ISSN 1533-9211

DOI: 10.5281/zenodo.8321498

THE IMPACT OF PROJECT-BASED FLIPPED LEARNING MODEL ON THE TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE SKILL OF PROSPECTIVE TEACHERS

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Abstract

A project-based flipped learning model was created in order to develop the skill of Technological Pedagogical Content Knowledge because the low ability of prospective teacher students in the 4.0 era was the driving force behind this research. Therefore, research is required to ascertain how the project-based flipped learning model affects the technological pedagogical content knowledge skills of future teachers. The goal of this study was to ascertain the impact of the project-based flipped learning model on prospective teachers' technological pedagogical topic knowledge skills. As many as 100 student teacher candidates are involved in this quasi-experimental study. The data collection tool evaluates students' knowledge of technological pedagogical content. The normality test, homogeneity test, paired sample t-test, and independent t-test were utilized in the data analysis technique. According to the independent t-test study findings, the value of sig (2-tailed) received a score of 0.00 < 0.05. This demonstrates that students who utilize project-based flipped learning models and those who use conventional learning have different average levels of technological pedagogical content knowledge. According to average outcomes, students who learn to apply the project-based flipped learning model perform better than those who study conventional methods. The study's findings indicated that the project-based flipped learning approach had an impact on prospective teachers' ability to comprehend technological pedagogical content. The results of this study can be utilized as a foundation for future teachers to build their pedagogy, content, and technological skills.

Keywords: Flipped Learning, TPACK, Students, Prospective Teachers

INTRODUCTION

Every area of human existence is impacted by the fourth industrial revolution; thus, society must be able to change to adjust to this new period (Eliyasni et al, 2019). The rapid advancement of information technology systems is what defines Era 4.0. Internet-based information technology systems and computerized systems are the technology and information systems that emerged during the fourth industrial revolution (Ramadhani et al, 2021). This information and technology system was created to simplify people's daily activities. The growth of this 4.0 era affects the educational system as well (Helsa & Kenedi, 2019). Era 4.0 demands that the educational system be capable of evolving into a modern education system. Each pupil is currently a young person who was born into the technological era. There are notable contrasts between the industrial revolution 4.0 era and the previous one. Teachers are not the primary source of student learning in the 4.0 era (Hamimah et al, 2019; Hamimah et al,

ISSN 1533-9211
DOI: 10.5281/zenodo.8321498

2019). Students can use the internet to find information and learning tools. This demonstrates how the current technology can take the role of the teacher as a learning resource. Teachers must master technology, especially when it is connected to the learning system, to respond to this paradigm. Teachers must be able to grow professionally so they can adapt to meet the difficulties of the 4.0 era. Teachers need to be proficient in a variety of learning tools that are in line with the needs of today's students and the developments of the 4.0 era. The process of creating information systems and technology guarantees that learning opportunities for students and teachers are more flexible and varied (Ghani & Muhammad, 2019). The learning process can be done anywhere, at any time, by both teachers and pupils. According to Hosseini, Hytönen, and Kinnunen (2002), teachers must possess the ability, knowledge, and skills linked to technology to implement technology-based learning processes. Incorporating technology seeks to be able to integrate the learning process.

It is challenging to increase teachers' technological proficiency (Mourtzis et al, 2018). To establish technology-based learning processes, teachers must become accustomed to them. Starting this can be done at university. So that students may create technology-based learning processes when they become teachers, teacher candidates must be able to master technology (Tendour et al, 2012; Uerz, Volman & Kral, 2018). The researchers' analysis of the literature revealed that prospective teacher students still lacked a strong grasp of technology (Sukaesih, Ridlo & Saptono, 2017; Supriyadi, Bahri & Waremra, 2018; Malichatin, 2019). Students can only master the technologies used in specific fields of study. This demonstrates that prospective teachers haven't been able to advance their expertise in conceptualizing and putting into practice technology-based learning procedures.

