of Technology
The implementation of technology in mathematics learning is inseparable from the aspect of the teacher’s attitude towards the learning material that will be taught to the students. Some materials are considered delicate and need the student understanding so that it becomes an obstacle for the teachers in implementing technology in the teaching-learning process. The following is an example of an interview excerpt supporting this statement after the data has been reduced.
“I find difficulty in teaching fraction material and I have not found a mathematical application that matches with the material so I don’t think it is necessary to use it . . . “(MT11)
“. . . in my opinion certain materials are quite difficult to use technology for example materials that require a fairly complex understanding of concepts, whereas usually, the existing technology is only as a counting aid, not as a tool to provide understanding to the students. Such aids sometimes cannot provide understanding to the students. In contrast to Geogebra which can help the students’ understanding of bound geometry . . . “(MT7)
“. . . sometimes for certain materials such as linear inequality system with three variables, I do not find a suitable application to help me in teaching the material, so for those materials I am more comfortable teaching conventionally, not adding elements of technology in the classroom with the aim to focus on the material . . . “(MT1)
“. . . on count type material I prefer to use a blackboard because when writing on the board, it can also be while explaining to students how to use the formula, how to calculate, and what the concept is like. The use of technology for such material can reduce the elements as I mentioned earlier” (MT3)

Table 1. Triangulation of Data related to Mathematics Learning Material that Does Not Fit with The Use of Technology of technology

| No. | Data Reduction                                                                                      | Conclusion                                                                 |
|-----|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| 1   | Material that is considered difficult for the students and the limited application of learning mathematics for certain materials. | Certain material is considered less suitable to use technological aids to focus more on the material being taught. |
| 2   | The use of technological elements in certain materials is only limited to calculating aids, not aids to provide understanding to students. |                                                                            |
| 3   | Certain materials are considered more comfortable if they taught without the elements of technology to focus on the material. |                                                                            |
| 4   | The use of technology makes it difficult for students to understand certain mathematical material. |                                                                            |

There are some materials that are considered unsuitable for using technology in the process of teaching-learning either because there are no appropriate applications for the material (e.g. Geogebra for geometry material) or because it is indeed to focus on the material so that it is well conveyed to the students. Integrating technology is considered to be an obstacle for teachers to deliver certain materials to the students accurately.

3.2. Facilities, Infrastructure, and Support Provided by the Schools are Inadequate for the Use of Technology in the Teaching-Learning Process

One aspect of support from schools is their facilities and infrastructure. The use of technology in the classroom is inseparable from the influence of the presence or absence of facilities and infrastructure owned by schools. Without the presence of adequate facilities, the use of technology in the classroom cannot be done. The following are examples of statements that conform to the above conditions based on the results of the interview that has been reduced.
“. . . our school only has one projector that is function properly so it must take turns with the other teachers . . . “(MT1)
“The unavailability of the projectors in each class, only in a few classes . . . “(MT2)
“. . . some projectors in school are old, and the screen is used to be a little blurry . . . “(MT4)
“. . . in some classes which I taught there are projectors installed, but it hasn’t been used for a long time, some cables have also been broken . . . “(MT8)
“. . . there are no projectors at school, so usually I only use a television connected to an HDMI cable for classes that are available with television . . . “(MT9)
Table 2. Data Triangulation related to the Limitations of Technology Tools Owned by Schools

| No. | Data Reduction                                                                 | Conclusion                                                                 |
|-----|--------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 1   | Not all school-owned projectors functioned properly.                          | The technology tools supported by the schools to use the tools are very limited, and the conditions are also inadequate. |
| 2   | Projectors that the school has only for a few classes do not cover the whole classes. |                                                                            |
| 3   | Some projectors in the school are old, and the screen is a bit blurry          |                                                                            |
| 4   | There are only a few projectors installed and there are cables that have been broken because they have not been used for a long time. |                                                                            |
| 5   | There are no projectors owned by the school; television as an alternative can not cover the whole. |                                                                            |

In addition to the lack of projector devices, inadequate internet access is also an obstacle for teachers in implementing technology in learning mathematics in the classroom. The following are excerpts from interviews that support this statement.

