The problematic: Teachers’ pedagogical ability in using technology on mathematics learning of junior high school

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Abstract. Technology has a positive influence on students. It improves students' achievement, motivation and attitudes towards learning mathematics. Unfortunately, based on some observations, there still found teachers who did not use technology in mathematics learning. This study aimed to describe the pedagogical ability of teachers to use technology in mathematics learning. It used qualitative descriptive research approach, while research subjects were 3 teachers of Junior high school Muhammadiyah 1 Malang. The research instrument consisted of a questionnaire and interview. Data analysis techniques used data reduction, data presentation, and conclusion. The results showed that (1) pedagogical ability of first teacher in using the technology was medium; (2) pedagogic ability of second teacher in using technology was high; (3) pedagogic ability of third teacher in using technology was medium; (4) factors led the inability of first teacher and third teacher in using technology in learning were the infrastructure, teacher competence, motivation of teachers, and the school environment.

1. Introduction

Teacher competence is one of the factors that influence the achievement of learning and education objectives in schools, and can improve teachers' motivation and performance to perform their duties professionally [1,2]. The Ministry of Education and Culture of Indonesia divides four kinds of competencies that must be possessed by teachers, namely pedagogic competence, personality competence, social competence, and professional competence [3,4]. The ability to manage the learning of learners which includes the understanding of the students, the design and implementation of learning, evaluation of learning outcomes, and the development of learners to actualize their potentials are pedagogic competencies [5,6]. Teacher’s pedagogic competencies can improve student achievement and motivation [7].

Utilization of technology in learning is one aspect of the eight aspects of pedagogic competence that must be mastered by teachers [8–10]. The ability of teachers to use technology becomes an important factor affecting the utilization of technology [11]. Teachers are said to have the pedagogic ability to use technology if they meet three indicators, namely (1) pedagogical knowledge of technology is the ability to use various technologies such as PowerPoint, Photoshop, Microsoft Excel, graphical calculator, game, GeoGebra, Cabri, algebraic calculator, Facebook, twitter and other online math applications; (2) knowledge of technology content is a pedagogical ability that uses technology to develop, enhance and guide students' thinking skills and help teachers in teaching mathematical concepts to be more easily understood by students and (3) knowledge of pedagogical content technology is a combination of understanding technology content and pedagogical understanding.
technology [12]. Considering that technology gives benefits in learning mathematics in order to improve the learning process, teachers must have the competence to master the qualified technology [13]. Technology is rapidly changing the way that teaching teachers offer opportunities to understand concepts in a more profound, often different, and more meaningful way [14].

The use of technology in mathematics learning can help teachers overcome the socio-cultural diversity of students, and can help students with diverse achievements [15]. Technology also has a positive influence on students such as it is able to improve student achievement, motivation and attitude toward mathematics learning [16, 17]. Other research showed the effect of technology in mathematics classes was able to help engage students in the learning process, enabling students to have higher accuracy with computational tasks, helping to create a mathematical environment that was without anxiety for students, helping to motivate students, helping students deeper understanding of mathematical content, develop conceptual understanding and improve students' skills problem solving [18, 19].

Previous research exposed the fact that the pedagogic ability of teachers in using technology in mathematics learning was lacking. Research showed that: 1) 62.15% of Primary, Junior High School, High School and Vocational High School teachers stated that they rarely used Information and Communication Technology in learning 2) 34.95% of teachers Primary School, Junior High School, and Senior High School less master of Information and Communication Technology on learning [20]. Research of in junior high school of Banjar City showed that skill of teacher in using technology was still not satisfactory. While the teacher taught mathematics topic that required abstractive thinking ability like geometry, they still find difficulty to visualize geometry concept through learning media because they did not master the software of geometry [21]. The research in Junior high school Sumedang showed the weak ability of teachers to use technology in learning due to the lack of knowledge about the usefulness of software mathematical that capable of reconstructing important concepts that were difficult to do manually [22]. The other research explained the pedagogic ability of teachers using technology in mathematics learning which was still relatively weak [23, 24].