For students to build and implement technology-based learning processes when they become teachers, the prospective teacher must master the skill of designing these processes. The term "TPACK ability" refers to the capacity to master technology in the learning process. TPACK, or technological pedagogical content knowledge, is a skill. To be able to incorporate technology-based learning processes, teachers must have the TPACK ability, which is a framework for thinking about this (Wang, Schmidt-Crawford, & Jin, 2018). A teacher or teacher candidate must be proficient in TPACK. This is done so that instructors can use technology and modify it to incorporate student-appropriate learning materials and pedagogical elements (Mishra, 2019). Technological knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge are some of the components that make up TPACK abilities (TPACK). Technology mastery-related knowledge is taught in kindergarten. CK is information about the teacher's understanding of the subject matter. Teachers need to be knowledgeable about learning models, learning methods, and learning approaches, which is known as PK. PCK is information about the idea of teacher pedagogical knowledge in applying learning to a specific subject to make learning effective. TCK is the knowledge that relates to the integration of technology and content comprehension so that it creates a learning technique that enhances but constrains each other. TPK is a theory or comprehension of how learning might alter if particular technologies are employed properly. TPACK is a component that involves

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DOI: 10.5281/zenodo.8321498

interactions between pedagogical, technological, and content knowledge. The following image displays the visualization:

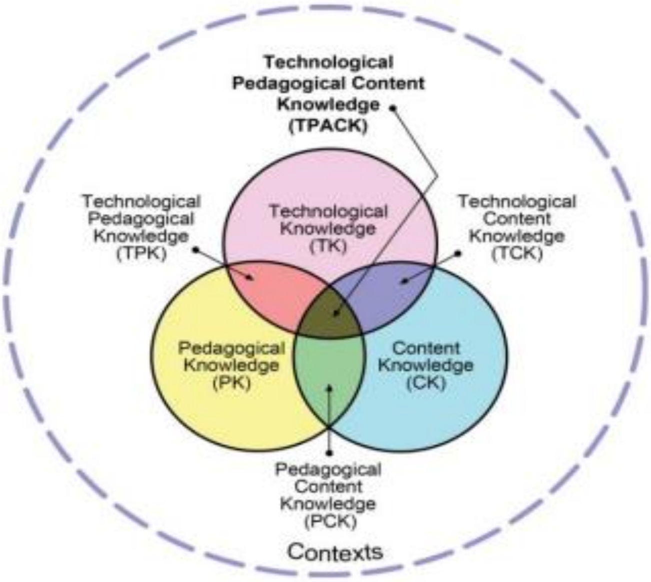

Figure 1: Components of TPACK

Figure 1 illustrates how the TPACK component developed from several other related components. Prospective teachers must strengthen their TPACK abilities (Maor, 2017; Swallow & Olofson, 2017; Baran et al, 2019). TPACK has access to high-quality education. The use of technology in today's learning is a new paradigm that TPACK can provide, and this is highly significant. According to numerous research, the effectiveness of TPACK has a significant impact on learning quality. According to the study's findings, TPACK skills in teachers can enhance student learning outcomes and the learning process itself (Koh, Chai, and Lim, 2017; Young et al, 2019; Absari, Priyanto, and Muslikhin, 2020; Açkgül & Aslaner, 2020; Lachner et al, 2021). These findings indicate that every teacher needs to develop their TPACK capability. This skill can be developed by aspiring teachers so that when they join the classroom, they are prepared to lead a technology-based learning process. However, it was discovered that the average TPACK ability of prospective teacher students were 56.78 based on the results of the initial test that researchers administered to 100 teacher candidates in Indonesia. This demonstrates that prospective teacher students still have low TPACK abilities. Consequently, a fix for the issue is required. According to the researcher's investigation, students' inexperience with building TPACK throughout the lecture process was what led to the low ability of TPACK. As a result, researchers created a learning model in earlier studies that were in line with the advancement of the 4.0 era and the characteristics of potential teacher students. The flipped project-based learning model is the one being used. The flipped learning model blends in-person and online learning methods into one mixed learning strategy (Wang & Zhu, 2019). Asynchronous and synchronous learning are combined in "flipped learning"

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ISSN 1533-9211
DOI: 10.5281/zenodo.8321498

(Lee, Lim & Kim, 2017). While synchronous learning takes place in real-time in the classroom, asynchronous learning requires that students learn autonomously using digital platforms. Project-based learning and flipped learning were combined to create this concept.