“I know an application called Kahoot! Then I tried to use it in my math class. I asked my students to install the application in their devices, but they complained that the internet facilities provided by the school were slow and the connection was often cut off . . . “(MT3)

“At school, I use the website with moodle sukailmu.com to provide some exercises, but we have to use personal internet access to access it because the internet available at school is inadequate . . .” (MT4)

“There is no internet access provided by the school, so we cannot use online websites “(MT9)

Table 3. Triangulation of Data Related to Inadequate School Internet Connections

| No. | Data Reduction                                                                 | Conclusion                                                                 |
|-----|--------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 1   | Internet access is often disconnected.                                         | Internet access is inadequate for the teaching-learning process.          |
| 2   | The internet connection at the school is inadequate, so it uses more often personal connections. |                                                                            |
| 3   | Internet facilities are not available in schools.                             |                                                                            |

In addition to the availability of adequate facilities, these facilities must also be practical and easy to use. Facilities such as projectors that are usually owned by the schools are not installed directly in the classroom. So, to use it, the teacher must install it first, and for teachers, this is an obstacle in implementing technology in learning mathematics in class because installation requires much time. The following is an example of an interview excerpt that suits these conditions.

“. . . because our school only has one projector, after using it, the projector is returned to the equipment section, so that both when it starts and finishes using it takes a long time to install and remove it . . . “(MT10)

“The tool is not available in class, so it takes a long time to install the tool “. (MT5)

“. . . the limitations of the projector or other equipment the school have for teachers to use it interchangeably. Borrowing the tool also requires the teacher to go through the administration phase, which is also not easy. Also, installation requires a long time to prepare . . . “(MT4)

Table 4. Data Triangulation Related to Technology Owned by the School is Not User-Friendly

| No. | Data Reduction                                                                 | Conclusion                                                                 |
|-----|--------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 1   | Technology cannot be directly used for learning activity in the classroom.     | Facilities that hinder the use of technology in classes not user-friendly. |
| 2   | Installation requires a lot of time.                                           |                                                                            |
| 3   | The equipment must be taken back to where it was stored before                 |                                                                            |
due to the limited number of units, and it takes time to do it as well.

The teachers think that the impractical tool that school has, as an obstacle for the teacher to use technology in learning mathematics in class. The tools that are not practical will require a lot of time to use the tool.

Based on several obstacles obtained, all obstacles have unity of themes which are then detailed in the following table.

**Table 5. Themes Related to Facilities, Infrastructure, and Support Provided by the Schools are Inadequate for the Implementation of Technology in the Teaching-Learning Process**

| No. | Obstacles                                                                 | Themes                                                                                     |
|-----|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| 1   | The technology tools that schools have to support the use of technology are very limited and the conditions are also inadequate. | Facilities, infrastructure, and support provided by schools are inadequate to use technology in the teaching-learning process. |
| 2   | Internet access is inadequate for use in learning in the mathematics classroom |                                                                                             |
| 3   | Facilities that hinder the use of technology in classes not user-friendly. |                                                                                             |

Based on several obstacles experienced by research subjects, the big idea is determined facilities, infrastructure, and support provided by schools are inadequate to use technology in the teaching-learning process.

3.3. The Level of Teacher Skills in Using Technology in Mathematics Learning

The availability of complete technological tools and appropriate mathematics learning materials cannot guarantee that there are no obstacles in implementing technology in mathematics learning in the classroom. The level of teacher skills in using technology is also a major factor that can obstruct the use of technology in the classroom. The following are citations of interviews related to this matter.

“I am not skilled in making technology-based media, namely Adobe Flash, so I often only use videos that are already available and download it from YouTube, so if I do not find videos that match with the material, then I do not use technology in the learning process . . . “(MT12)

“I have difficulty in using some Geogebra applications and other applications that are commonly used in mathematics learning, so I cannot implement them . . . “(MT8)

“I master several applications but not as a whole “(MT1)

The data triangulation that related to the lack of teacher skills in using technology related to technology use can be seen in the following table.

