Developing Teaching and Learning Model with TPACK Framework and Blended Learning Content for Science and Mathematics in Elementary School Teacher Education Program

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Abstract

The aim of this research is to develop teaching and learning model by using TPACK (Technological Pedagogical and Content Knowledge) framework and blended learning content. It is a teaching and learning model that allows lecturers to combine technological skill, pedagogical skill, and content skill to teach science and mathematics for Elementary School Teacher Education Program at Satya Wacana Christian University (SWCU) with hybrid instructional delivery method (face to face and online). Six steps of ASSURE model was used to develop this model. Those steps are: 1) analyse learners, 2) state objectives, 3) select method, media, and materials, 4) utilize media and materials, 5) require learner participation, 6) evaluated and revise. The result of the research is that a model and procedures of teaching and learning by using TPACK framework with blended learning content developed in Moodle as a media for hybrid learning. In SWCU, Moodle is recognized as flexible learning. For the research subjects selected for this research are college students of Basic Concept of Mathematics I and Development of Science Teaching and Learning class. The result was this model of teaching and learning can make students active in learning and increase their academic achievement in learning mathematics and science.

KEYWORDS: Model of teaching and learning, TPACK, Blended Learning, Mathematics, Science.

Introduction

Many facts have proven that technology is developing very fast. The development affects education especially in the usage of computer and Internet as a teaching and learning media. Through the use of computer and Internet, students will be easy to do their assignments, save more time to access information quickly for their learning purposes.

This development must be anticipated by lectures so that the technology can be utilized effectively in teaching and learning process. This requires lecturers to teach course content with technology to create appropriate learning environment for 21st century students. Many students in this digital era use laptop, ipad, tablet pc, and smartphones in their daily activities at university. Therefore, it is urgent for lecturers to design a teaching and learning model that can facilitate students’ learning with those gadgets so that learning will be more meaningful and effective for them.
To design an appropriate model for teaching and learning with technology, special skills are needed for lecturers. Lecturers have to have three skills. They are technological skill, Pedagogical skill, and content skill. The combination of the three skills is well known as Technological Pedagogical and Content Knowledge (TPACK).

By implementing TPACK in classroom lecturers are expected to create a joyful and effective learning for students and the goal of learning is achieved. The method of instructional materials delivery wills not just a face but also online to allow students to learn independently, think critically, and utilize technology to learn effectively. If this kind of learning environment is created then, the teaching and learning process can be done anytime, anywhere, without any dependency on face-to-face meeting. Therefore, this research is done to design a teaching and learning model that combine face-to-face meeting and online meeting with blended learning by the means of Moodle as a learning management system.

**Literature reviews**

**Teaching and Learning Model**

A model describes a form of thinking. A model usually describes a whole concept that is connected to one another. A model also viewed as an effort to implement a theory. It is also an analogy and a representative of variables that are included in the theories. (Udin S. Saputra, 2001)

According to Winataputra (2001), a teaching and learning model is a tool to help the designer to understand the framework of theories and to implement the theories to create effective and efficient activities for teaching and learning. According to Fausner as quoted by Winataputra (2001) said that a teaching and learning designer cannot design an effective teaching and learning if he/she recognizes one model only. A designer of instruction must choose appropriate design according to specific situation and setting for teaching and learning. Therefore, deep knowledge and understanding of models of teaching and learning and how to implement those models in appropriate context are very needed.

Thus, teaching and learning model can be defined as conceptual framework, which describes systematic procedures in organizing learning experience to reach certain learning goal. In this research, TPACK framework is used to create a teaching learning model procedures with blended learning so that students can follow online materials with multimedia that are organized systematically by using Moodle to make the teaching and learning be effective for students.

**Definition and Implementation of TPACK**

TPACK stands for Technological Pedagogical and Content Knowledge. This concept first developed by Dr. Lee Schulman that combines Pedagogical and Content Knowledge domain. Further, Punya Mishra and Matthew J. Kohler adding a new domain called Technological domain. The development of technology causes many researchers to do research related to technology in education. Basically, TPACK combines technological, pedagogical, and content knowledge in a context. Mishra and Khoehler explains that effective teaching needs complex understanding that is connected in three main source of knowledge: technology, pedagogy, and content, and how those three
sources can be implemented according to their context. (Koehler & Mishra, 2008, 2009; Mishra & Koehler, 2006). Those connections can be described as follows:

![Figure 1. TPACK framework (source: www.tpack.org)](image)

**Blended Learning**

Blended learning has two words: Blended and Learning. The word “Blend” means “to mix or mingle (components) together thoroughly” (Collins English Dictionary, 2013) whereas learning has the general meaning that is “the act of gaining knowledge” Therefore, Blended learning means there is a mixture of learning forms. Harvey Singh (2003) said that

“blended learning mixes various event-based activities, including face-to-face classrooms, live e-learning, and self-paced learning. This often is a mix of traditional instructor-led training, synchronous online conferencing or training, asynchronous self-paced study, and structured on-the-job training from an experienced worker or mentor”.

