

# HASIL CEK\_The effectiveness of blended learning to improve pre-service teacher TPaCK in developing multimedia learning mathematics at elementary school

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## <sup>2</sup>The effectiveness of blended learning to improve pre-service teacher TPaCK in developing multimedia learning mathematics at elementary school

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**Abstract.** This study aims to determine the effectiveness of blended learning towards the improvement of pre-service teacher TPaCK (Technological Pedagogical Content Knowledge) in developing multimedia learning mathematics in elementary schools. The type of this research is a quasi-experimental design. The research method used is a non-equivalent control group design. The population of this study was the 6th-semester students of the 2018/2019 academic year of the PGSD UAD study program of 315 students grouped in 7 classes. The sample used was an experimental class of the class controller drawn at random. The method of collecting data uses observations in multimedia learning mathematics that have been developed by pre-service elementary school teachers. The research instrument used the TPaCK assessment sheet that had been taken expert validation. The results of the study showed that at a significance level of 5% blended learning was effective in increasing the TPaCK of pre-service teachers in developing multimedia learning mathematics in elementary schools.

### 1. Introduction

The emergence of the fourth generation industrial revolution or also called the industrial revolution 4.0 is the impact of the development of increasingly rapid science and technology. To face the industrial revolution 4.0, Yogyakarta Special Province has prepared itself with the Jogja Smart Province scheme. Jogja Smart Province is a grand design to stimulate the growth of innovation in utilizing digital technology in all aspects of services in the province of DIY, including aspects of education services.

Education in Yogyakarta is one of the aspects that is very much considered in the Jogja Smart Province scheme, especially Yogyakarta, has the title as a student city. In Yogyakarta, there are also many LPTK (educational institutions and education staff) who also prepare students to become pre-service teachers who are ready to face increasingly rapid technological developments, one of which is the Elementary School Teacher Education study program Ahmad Dahlan University (PGSD UAD). To support the Jogja Smart Province scheme, PGSD UAD students are prepared to become competent pre-service elementary school teacher not only in terms of professionalism, pedagogical, social, and personality but also in using technology. It is by the 2007 national education minister's regulation, which states that a teacher must have competence in information and communication technology. Competence



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in the field of information and communication technology serves to develop itself and as a support for the learning process [1].

The use of technology in the learning process requires competent teachers. Competent in question is a teacher who can integrate professional skills, pedagogical abilities, and technology in learning. These three abilities, according to Koehler and Mishra, are referred to as Technological Pedagogical Content Knowledge (TPaCK) [2]. TPaCK is a theoretical framework to measure the ability of teachers to integrate technology into learning. There are seven components in TPaCK namely 1) Technological knowledge (TK), 2) Pedagogical knowledge (PK), 3) Content knowledge (CK), 4) Technological Content Knowledge (TCK), 5) Pedagogical content knowledge (PCK), 6) Technological content knowledge, 7) Technological Pedagogical Content Knowledge (TPaCK) [3].

Technological Knowledge (TK) is the knowledge of pre-service teachers about what and how technology, software, or applications can be used for learning. Pedagogical knowledge (PK) is knowledge of student characteristics, development of learning plans and evaluation of learning outcomes, and what are the methods /models/learning strategies that can be used in mathematics learning in elementary school. Content knowledge (CK) is the mastery of pre-service teachers in the subject matter of mathematics widely and deeply. Technological Content Knowledge (TCK) is the ability of teachers to deliver material using technology. Pedagogical content knowledge (PCK) is the ability to deliver material to students. In delivering material, the teacher does not only give material but uses specific strategies in delivering material [4]. Technological Pedagogical Content Knowledge (TPaCK) is the teacher's ability to carry out mathematics learning by integrating learning strategies and technology [5].

The ability of TPaCK is essential for elementary school pre-service teachers because pre-service teachers who have the capability of TPaCK can integrate technology in the learning process according to the learning material and learning strategies that are appropriate to the characteristics of students. The use of technology, according to Drijvers, Boon, and Van Reeuwijk in the learning process, is beneficial for students in understanding subject matter, especially mathematics subjects [6]. It is common knowledge that mathematical material is abstract. Though, the level of cognitive thinking of elementary school students according to Piaget is still a concrete operational nature. The task of elementary school pre-service teachers is to design abstract mathematical learning to be more concrete, contextual, or more realistic according to the level of thinking of students. NCTM also provides effective teacher ideas. Effective teachers are expected to be able to utilize the potential of technology to develop student understanding, stimulate interest in learning, and improve students' mathematical skills [7]. However, the research conducted by Utama shows that mathematics learning in elementary schools tends to be textbook oriented and less contextual so that mathematical concepts are difficult to understand and result in mathematics learning outcomes that are less than expected [8].

The emergence of technology in mathematics learning is one strategy that can be used to make abstract mathematical concepts more concrete. Aija and Inga describe various benefits of technology in the learning process, namely increasing student learning motivation because mathematical content presented in accordance with the development of the digital era, helps students associate concepts with the initial abilities students have, helps teachers create a different learning atmosphere, a more visual learning process, concrete, fun, and interesting [9]. Research conducted by Mehmed shows that graphics calculator technology and graphics programs improve students' mathematical abilities [10].