**Table 6. Triangulation of Data Related to the Lack of Teacher Skills in Using Technology**

| No. | Data Reduction                                                                 | Conclusion                                                                                     |
|-----|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| 1   | Difficulties in using an application that commonly used in mathematics learning. | Lack of skills in using and making technology-based media.                                      |
| 2   | Implementation is limited as far as using readily available media or learning videos. |                                                                                                 |
| 3   | Difficulties in using an application that commonly used in mathematics learning. |                                                                                                 |
| 4   | The mastery of application in mathematics learning that is not maximal.          |                                                                                                 |

Many factors cause a lack of teacher skills in using technology in learning. It can be found through citations of interviews as follows.
“...until now, training by using computer software in mathematics learning is not maximal, so teachers are not updated regarding new software nowadays...” (MT1)
“... many learning applications that I master are only obtained when I was studied in college and autodidact, the training and socialization from the related institution are not yet reaching to our area...” (MT3)
“The mastery of education technology is something that I got more than autodidact, and I hope there are more literature and training for the teacher so that it will help them to master it easily. . .” (MT6)
“I learn more in using technology in the learning process through the internet than join in training” (MT11)

Table 7. Triangulation of Data Related to Lack of Training of How to Use Technology Properly

| No. | Data Reduction                                                                 | Conclusion                                             |
|-----|-------------------------------------------------------------------------------|--------------------------------------------------------|
| 1   | The lack of using mathematics application/software.                            | Training and introduction of software of mathematics learning are still not reaching all areas, and it is still not maximal in its implementation. |
| 2   | The training cannot reach all area.                                            |                                                        |
| 3   | The most technology skill and the skill for using mathematics application are obtained during the lecture period only. |                                                        |
| 4   | The lack of references in learning the use of technology in mathematics learning. |                                                        |
| 5   | Technology skill in mathematics learning is obtained through autodidact more than through training. |                                                        |

Based on the statement above, most of the teachers only get skill in using technology based on the learning process that is conducted with autodidact or personal learning. It shows that training in the use of technology in mathematics learning in the classroom is not maximal. Meanwhile, the lack of training and socialization from the government or institution can give impact on teacher skill in using technology. It causes teacher skill levels in using technology can be categorized at a low level.

3.4. Discussion
The use of technology in mathematics learning is an important thing that can be conducted to change the perspective of students on mathematics learning. The use of technology in the classroom is also giving students motivation and an opportunity for them to explore ideas in mathematics learning that are taught. Technology can help students in understanding mathematics concepts abstractly. But, the teacher often finds difficulty in using technology in the classroom in Mathematics learning. The obstacles can be categorized into three aspects.

First, the aspect of mathematics learning is considered not appropriate to use technology tools to be more focused on the material that is taught. The difficult material to be taught is considered by the teacher as an obstacle to using technology in mathematics learning. While the use of technology in the classroom can be considered as an obstacle for them to deliver mathematics material because it is considered more easily to deliver material without tools so that students can more be a focus on the material that is delivered. This statement is similar to previous research that the support material, the appropriate learning goal, and the availability of technology that is used in the material will give an impact that teachers will implement technology in the learning in the classroom [22]. Teacher prefers to choose to not use in certain material to make them focus on delivering the material [22, 23].

Although teachers in this subject of the research have good TPACK, many mathematics materials are still considered as their obstacles because this aspect is influenced by the different perspectives or the teachers’ way of assesses on Mathematics material that will be taught can be delivered well with the help of technology or not. It can be seen from the data that was obtained from the research subject MT1 who assumes that the fractional operational material is an obstacle. It is similar to MT7 who assumes that the use of technology in the classroom is not quite in helping teachers to deliver material to students.
The obstacle related to the difficult material can be solved by developing material that digitally-based on content organization, pictures, and interesting problems for the student. It can increase the quality of Mathematics learning in the class [25]. However, to change perspective or assessment teacher so that the teacher can keep in implementing technology in the learning process, it needs training and experience form teacher [26].

The second aspect is the facilities and infrastructure that is provided by the school is not adequate to implement the use of technology in the learning process. Although the teacher has a good perspective and assessment of the use of technology in the classroom, it will not be maximal if it is not supported by the complete facilities. The lack of facilities can prevent the teacher from implementing technology in mathematics learning in the class because in its implementation is needed some tools to support the use of those technologies, namely computer, projector, television, internet access, etc.