Another definition is from Charles D. Dziuban (2004). He said about blended learning as follows:

“blended learning” refers to courses that combine face-to-face classroom instruction with online learning and reduced classroom contact hours (reduced seat time). The latter point is an important distinction because it is certainly possible to enhance regular face-to-face courses with online resources without displacing classroom contact hours.

Based on those definitions, it can be concluded that blended learning is a hybrid learning that combine traditional face-to-face and online meeting synchronously and or asynchronously without displacing classroom contact hours.

**Methodology**

a. Procedure of developing the model of teaching and learning and its implementation

Six steps of ASSURE model is used to develop the model. Those steps are: 1) analyze learners, 2) state objectives, 3) select strategies, technology, media, and materials, 4) utilize media and materials, 5) require learner participation, 6) evaluated and revise
(Sharon E. Smaldino, James D. Russel, Robert Heinich, dan Michael Molenda, 2005). Those steps are described clearly in the figure below:

![Assure Model](image_url)

**Figure 2. Assure Model**

Based on the figure above, steps of ASSURE can be explained as follows:

1. **Analyze learners**
   First step that lecturers have to do is to identify characteristics of their students in doing learning activities. In this research, the subject of the research are 2012 and 2010 students of Elementary School Teacher Education Program at Satya Wacana Christian University. The result will be used to see the ability of students in using computer and internet and their prior academic achievement in Basic Concept of Mathematics I course and Science Teaching and Learning Development course. Understanding the prior ability of students will help lecturers to decide method and process of effective and efficient teaching and learning.

2. **State Objectives**
   The second step is deciding the goal of learning based on characteristics of students. The analysis result of students’ characteristics and the basic competency and indicators must be in line with TPACK framework. By using TPACK framework, the combination of technology with pedagogical and content knowledge can make students active in learning.

3. **Select method, media, and materials**
   The third step is deciding a method, media, and materials for teaching and learning to be used in the face-to-face meeting and online. Those three components are important to help students to achieve the learning goal.

4. **Utilize media and materials**
   After deciding method, media, and materials, the next step is utilizing those three components in the teaching and learning process. To be effective, expert validity of the media should be done. This will measure the validity and reliability of the media and materials. After the validation, the media should be tested in a small group of students (consist of 5-10 students).

5. **Require learner participation**
The next step inviting students for participation in learning. Students must be active in learning in order to successfully reach the goal of learning. Blended learning is used. Therefore, students must be autonomous in learning. In this research, discussion and group investigation method was used to increase students’ participation in learning mathematics, whereas, project based learning was used to learn science.

6. Evaluate and revise
After lesson plan is created, the next step is evaluating. Evaluation should be done in order to collect data related to strengths and weaknesses of the design. In this research, the product that has to be evaluated are the model of teaching and learning process based on TPACK framework, instructional materials such as lesson plan, worksheet, teachers’ evaluation sheet, and students’ respond sheet. The result of the evaluation can be used as input or suggestion for further revision.

b. Technique and Instruments to collect data
Data analysis was done through validation and testing by calculating the scores obtained to assess the quality of the learning model is developed. The data collected in this study in the form of qualitative data that score with a scale of 1-5 (score 1 for very low, a score of 2 for low, 3 to score enough, a score of 4 for good, and a score of 5 for very good) from the results of expert assessment and student assessment related to applied learning, the advantages and disadvantages of learning. Score qualitative data converted into quantitative data using a reference conversion as shown in Table 1 using a Likert Scale (Suharsimi Arikunto, 2003). Pre-test and post-test results are analysed by comparing the results of the comparative analysis of the initial conditions with conditions after a learning model have been developed.

c. Data analysis technique

<table>
<thead>
<tr>
<th>Formula</th>
<th>Calculation</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{x} &gt; M_i + 1.8SD_i$</td>
<td>$\bar{x} &gt; 4.20$</td>
<td>Very good</td>
</tr>
<tr>
<td>$M_i + 0.6SD_i &lt; \bar{x} \leq M_i + 1.8SD_i$</td>
<td>$3.40 &lt; \bar{x} \leq 4.20$</td>
<td>Good</td>
</tr>
<tr>
<td>$M_i - 0.6SD_i &lt; \bar{x} \leq M_i + 0.6SD_i$</td>
<td>$2.60 &lt; \bar{x} \leq 3.40$</td>
<td>Enough</td>
</tr>
<tr>
<td>$M_i - 1.8SD_i &lt; \bar{x} &lt; M_i - 0.6SD_i$</td>
<td>$1.80 &lt; \bar{x} \leq 2.60$</td>
<td>Low</td>
</tr>
<tr>
<td>$\bar{x} \leq M_i - 1.8SD_i$</td>
<td>$\bar{x} \leq 1.80$</td>
<td>Very low</td>
</tr>
</tbody>
</table>