The problematic pedagogical ability of teachers in using technology in mathematics learning is still commonly found in certain schools. This research was to analyze the pedagogic ability of teachers in using technology and to know the cause of the difficulty of teachers in using technology and to know the solution in overcoming it. This research was expected to give contributions for the related parties in education such as Ministry of Education and Culture, teachers and schools and provide solutions for other research. Thus, this research discussed "How does the Problem of Teacher Pedagogic Ability in using Technology at Junior High School on Mathematics Learning".

2. Research Methods

The approach used in this study was qualitative, especially descriptive research. Subjects in this study were 3 mathematics teachers of Junior high school Muhammadiyah 1 Malang, where subjects were selected based on the total number of teachers in the school that there were only 3 math teachers. The research instrument consisted of: (1) questionnaire used to know pedagogic ability of teacher using technology, questionnaire consisted of 30 items of question using liker scale which 1 showed very inadequate teacher, 2 showed poor teacher, 3 showed capable teacher, 4 showed teacher very capable of using technology. The questionnaires adapted from [25]; (2) the interview guide aimed to find out more in depth pedagogic ability of teachers in using technology, knowing the causes of difficulties experienced by teachers and appropriate solutions to overcome the difficulties teachers use technology, as for questions in the interview that were (a) did the teachers ever use software mathematics in learning? (b) Whether the teachers were able to use software GeoGebra or graphical, calculator or software algebra in learning, if you are not able to answers, the why? Where questions in interviews can change based on statements from the subject.

Data analysis techniques used to analyse the questionnaire and interview data as follows: (1) questionnaire analysed by Liker scale using the formula total score per indicator (TS) = (1×B1) + (2×B2) + (3×B3) + (4×B4), where B1, B2, B3 and B4 represent the number of items selected on the
scalar 1,2,3,4 then will be grouped according to table 1 adapted from [25] after which it is summed as a whole to know the categories subject pedagogic abilities using technology based on table 2 adapted from [25]; (2) Data analysis techniques for interviews included: (a) data reduction that was sorting important and less important data, then the data was connected with questionnaire that has been filled by 3 mathematics teachers of Junior high school Muhammadiyah 1 Malang; (b) the presentation of data that is reduced data presented in the form of a description or narrative text to provide ease of researcher or reader to understand what happened; (c) the conclusion that is put forward the conclusion of research supported by valid data, at this stage conclusion which presented by researcher based on all result of data analysis obtained.

### Table 1. Pedagogical Capabilities in Using Technology in Learning

| Total Score (TK) | Category   |
|------------------|------------|
| 30 ≤ x ≤ 58      | Low        |
| 58 < x ≤ 87      | Medium     |
| 87 < x ≤ 120     | High       |

### Table 2. Knowledge Content Technology, Knowledge Pedagogic Technology and Knowledge Content Pedagogic Technology

| Total Score (TK) | Category |
|------------------|----------|
| 10 ≤ x ≤ 18      | Low      |
| 18 < x ≤ 28      | Medium   |
| 28 < x ≤ 40      | High     |

3. Result and Discussion

3.1. Result

The results were presented based on the indicators of pedagogical abilities of the teachers to use technology. The indicators are as follows: (1) pedagogical knowledge of technology is the ability to use various technologies such as PowerPoint, Photoshop, Microsoft excel, graphical calculator, game, GeoGebra, Cabri, algebraic calculator, Facebook, twitter and other online math applications; (2) knowledge of technology content is a pedagogical ability that uses technology to develop, enhance and guide students' thinking skills and help teachers in teaching mathematical concepts to be more easily understood by students and (3) knowledge of pedagogical content technology is a combination of understanding technology content and pedagogical understanding technology [12].

The results of the study will describe each mathematics teacher who teaches a different class where the first teacher or subject G1 is a mathematics teacher who teaches grade 7, second teacher or subject G2 is a mathematics teacher who teaches grade 8, and the third teacher or subject G3 is a teacher mathematics teaching class 9.