The project's method was chosen because it is appropriate for the era of Industry 4.0. (Yustina, Syafii, & Vebrianto, 2020). This is because project-based learning requires students to learn from projects that are created and involve a variety of skills and abilities, making them perfectly suited for usage in education in the 4.0 era. This project-based flipped learning methodology has been approved as legitimate and practicable for use in enhancing the TPACK skills of future teachers. Therefore, more investigation is required to determine whether the established project-based flipped learning model can influence the TPACK proficiency of future teacher students.

There has never been a study like this one. Only the impact of TPACK on the learning process is examined in the available study (Jang & Chen, 2010; Lee & Kim, 2014; Irmita & Atun, 2018; Baran et al, 2019). This study is distinct from previous studies. This study focuses on how the project-based flipped learning methodology affects the TPACK proficiency of future teachers. Consequently, the goal of this study was to ascertain how the project-based flipped learning approach affected the TPACK ability of future teachers.

RESEARCH METHODOLOGY

This study uses a non-equivalent control group design and a quasi-experimental methodology. 100 prospective teachers participated in this study. 50 people made up the experimental class and 50 people made up the control class. The table below shows how this study was set up:

Table 1: Research Design

Group	Pre-Test	Treatment	Post-Test
Experimental	O1	X	O2
Control	O3		O4

Description

- X: Use of project-based flipped learning models
- O1: Pre-test (TPACK skill of prospective teachers before using the project-based flipped learning model)
- O2: Post-test (TPACK skill of prospective teachers after using the project-based flipped learning model)
- O3: Pre-test (TPACK skill of prospective teachers before using the conventional model)
- O4: Post-test (TPACK kill of prospective teachers after using the conventional model)

Up to 10 questions from the TPACK ability test are used in the data collection instrument. Experts evaluated the viability of the prior experiments and approved their use. The data analysis method made use of SPSS 26. The tests utilized were independent t-tests, paired sample t-tests, normality tests, homogeneity tests, and descriptive statistical tests.

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DOI: 10.5281/zenodo.8321498

The research's primary hypothesis is

- Ho: The project-based flipped learning model has no impact on prospective teacher students' TPACK skill.
- H1: The project-based flipped learning model has an impact on prospective teacher students' TPACK skills.

RESEARCH RESULT

After the control class and the experimental class received treatment, the TPACK ability was measured. The control class was given treatment utilizing both a conventional learning model and a project-based flipped learning model. The following table shows the results of the data tabulation for the experimental class and the control class:

Table 1: Recapitulation of Control Class and Experiment Class

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Pre-Test Eksperimen	50	57	67	60.34	3.280
Post-Test Eksperimen	50	0	93	87.66	12.876
Pre-Test Control	50	57	67	60.70	3.683
Post-Test Control	50	60	83	64.82	4.360
Valid N (listwise)	50				

The normality test comes next. This will show whether the data are regularly distributed or not. The following table shows the findings of the normality test:

Table 2: Normality Test Results

Tests of Normality							
	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
TPACK	Pre-test Experiment	.226	50	.992	.836	50	.700
	Post-test Experiment	.460	50	.261	.254	50	.165
	Pre-test Control	.242	50	.727	.822	50	.300
	Post-test Control	.269	50	.983	.750	50	.727
a. Lilliefors Significance Correction							

Table 2 shows that each item is eligible for a minimum score of 0.05. This demonstrates that the four groups of data are distributed normally. The paired sample t-test was then performed. This test attempts to determine whether the project-based flipped learning model can help future teachers develop their TPACK skills. The following table shows the calculation's outcomes:

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ISSN 1533-9211

DOI: 10.5281/zenodo.8321498

Table 3: Paired Sample T-Test

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-Test Eksperimen - Post-Test Eksperimen	-27.320	13.990	1.979	-31.296	-23.344	-13.808	49	.000
Pair 2	Pre-Test Control - Post-Test Control	-4.120	3.910	.553	-5.231	-3.009	-7.450	49	.000

Table 3's measurement findings demonstrate that the output of pair 1 results in a value for sig (2-tailed) that is 0.00 less than 0.05. This demonstrates a difference in TPACK skills between the experimental class's pre-test and post-test. As seen in the output of pair 2, the value of sig (2-tailed) receives a value of 0.00, which is less than 0.05. This demonstrates that TPACK's performance for the control class pre-test and the control class post-test differs. The homogeneity test comes next. This test seeks to establish the homogeneity of the data. The data tested were the post-test of the experimental class and the control class. The results of the data calculation can be seen in the following table:

Table 4: Homogeneity test

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
TPACK	Based on Mean	.181	1	98	.671
	Based on Median	.092	1	98	.762
	Based on Median and with adjusted df	.092	1	57.240	.762
	Based on trimmed mean	.089	1	98	.766

The output value of sig based on the mean is 0.181, which is more than 0.05, as can be shown in table 4. This establishes the normal distribution of the data. The independent sample t-test calculation comes next. This assessment seeks to determine whether future teacher students who learn using a project-based flipped learning model differ from those who learn conventionally. The following table displays the computation results:

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DOI: 10.5281/zenodo.8321498

Table 5: Independent T-Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
TPACK	Equal variances assumed	.181	.671	11.881	98	.000	22.840	1.922	19.025	26.655
	Equal variances not assumed			11.881	60.091	.000	22.840	1.922	18.995	26.685

Table 5 shows that the value of sig (2-tailed) receives a score of 0.00, which is less than 0.05. This demonstrates that students who employ a project-based flipped learning model and students who learn conventionally have different average TPACK abilities. The following table can be used to determine the significant TPACK capability:

Table 6: Results of Post-Test Data Comparison between the Control Class and Experimental Class

Group Statistics					
	Class	N	Mean	Std. Deviation	Std. Error Mean
TPACK	Post-test Experiment	50	87.66	12.876	1.821
	Post-test Control	50	64.82	4.360	.617

Table 6 shows that the experimental class's post-test value (87.66>64.82) is higher than the control class's. This demonstrates how the project-based flipped learning model significantly affects the TPACK proficiency of future teachers.

This study establishes the impact of the developed STEM-based flipped learning approach on the TPACK skill of prospective teachers. The findings of this study are confirmed by earlier studies. The flipped learning method was able to enhance student learning outcomes, according to the findings of studies by Salimi and Yousefzadeh (2015), Karagöl & Emrullah (2019), Orhan (2019), and Sablan & Hidayanto (2022). Flipped learning, according to research by Lee, Kang, and Kim (2015), can boost students' motivation to study. According to research by Karaca & Ocak (2017), the flipped learning model can enhance students' cognitive thinking process, which would enhance the standard of their learning.

According to studies by Chao, Chen, and Cuang (2015), Wang and Zhu (2019), and Challob (2021), the flipped learning paradigm can enhance the learning environment for students. Flipped learning allows for better learning outcomes for the students that use it. Flipped learning can also help students learn to better control their behavior while they are studying. Flipped learning can deliver learning that enhances students' self-control (Lee & Eun, 2106; Kim, So, & Joo, 2021).

These results demonstrate that flipped learning can raise the standard of learning. The project-based flipped learning model, which has been designed and tested, is examined in this study to see if it has any impact on the TPACK ability of future teachers. In this study, it was discovered that the project-based flipped learning model had a favorable impact on future teachers' TPACK skills. The hybrid learning model is known as "flipped learning" is reversed. Flipped learning is a method that teachers utilize to dramatically cut down on direct connection with students (Ztürk & Akrolu, 2021). This methodology makes the most of technology for online learning. In the flipped learning model, students are required to comprehend the online course materials before engaging in face-to-face learning. Flipped learning, according to much research, can raise the standard of learning. This demonstrates that the flipped learning approach is appropriate for use right now.