The great benefits of using technology in mathematics learning in elementary schools are considered by the UAD PGSD study program to prepare students to become pre-service teachers who have superior TPaCK. One thing that can be done to develop the ability of TPaCK students is to use the blended learning method in the learning process at the University. Blended learning is a combination of face-to-face learning with learning using e-learning [11]. Blended learning aims to help educators develop a better learning process; providing opportunities for individual learning practices, easy to use, and continues to develop; and increase the flexibility of the learning schedule. Face-to-face learning can be used for interactive experiences with educators, while online classes provide a lot of knowledge content that can be accessed by pre-service teachers whenever and wherever as long as they have internet access

[12]. Learning using blended learning has benefits, namely Flexibility, which means that pre-service teachers can contribute to learning at their own chosen time and place [13]. Kintu, Zhu, & Kagambe also mention some of the benefits of blended learning, namely, effective and efficient learning, pre-service teachers can discuss with lecturers outside of face-to-face hours, not spend too much energy to teach, and broader learning range [14]. Learning using blended learning is also effective in developing the character of pre-service teachers who are communicative, creative, curious, and hard-working [15].

PGSD Study Program UAD has e-learning that can be used for the online learning process. The e-learning in this study was used for blended-learning. The purpose of the use of e-learning is to look at the effectiveness of blended learning to improve pre-service teacher training in developing multimedia learning mathematics in elementary schools.

**2. Methods**

This research was conducted at the elementary school education study program of Ahmad Dahlan University (PGSD UAD). This study used a quasi-experimental design with non-equivalent control group design. The population of this study was the 6th-semester students of the 2018/2019 academic year of the PGSD UAD study program of 315 students grouped in 7 classes. The sample used was one experimental class, and one control class has taken randomly. Experimental class and class control, each consisting of 45 students. The experimental class uses the blended learning model (expository and multimedia doing exercises based on e-learning), while the control class uses regular learning (expository and direct multimedia-making exercises).

The research data is a TPaCK score. The method of collecting data uses observations in multimedia learning mathematics that have been developed by pre-service elementary school teachers. Multimedia learning developed using the Macromedia flash application. The research instrument uses TPACK assessment sheets that have been validated by experts. The assessment sheet consists of 20 points of assessment with a Likert scale, which has five alternative answers, namely very high, high, moderate, low, and very low as shown in Table 1.

**Table 1.** Interval and TPaCK criteria

| Interval                                   | Criteria  |
|--|-----------|
| $X > (X_j + 1.8 s_x)$                      | Very High |
| $(X_j + 0.6 s_x) < X \leq (X_j + 1.8 s_x)$ | High      |
| $(X_j - 0.6 s_x) < X \leq (X_j + 0.6 s_x)$ | Moderate  |
| $(X_j - 1.8 s_x) < X \leq (X_j - 0.6 s_x)$ | Low       |
| $X \leq (X_j - 1.8 s_x)$                   | Very Low  |

The analysis technique used is parametric statistics. One sample t-test used to test the effectiveness of the blended learning and regular models while comparing the blended learning and regular models using the independent sample t-test.

**3. Result and Discussion**

Table 2 present a description of the data from the TPaCK assessment of pre-service teacher elementary school in the blended-learning class and regular class.

**Table 2.** Data description of TPaCK assessment results

| Description         | blended-learning | Regular |
|---------------------|------------------|---------|
| Average             | 67.76            | 63.42   |
| Standards deviation | 4.2              | 3.31    |
| Max empirical score | 82               | 67      |
| Max ideal score     | 100              | 100     |

| Description         | blended-learning | Regular |
|---------------------|------------------|---------|
| Min empirical score | 61               | 58      |
| Min ideal score     | 20               | 20      |

Based on Table 1, the average assessment TPaCK pre-service teacher in blended-learning class is 67.76. The average TPaCK results of the blended-learning class based on the assessment criteria in Table 1 fall into the high criteria, while the average TPaCK in the regular class is 62.93 in the moderate criteria.

Data on the results of TPaCK assessment of elementary school pre-service teacher are converted into very high, high, moderate, low, very low criteria. Table 3 present the frequency distribution and percentage of TPaCK assessment scores are presented.

**Table 3.** Distribution of Frequency and Percentage of TPaCK

| Criteria for | Blended-learning |       | Regular |       |
|--------------|------------------|-------|---------|-------|
|              | f                | %     | F       | %     |
| Very High    | 3                | 6.67  | 1       | 2.22  |
| High         | 28               | 62.22 | 7       | 15.56 |
| Moderate     | 14               | 31,1  | 37      | 82.22 |

Data in Table 3 shows that the TPaCK frequency distribution in blended-learning and regular classes are equally in the criteria of moderate, high, and very high. However, the highest frequency of the blended learning class is in the high criteria while the regular class is in the moderate category. In both classes there were none in the low and very low categories.