### Table 3. Pedagogical Capabilities in Using Technology of Subject G1

| Indicator KPT                 | Total Score |
|-------------------------------|-------------|
| Content Knowledge of Technology | 25          |
| Pedagogic Knowledge of Technology | 26          |
| Pedagogic Content Knowledge of | 25          |
Overall, G1 had moderate pedagogical skills in using technology. Content Knowledge of technology from subjects G1 was moderate because it obtained a score of 25, while the pedagogical knowledge of technology from subjects G1 was moderate because it gained a score of 26, and pedagogic content knowledge of technology was classified as medium also because it obtained a score of 25.

Content knowledge of technology of subject G1 was able to use PowerPoint, Photoshop and Microsoft excel to help her in presenting classroom materials as interesting as possible so that learning became meaningful. G1 was able to use Facebook, twitter and other online applications to engage in professional teacher association forums in sharing teaching experiences and helping each other through professional profession. However, G1 was not able to use graphic calculators, GeoGebra, software algebra and other online math applications because there was no application. She never learn about how to use the application. G1 was not able to make math animation using Adobe Flash caused the lack of knowledge about Adobe Flash. Interview showed subject G1 was incapable of using graphic calculator apps, GeoGebra, software algebra and other online math applications as follows:

Q : Why you can't use a graphic calculator, geogebra or Adobe Flash?
G1 : There are several reasons such as my ability to be less able to master these applications, have never attended training using them, and do not have the application.

Pedagogical knowledge of technology from subjects G1 was not able to use technology to develop students' thinking skills because of the lack of knowledge and competence of teachers in using software mathematical. G1 was not capable of using mobile to teach math because she had not yet learned that advice. G1 was not able to use technology to provide assessment forms such as daily tests and game assignments because she had no special skills to create games. Interview showed subject G1 was not capable to use mobile and gaming as follows:

Q : Why aren't you able to use a mobile device or game to do assessments such as assignments and daily tests?
G1 : Because I don't have the device and I don't have the ability to use it.

Pedagogic content knowledge of technology subject G1 was unable to use technology to develop students' skills in problem solving because she did not have the software such as GeoGebra. It was in line with research that said GeoGebra applications were able to develop and improve students' skills in problem solving [26–29]. G1 was unable to use technology to demonstrate mathematical models or concepts due to a lack of knowledge about use of mathematical software such as GeoGebra, algebra software and graphic calculators. Other research also showed that GeoGebra and algebra software could help and enable students to understand the concept of geometry and algebra [30, 31]. G1 was incapable to use technology to integrate mathematics learning and other learning because G1's knowledge of mathematical relationships with other learning was still lacking. So, she was not able to use technology as a capable tool in displaying such relationships. The interview showed subject G1 was incapable of using technology on the pedagogical knowledge of technology content as follows:

Q : Why are you unable to use technology to demonstrate mathematical concepts?
G1 : Because I did not have the ability to use technology such as geogebra and other mathematical software so I had difficulty demonstrating mathematical concepts to
be more easily understood

Q: What do you think the school should do to overcome the difficulties teachers use technology in learning?

G1: Hold a workshop, share software for free, give appreciation to teachers who use technology innovatively.

Table 4. Pedagogical Capabilities in Using Technology of Subject G2

| Indicator KPT                                  | Total Score |
|------------------------------------------------|-------------|
| Content Knowledge of Technology                 | 30          |
| Pedagogic Knowledge of Technology               | 32          |
| Pedagogic Content Knowledge of Technology       | 30          |
| **Total Categories**                           | **92**      |

Overall, G2 had high pedagogic ability in using technology. Content knowledge of technology from G2 is high because it scored 30, and same goes to G2 with a score of 32, and pedagogical content knowledge of technology is high as well because it scores 30.

Content knowledge of technology G2 was capable to use PowerPoint. She was very capable in using Microsoft Excel to help teachers in presenting classroom material as interesting as possible so that learning became meaningful. G2 was able to use graphic calculators, GeoGebra, graphic calculators and other online math apps used to help students’ math learning. G2 was unable to use technology like Photoshop to create and edit simple images. It was not used as a software that helped in learning. The interview showed why G2 was not capable to use Photoshop software as follows:

Q: Why are you able to use GeoGebra and other math applications?