In this study, a project-based learning strategy was integrated with the flipped learning model. The project-based flipped learning model is the name of this approach. With this project-based flipped learning model, each learning process is integrated with a project-based approach. Students are required to do independent assignments, in addition, to independently comprehending online learning materials during the asynchronous learning process. Simple independent projects are created and tailored to the needs of students who want to become teachers. To complete this assignment, students must be able to learn using a variety of knowledge that is available both offline and online. Similar to synchronous learning which involves students working together to complete projects that further the learning process.

This study demonstrates how the project-based flipped learning model can help future teachers enhance their TPACK skills. There are several causes for this. In the project-based flipped learning approach, teacher candidates are exposed to pedagogical resources that must be mastered both asynchronously and synchronously. According to this model, they are expected to comprehend the lesson materials delivered while also having the opportunity to look for more information from other sources, both online and in their surroundings. It is hoped that teacher candidates will be able to comprehend the material according to the course requirements. The capacity for content knowledge can be improved through this procedure. A continuous learning approach can be used to develop the content knowledge component (Yusuf, 2017; Zhou et al, 2022). Additionally, in this project-based flipped learning model, issues have been presented that call for students to work on a project to develop effective teaching methods for students at school. The prospective teacher for this project-based flipped learning model must be able to identify teaching innovations that complement the subject matter.

This will help future teachers directly advance their pedagogy expertise. Only teachers can comprehend pedagogy (König et al., 2014; Gess-Newsome, 2019). Because this has to do with objectives, procedures, assessment, learning strategies, and other elements of the learning process. To enable teacher candidates to create a technology-based learning process, the project-based flipped learning model method was also established. The project that is being described in this model can only be resolved with technology. This will significantly advance the technological abilities and understanding of prospective teachers. This is consistent with the claim that teachers must be acclimated to using technology in the learning process to adopt technology-based learning (Belo et al, 2016; Taimalu & Luik, 2019). Other TPACK components will focus on enhancing content knowledge, pedagogical knowledge, and technological knowledge. Prospective teacher students will naturally be able to build

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ISSN 1533-9211
DOI: 10.5281/zenodo.8321498

Pedagogical Content Knowledge skills once they have mastered the Pedagogical Knowledge and Content Knowledge components. Additionally, prospective teachers will naturally be able to gain technological content knowledge skills as they master both technological and content knowledge. The ability of teachers with pedagogical knowledge will then improve as they learn both technology and pedagogy knowledge. The ability of Technology Pedagogy Content Knowledge will also improve as a result of acquiring the abilities of Technology Content Knowledge and Technology Pedagogy Knowledge.

It is clear from this interaction that each TPACK component will have an impact on the others. The project under this flipped learning model allows for the development of interactions between TPACK elements. This is what makes the project-based flipped learning model affect prospective teachers' TPACK skills.

CONCLUSIONS

The output of pair 1 receives a sig (2-tailed) value of 0.00 less than 0.05, according to the measurement results of the paired sample t-test. This demonstrates a difference in TPACK skills between the experimental class's pre-test and post-test. It is evident from pair 2's output that the value of sig (2-tailed) is 0.00, which is less than 0.05. This demonstrates that TPACK's performance for the control class pre-test and the control class post-test differs. The value of sig (2-tailed) was found to have a score of $0.00 < 0.05$ based on the independent t-test results. This reveals that learners who employ a project-based flipped learning model and those who learn conventionally have different average TPACK skills. The post-test value of the experimental class was higher than that of the control class (87.66>64.82), according to the average value data. This reveals that the project-based flipped learning model has a big impact on prospective teachers' TPACK skills.

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