Comparing mathematics teachers’ technological pedagogical knowledge (TPK) and their readiness in organizing online learning

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Abstract. The rapid development of communication and information tools in this era has an impact on the learning process. There is a theoretical framework that discuss about teachers’ knowledge in integrating technology in education. One of the components of this framework is Technological Pedagogical Knowledge (TPK). This study aims to compare between the mathematics teachers’ TPK level and their readiness in organizing online learning. A survey to the total 48 mathematics teachers was done. This survey consists of five statements as the media for teacher to doing self-assessment of their TPK and five question about their readiness in organizing online learning. From the survey results it appears that the teacher's TPK level obtained from self-assessment is not in accordance with the teacher's statement related to their readiness in implementing online learning. There are 18.75% of teachers whose self-assessment results are at a low level, but more than 64% of teachers have not mastered various applications to facilitate online learning. Furthermore, the forms of effort made by teachers in perfecting the online learning process are also very limited, as evidenced by the existence of 80% of teachers who interpret online learning by sharing material online without adequate discussion facilities.

1. Introduction
The existence of rapid changes to the development of communication and information tools in the 21st century have many impact on various fields [1]. In order to prepare someone to be able to adapt the needs of this era, the integration of technology into education is an alternative solution [2]. In the field of mathematics education, technology is considered important because it can improve students’ learning [3].

The integration of technology in education requires the readiness of various parties, including teachers. A theoretical framework called Technological Pedagogical Content Knowledge (TPACK) appears as a theory that is useful for understanding how the teacher's knowledge in integrating technology when he is carrying out the learning process [4]. Technological Pedagogical Knowledge (TPK) is one of its component. TPK is related to how the diversity of technologies that teachers can use in teaching and understanding that technology may change the ways teachers teach [4], [5]. This component also includes the teacher's understanding of the potential tools that can used to particular learning activities, such as presenting the learning content, check student attendance, scoring, discourses and so on [5–7].
Beside this, online learning is a form of technology integration in education [8]. Its implementation requires readiness from the teacher, because the teacher plays a role in determining the ways of learning process [9]. Some research related to online learning is conducted to assess the performance of mathematics teachers in implementing online learning with the help of certain applications, rather than assessing the performance and readiness of teachers in preparing mathematics learning with various applications [10], [11].

The importance of TPACK has initiated various studies, for example the development of the TPACK standard and the teacher's TPACK development model [1], [12], the development of TPACK assessment tools [13], how the TPACK characteristics possessed by the teacher [14]–[16]. In the development of TPACK assessment tools, previous research has carried out the development of performance tests and self-assessment test kits. However, particularly in Indonesia, the self-assessment technique has not been widely implemented.

Previous studies have also shown that integrating technology into learning is challenging, complex and requires careful planning strategies with policy makers [17]. Thus, there is a need for research that can gather information about teachers’ TPK based on the self-assessing method, and how teachers’ implementing their knowledge into online learning. So that, this study aims to comparing the results of the mathematics teacher's TPK self-assessment and the result of teachers’ perception about their readiness on implementing online learning. To be expected the results of this study will be a reference for various parties to develop teacher preparation programs in integrating technology into the learning process.

2. Methods

In order to achieve the study objectives, the researcher was used the survey method. This survey as a tool for the mathematics teacher to make an assessment of themselves. In addition, respondents were also asked questions about how they carry out the online learning process, as a part of the integration of technology in teaching. There are five statement as an indicator to measure the mathematics teachers' TPK that adopt from [13]. All respondents were instructed to choose answers on a Likert scale, such as strongly disagree, disagree, neither agree or disagree, agree, strongly agree. Table 1 shows the statements and the question for all respondents. All respondents filled out questionnaire distributed online, through google form.

Table 1. Statements and Questions on the Survey

| Statements                                                                 | Questions                                                                 |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 1. I can choose technologies that enhance the learning approaches for a lesson | 1. Have you ever received training / learning related to online learning before? |
| 2. I can choose technologies that enhance students’ learning for a lesson    | 2. Where have you received training / learning related to online learning?  |
| 3. My teacher education program has caused me to think more deeply about how | 3. What technology / application you use in implementing online learning |
| technology could influence the teaching approaches I use in my classroom    | 4. Is the technology that you use is technology that has been studied before? |
| 4. I am thinking critically about how to use technology in my classroom     | 5. How do you carry out mathematics online learning?                        |
| 5. I can adapt the use of the technologies that I am learning about to      |                                                                           |
| different teaching activities                                              |                                                                           |

There are 48 mathematics teachers have been respond this questionnaire. The respondent consist of various educational backgrounds and teaching experiences. All respondents assigned to teach mathematics in various districts or cities, in Indonesia. The respondents’ data are presented in Table 2.
### Table 2. The Respondents’ Data

| Respondents | Percentage |
|-------------|------------|
| Educational Background | Bachelor degree | 70.8 |
| | Teacher Professional Education Program | 6.3 |
| | Master degree | 22.9 |
| | < 5 Years | 56.3 |
| Teaching experience | 5-10 Years | 16.7 |
| | 10-15 Years | 6.3 |
| | 15-20 Years | 10.4 |
| | > 20 years | 10.4 |

The data in this survey is used to determine the TPK level of mathematics teachers. Successively the teacher's answer to each statement would mean 1 for strongly disagree, 2 for disagree, 3 for neither agree/disagree, 4 for agree, and 5 for strongly agree. Then the scores are converted into individual scores by using the following formula:

\[
\text{Individual Scores} = \frac{\sum \text{student questionnaire score}}{\sum \text{questionnaire’s maximum score}} \times 100
\]

After that, the respondents are grouping into the three criteria, namely high, medium, and low. The criteria to determine the teachers’ level is based on the following Table 3.