Notes:
- $M_i$ = ideal score average
- $\frac{M_i}{2}$ (maximum ideal score + minimum ideal score)
- $SDi$ = Deviation Standard ideal
- $\frac{M_i}{6}$ (maximum ideal score + minimum ideal score)
- $x$ = average score of empirical data
Result and Discussion

Evaluation of the teaching and learning model by using TPACK framework with blended learning based on ASSURE design is done before try out was conducted. The evaluation was done by expert of pedagogy (face-to-face and online), media, and learning materials. The result of the evaluation is described as follows:

a. Result of product evaluation on the pedagogy aspect
The assessment in this aspect includes the appropriateness of objectives, method of teaching and learning, appropriateness of media and materials used, syntax of teaching and learning with appropriate method, difficulty of learning activities for students, clarity of instruction, and assessment method. The result is good with 4.14 score average.

b. Result of product evaluation on media aspect
Evaluation result of this aspect includes appropriateness of media used for teaching and learning, easiness of media used, availability of media, and its function to deliver learning materials. The score of this aspect is 3.75 that is included as good.

c. Result of product evaluation on the teaching materials aspect
The evaluation result of this aspect includes the appropriateness of standard competence and basic competence, appropriateness of materials with students’ ability, completeness of materials, easiness of materials, easiness of access for PC, laptop, and hand phone (include compatibility), multimedia usage (video, audio, and images or text). The score of this aspect is 3.71 which is regarded as good.

d. Result of product try out
Tryout was done for small group and big group. The results is shown in the table 2 bellow.

Table 2
Result of Product Tryout

<table>
<thead>
<tr>
<th>No</th>
<th>Types of Tryout</th>
<th>Score</th>
<th>Average</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pedagogy aspect</td>
<td>4.13</td>
<td>3.98</td>
<td>GOOD</td>
</tr>
<tr>
<td>1</td>
<td>Media aspect</td>
<td>4.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Material aspect</td>
<td>3.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pedagogy aspect</td>
<td>4.04</td>
<td>4.14</td>
<td>GOOD</td>
</tr>
<tr>
<td>1</td>
<td>Media aspect</td>
<td>4.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Material aspect</td>
<td>3.88</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The result shows that the model that was developed is categorized as good. Therefore, the teaching and learning model that was developed could be implemented well in classroom and students can follow the instructions well.

e. Students participation
The assessment of the model is not only for the model that was developed but also to the participation of students in teaching and learning. Students’ participation in teaching and learning especially in the online forum discussion was increasing.
face-to-face meeting, students were embarrassed answer lecturer’s questions. However, when online forum discussion was available, students wanted to give their comments and answered the questions given by lecturer. They also gave comments to the responds of their classmates. It shows that online forum discussion give opportunity for students to be active in discussion.

f. Students academic achievement for science and mathematics

The academic result of students in Basic Concept Mathematics 1 and Teaching and Learning Development class can be shown in the following table.

<table>
<thead>
<tr>
<th>Category</th>
<th>Basic Concept Mathematics 1</th>
<th>Science Teaching and Learning Development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>before</td>
<td>after</td>
</tr>
<tr>
<td>Average</td>
<td>62</td>
<td>71</td>
</tr>
<tr>
<td>Maximum score</td>
<td>95</td>
<td>87</td>
</tr>
<tr>
<td>Minimum score</td>
<td>27</td>
<td>50</td>
</tr>
</tbody>
</table>

The result shows that there is an increasing score of students grade in Basic Concept Mathematics 1 and the Teaching and Learning Development course although it is not maximum yet. Therefore, the implementation of the model of teaching and learning with TPACK framework affected students’ learning because students were active in the teaching and learning process.

g. Result of product revision

Researchers believe that there are some weaknesses in the implementation of this teaching and learning model and it needs to be revised. The revision are: 1) selection of teaching method for online meeting 2) not all students were involved in online discussion 3) limitation of internet connection used 4) there was difficulty in conducting teleconference and 5) other mobile apps such as wechat, Kakao Talk, Line, etc were not used yet.

**Conclusion**

The result of the research is that a model of teaching learning by using TPACK and context of teaching and learning with blended learning for Basic Concept of Mathematics 1 and Science Teaching and Learning Development. The teaching and learning model that was developed was categorized as good based on three aspects - pedagogy, media, and materials. The result of implementation shows that this teaching and learning model can increase students’ participation in learning mathematics and science at Elementary School Teacher Education program in Satya Wacana Christian University.
References