G2: Because I use it often, a high sense of curiosity is how to use it so that I learn automatically on the internet.

Pedagogic knowledge of technology G2 was able to use technology to engage students critically in problem solving and able to assess mathematical learning using websites and other software to improve the quality of learning. G2 was able to use technology for assessments such as daily reactions and the task using games from the internet. It impacted the classroom atmosphere to be fun, more active, serious, and happy and the students enjoyed playing those games. G2 was very capable to use Mobilet to teach math such as using WhatsApp to send tasks and modules as learning materials in the classroom so that learning becomes more effective. The interview showed why G2 was able to use the following technology:

Q: How do you use the game for assessment?

G2: When my geometry test once gave a game to complete after the children finished it they would get the value and the game I got from the internet for free, it was seen that children were happy, serious and active and enjoying the game.

Pedagogical content knowledge of technology G2 was able to use mathematics Microsoft to develop students’ skills in problem solving so that students’ mathematical achievement increased (32). G2 was able to use technology to demonstrate mathematical models or concepts such as software of Wingeom, math quiz creator, mathematics Microsoft and Cabri geometry. G2 often used math quiz creator software because it was very detailed in outlining the problem solving. It caused easier for students to understand the concept of mathematics. G2 was able to use technology to display
mathematical content in different ways i.e. using geometry and geometry Cabri that display mathematical concepts such as geometry in 3D, so the students were easy to visualize geometries. Interview showed G2 was capable to use technology on the pedagogical content knowledge as follows:

Q : What application do I often use to demonstrate mathematical concepts in classes other than geogebra?
G2 : I used Wingeom, Math quiz creator, Microsoft mathematics, Cabri Geometry. But I often use the Math Quiz Creator because it’s very detailed in solving problems.

Q : What do you think should be done by teachers who have difficulty using mathematical software?
G2 : Build complete facilities and infrastructure, conduct routine workshops, and distribute software for free.

Table 5. Pedagogical Capabilities in Using Technology of Subject G3

| Indicator KPT                        | Total Score |
|--------------------------------------|-------------|
| Content Knowledge of Technology      | 25          |
| Pedagogic Knowledge of Technology    | 24          |
| Pedagogic Content Knowledge of Technology | 23          |
| Total                                | 72          |

Overall, G3 had a moderate pedagogical ability in using technology. Content knowledge of technology for G3 is classified as moderate because it scored 25, while the pedagogic knowledge of the technology from the G3 is classified as moderate because it scored 24, and the pedagogical content knowledge of technology is moderate as well because it scores 23.

Content knowledge of the technology G3 was incapable to use a graphical calculator, GeoGebra, algebra calculator and other online math apps to help students in mathematics learning because of low ability, lack of motivation and no time to learn how to use those applications. G3 was not able to make math animation using adobe flash because it was difficult to understand, but G3 suggested to use animations that already exist on the internet. Interview showed why G3 was incapable to use graphic calculators, GeoGebra, algebra calculators and others as follows:

Q : Why are you unable to use mathematical software like Geogebra?
G3 : Because knowledge is still low, the motivation is still strong for learning mathematics software, it is difficult to divide the time to study.

Pedagogic knowledge of the technology G3 was incapable to use technology such as mathematical software to develop students' thinking skills because of teachers' lack of mastery about using mathematical software such as GeoGebra, algebra and graphic calculators' software. G3 were incapable of using technology to provide game evaluation forms such as daily tests and assignments due to a lack of knowledge about how to operate and create games and the absence of game experts that teach how to make game. G3 was incapable of using mobilet to teach mathematics because there are too many things to be mastered and prepared in learning. Interview showed why G3 was incapable to use the following technologies:

Q : Why aren't you able to use games to assess students' mathematical abilities?
G3 : Because I did not have the ability to use it besides that I was not very
interested in trying it because it needed a lot of preparation.