### Table 3. Teacher’s TPK Level Criteria

| Grouping Criteria | Level |
|-------------------|-------|
| Individual score ≥ \( \bar{x} \) + Standard deviation | High |
| \( \bar{x} \) + Standard deviation ≤ Individual score ≤ \( \bar{x} \) - Standard deviation | Medium |
| Individual score ≤ \( \bar{x} \) - Standard deviation | Low |

### 3. Result and Discussion

Based on the results of calculations on the questionnaire scores of all respondents, obtained TPK level data of mathematics teachers is as in the following Table 4.

### Table 4. The percentage of mathematics teachers’ answer for self-assessing TPK

| Mathematics Teachers’ TPK Level | Percentage |
|---------------------------------|------------|
| High                            | 12.5       |
| Medium                          | 68.75      |
| Low                             | 18.75      |

Table 4 shows the level of mathematics teachers’ TPK level from the self-assessment method. The percentage of each level also give information that 6 teachers in the high level, 33 teachers in the medium level, and 9 teachers in the low level.

In order to find out the readiness of the teacher in implementing mathematics online learning. All of respondents also answer five question that can be seen in the Table 1. For question number 1, obtained that 52.1% respondent say that they have never received training related to online learning. In addition, as many as 47.9% of respondents stated that they had received training related to online learning in various places, such as in college, in schools where they taught, and in other places that were sought independently.

Furthermore, through this survey also obtained data on technology, especially applications used by teachers in implementing mathematics online learning. The application most widely used by teachers
is WhatsApp, followed by Google Classroom. While other applications such as Edmodo, Microsoft Office 365, Quiziz, Youtube, Zoom Meeting are only used by a few respondents. Regarding how they learn about these applications, data obtained that more than 64% of respondents learn the applications independently.

To complete the data in this study, Table 5 shows the teacher's answers regarding the question about their readiness in carry out the mathematics online learning.

**Table 5. Mathematics Teachers’ Answer about How They Implement the Online Learning Process**

| How do you carry out mathematics online learning? |
|--------------------------------------------------|
| **Answer 1:** Provide modules through the application and then start the discussion on the specified application. (Only provide material and questions, the discussion is very limited) |
| **Answer 2:** For face-to-face learning at the zoom meeting room, For discussion using WhatsApp, For examination using Google Form, To explain content using shared learning videos via Youtube (Try to do various ways to be effective online learning) |
| **Answer 3:** Search for lesson content on YouTube and share it with students (Not making video by herself, try to gives students the opportunity to ask questions via WhatsApp group) |

Table 5 tells about the types of online learning that has been done by the teachers. Most teachers only share material and discuss it if students ask questions, as expressed in Answer 1 and Answer 3. No more than 20% of teachers who try very complex in carrying out this online learning, or as expressed in Answer 2. The teacher's activities also illustrate the level of TPK that teachers have, because one important aspect of TPK is the ability of teachers to be flexible and creative in planning and implementing learning processes that are integrated with technology [5].

The teachers’ respond for five question above show that teacher readiness in implementing online learning still needs to be improved. If explored further, educational background does not really affect the creativity and efforts of teachers in implementing online learning. Since the teachers state that they have diverse learning resources, not only from the formal education process in college. Intention and experience are things that largely determine the knowledge and readiness of these teachers. This finding is in line with the results of research by [18]. The thing that also influences is the will and facilities owned by the teacher. The success of online learning can occur if there is collaboration between learning facilities and experience in practice [9], [19]. The teacher's TPK level also seems to be incompatible with the teachers’ readiness in implementing online learning. This is consistent with the results of research by [16] which shows that the value of teacher performance in ICT-based learning is lower than the value of teacher self-assessment related to TPACK.

4. Conclusion

The results of this study show that the teacher's TPK level obtained from self-assessment is not in accordance with the teacher's statement related to their readiness in implementing online learning. Only 18.75% of teachers whose self-assessment results are at a low level, but more than 64% of teachers have not mastered various applications to facilitate online learning. Furthermore, the forms of effort made by teachers in perfecting the online learning process are also very limited, as evidenced by the existence of 80% of teachers who interpret online learning by sharing material online without adequate discussion facilities. Actually, there is a limitation in this study due to the limited...
respondents and questions in this study. However, it is expected that the results of this study can be useful as a reference for further research or as a material consideration in making learning programs for prospective teachers.

5. References

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**Acknowledgement**
Researchers like to thank all participants who have voluntarily engaged in the survey.