The average results of TPaCK assessment of elementary school teachers based on TPaCK aspects are presented in Table 4.

**Table 4.** Average results of TPaCK assessment

| Aspect | Blended-learning |          | Regular |          |
|--------|------------------|----------|---------|----------|
|        | Average          | criteria | Average | Criteria |
| TK     | 3.67             | High     | 2.71    | Moderate |
| CK     | 3.84             | High     | 3.71    | High     |
| PK     | 3.34             | High     | 3.53    | High     |
| TCK    | 3.35             | High     | 3.32    | Moderate |
| TPK    | 3.29             | Moderate | 3.07    | Moderate |
| PCK    | 3.22             | Moderate | 3.2     | Moderate |
| TPaCK  | 3.19             | Moderate | 2.76    | Moderate |

Table 4 shows that the technological aspect of knowledge of elementary school pre-service teachers in the blended learning class is in the high category, while in the regular class is in the moderate category. It means that elementary school pre-service teachers in the blended learning class can use the Macromedia flash application such as creating navigation buttons, creating animations, making moving images, and entering sounds well. The aspect of content knowledge is at high criteria in both classes. It means that the mathematical material developed is correct according to the concept, indicators developed following basic competencies, and the questions developed can be used to measure material competencies to be achieved. Pedagogical knowledge aspects are also at high criteria in both classes. It means that elementary school pre-service teachers master the understanding of the scientific approach and its stages well. The Technological Content Knowledge aspect is in the high criteria in the blended

learning class, while in the regular class, the criteria are moderate. It indicates that elementary school pre-service teachers in the blended learning class can present material and separate parts of the material into flash-based multimedia accurately. The technological aspects of pedagogical knowledge are in the moderate criteria in both classes. It means that the scientific stages appear in the developed mathematical multimedia. The Pedagogical Content Knowledge aspect is in the moderate criteria in both classes. It means that the material is presented according to the scientific stage. The technological pedagogical content knowledge aspect is in the moderate category in both classes. It shows that the pre-service teacher has been able to present mathematical material according to the scientific stages in multimedia learning. Teacher candidates can also make questions and assessments in multimedia learning mathematics.

After the data has been described, then hypothesis testing is carried out to test the effectiveness of blended-learning. However, before the assumption of normality and homogeneity was tested. The results of normality and homogeneity tests are presented in Table 5 and Table 6.

**Table 5.** Normality Test Results

| Class            | p value | Description |
|------------------|---------|-------------|
| Blended-learning | 0.232   | Normal      |
| Regular          | 0.423   | Normal      |

Table 5 shows that p-value in both classes is higher than 0.05 means the assumption of normality is fulfilled. The homogeneity of variance test results in both classes is presented in Table 6.

**Table 6.** Test Results Homogeneity of variance

| Class            | p value | Description |
|------------------|---------|-------------|
| blended-learning | 0.083   | Homogeneous |
| regular          | 0.307   | Homogeneous |

Table 6 shows that the p-value greater than 0.05 means that the variance in both homogeneous class so that the assumption of homogeneity is fulfilled. Because the assumptions of normality and homogeneity have been fulfilled, it is continued by testing one sample t-test to test the effectiveness of learning in blended learning and regular class. The result of one sample t-test is presented in Table 7.

**Table 7.** Results one sample t-test

| Classroom        | p-value | Description |
|------------------|---------|-------------|
| blended-learning | 0.211   | Rejected    |
| regular          | 0.072   | Rejected    |

Table 7 shows that the p-value more significant than 0.05 test decision. The hypothesis in both classes was rejected, meaning learning using blended learning and regular learning was effective in learning to improve TPaCK. To see which learning is more effective, proceed with the test of independent samples test. The test results of the independent samples test are presented in Table 8.

**Table 8.** Test Results independent test samples

| p value | Description |
|---------|-------------|
| 0.042   | Rejected    |

Table 8 shows that the p-value is smaller than 0.05 the decision of the hypothesis test is rejected, meaning learning using blended learning is more effectively used in learning to improve TPaCK. The results of this study corroborate the results of Ghaida's research, Petra, & Joke that learning with blended learning can develop pre-service teacher TPKCK [16]. Ghaida, Petra, & Joke also added that blended

learning made pre-service teachers more independent in finding learning resources. Learning resources provided online that contain assignments and activities are thought to be able to improve attitude, competence, and confidence in integrating ICT in the learning process. It is because exploring learning materials available online can help teachers better understand the learning that is integrated with ICT so that it can develop TPaCK [17].

#### 4. Conclusion

The results of this study indicate that effective blended learning is used to improve TPaCK for elementary school pre-service teachers. Pre-service teachers are more flexible in learning to develop multimedia learning whenever and wherever as long as they have an internet connection at online learning sessions. While the face to face session is used to discuss with lecturers. Therefore blended learning can be an alternative that can be used to develop the technological capabilities of elementary school pre-service teachers.

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