The commonly used tool that is used by the teacher in the learning process in the class is an LCD projector. The teacher usually uses a projector to show a presentation slide in the form of PowerPoint, pictures or learning video. The lack of a projector tool that is available in school became an obstacle for the teacher to integrate technology in mathematics learning. Besides projector, television also can be used to show learning videos. However, the obstacle that will be faced by the teacher is the same; school does not provide television in every class. The teacher should talk alternately with another teacher in using technology or waiting for the chance of teaching in the class that provides those tools to implement the technology of mathematics learning. Besides, the tool that is not practiced or not user-friendly in its use is also an obstacle for the teacher because it takes time to prepare it. Internet access that is provided by the school is not adequate to be used in learning activities. If we see in the previous research, similar research also describes that access to use technology that is not adequate give an obstacle to the teacher to integrate technology in the learning process in the class [27, 28].

There are many schools, especially in the village area that does not get adequate facilities, there is no projector in the classroom and the slow connection internet. It is different from schools in the city area, at least they have many projectors in school. The inequality of education service can be the main factor of an obstacle for the teacher to use technology in the learning process. The subject of the research MT7 who stay in the city area is preferred to choose material as its obstacle in using technology. It is different from MT9 who stay in the frontier of the city and village area who choose facilities that are not adequate for them. The inequality between schools in the city area and the village area is also an obstacle in the implementation of computer-based National Examination in Indonesia [29]. In the worst level, the inequality of education service also shows that there is inequality of library availability and even less than 80 percent. It means that if it is assumed one school one library, so at least there are 3 out of 10 schools in the junior high school level or senior high school level in Indonesia that does not have a library [30].

Facilities and infrastructures that provide by school become an essential support thing for the teacher in the learning process. The adequate facilities and infrastructures are important in creating professionalism of teacher, support the change of the learning that is more variety, increase the confidence of the teacher in teaching and give a positive impact on the satisfy and student achievement [31, 32].

The third aspect is teacher skill level in using technology. The positive teacher attitude in the use of technology and the adequate fulfillment of facilities must be followed by teacher skill in its use or making many technology-based learning media. The skills or abilities of the teacher are other internal aspects besides the aspects of the outlook or assessment of the material and use of technology. Lack of skills possessed as a barrier for teachers to implement technology in learning mathematics in the classroom. MT8 and MT12 research subjects cannot use technology if the medium is not available directly. Likewise, with previous studies, similar findings also indicate the techniques and skills possessed by teachers in using technology influence the implementation of technology use in mathematics classes [33–36].

In this research, teachers are considered to have excellent technical skills because based on the questionnaire given by teachers has a good TPACK. However, technological knowledge gained
according to MT3 and MT6 is more obtained through self-taught learning processes than through training. Thus, the factors that influence the lack of teacher skills in using technology are due to the lack of training related to this matter.

Skills in using technology gained through training and outreach to develop teacher professionalism and as an introduction to applications, videos, learning websites, and other technologies that can be used in mathematics learning can have a positive impact on the implementation of technology in the classroom [37]. In addition, through training and the socialization of teachers’ positive attitudes towards the use of media are well-formed by equipping teachers with strategic skills on how to find and choose the right content to use in learning [38]. Indirectly, systematic training and outreach will reduce obstacles in the first aspect.

The use of technology in learning mathematics requires teachers to have the skills and knowledge about the use of technology. In addition, a positive outlook and assessment of the use of technology in the classroom with the ability to choose the right material or content is also a challenge for teachers. In addition, TPACK which is owned by mathematics teachers must also be considered and developed through training because most of the TPACK mathematics teachers are lower than other subject teachers, such as science teachers, ICT teachers, and homeroom teachers [39].

4. Conclusion
Based on the results of the analysis, the obstacles of mathematics teachers in the digital era in implementing technology in mathematics learning include: (1) mathematics learning material that is less suitable for the use of technology; (2) facilities, infrastructure, and support provided by the schools are inadequate for the implementation of the use of technology in teaching-learning; (3) the level of teacher skills in using technology in mathematics learning. As for the aspects that cause factors in the occurrence of obstacles in the use of technology in mathematics learning are: (1) teachers’ views and assessments of the effectiveness or use of technology in learning mathematics in the classroom; (2) unequal access to education services between schools in cities and villages; and (3) lack of training and information provided to teachers about the use of technology in mathematics classes.

This research provides a general description of the obstacles experienced by the teachers in South Kalimantan, Indonesia and the factors that influence them on the use of technology in mathematics learning in the classroom. Further research specifically for the teachers in rural and urban areas needs to be done to see more specific obstacles. In addition, this research is limited to the long-term teaching coverage of teachers who are only in the span of 0-3 years.

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