Pedagogical content knowledge of technology G3 was not able to use technologies such as GeoGebra, software algebra and graphical calculators to develop skills in problem solving because there was still a lack of knowledge about use mathematical software. G3 was not able to use the technology to demonstrate a model or mathematical concepts due to the limited facilities and infrastructure such as software, mathematics computers for students who were less complete. It also needed the expert of use mathematical software to provide workshops on how to use the software. G3 was incapable to use technology to display mathematical content in a different way than usual because of the ability to process and technologies used that were still lacking, like unable to use mathematical software that was capable of displaying more real math content in real life. Interview showed G3 was unable to use technology on the pedagogical knowledge of technology content as follows:

\[ Q : \text{Why aren’t you able to demonstrate mathematical concepts using mathematical software?} \]

\[ G3 : \text{Because of the many constraints such as the limited facilities and infrastructure, it has never attended a software use workshop.} \]

\[ Q : \text{What do you think the teacher should do to reduce the various obstacles faced?} \]

\[ G3 : \text{Schools must hold free workshops for teachers, complete facilities and infrastructure, schools provide free software.} \]

3.2. Discussion

The first teacher has a moderate pedagogical ability in using technology, second teacher has a relatively high pedagogic ability, while third teacher has a pedagogic ability classified as moderate. The second teacher has a pedagogic ability that is relatively high compared to the first teacher and the teacher of these three because the second teacher has strong motivation and a high sense of curiosity to use mathematical technology or software by learning autodidacts on the internet so that they are able to use some mathematical software. The second teacher also has a high spirit of learning how to use mathematical software compared to first and third teachers.

The interview results shows that the first and third teachers were still having difficulty in using technology such as using mathematical software. Factors that cause it were because the teachers were not able to use technology, among others: (1) the lack of facilities and infrastructure; (2) the lack of teachers' competence in using technology; (3) teachers were less motivated to use technology in learning; (4) less supportive from school to develop teacher's competence and motivation using technology in learning; (5) the availability of teacher time. In line with (33,34) viewed that several factors affecting teachers' ability in using technology were (1) technological accessibility levels such as facilities and infrastructure in schools; (2) training to develop teachers' competence in using technology; (3) community and school support; (4) school culture; (5) computer attributes and (6) attitudes toward technology.

Interview results with the teacher that solutions could be done to overcome the inability of teachers using technology in learning, among others: (1) the government must provide facilities and infrastructure technology such as computers, internet, math software, LCD and monitor in classroom adequate for teachers and students used in learning; (2) the government should often hold workshops or training on teacher competency development in using technology; (3) schools should create a productive environment for teachers and students to generate motivation and be able to develop teachers' competence in using technology such as rewarding teachers who are able to use technology innovatively. In line with several studies (35) professional technology integration training program was able to improve teacher ability in using technology in learning mathematics. Self-efficacy computer, extensive teaching experience, adequate computer technology support, pedagogical teacher practice and professional development in computer technology integration bring positive change could
be made in the educational process for teachers to improve teachers' skills in using computer technology (11).

4. Conclusion
As results, it can be concluded that (1) pedagogical ability of first teacher in using technology is classified as moderate; (2) pedagogical ability of second teacher in using technology was high; (3) the pedagogical ability third teacher in using technology was moderate; (4) the factors causing teachers' inability to use technology in learning is as follows: (a) availability of facilities and infrastructure that were still not maximal such as math software, computers, and others; (b) the competence of teachers in using technology was still less than the maximum; (c) teachers' motivation to use technology in learning was lacking; (d) school did not support teacher to develop competence environment and motivation in using technology in learning.

Suggestions for researchers who are interested in this research are (1) the subjects in this study are relatively few, to obtain more valid data using more subjects; (2) the questionnaire adopted from Australia in this study is still not in accordance with the ability of teachers in several regions of Indonesia, and it is hoped that interested researchers are able to adapt by adding several appropriate variables before use.

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