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ANALYSIS OF THE IMPLEMENTATION OF TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK) FRAMEWORK IN LESSON PLAN

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ABSTRACT

Technological pedagogical content knowledge (TPACK) is a relatively new learning approach in education. The practice of implementing this method includes mastery of technology, pedagogical, and learning content knowledge. All three are essential and in line with current educational needs. Therefore, teachers need to be able to apply the TPACK framework in lesson plans. This study aimed to analyze the application of TPACK in lesson plans in elementary schools in Gunungsitoli City, North Sumatra Province. This research is a mixed methods research of explanatory sequential type. The research sample in this study was the lesson plans with 5 lesson plans from six teachers. The collected lesson plans were analyzed by checking the TPACK framework and were validated using triangulation technique, such as documentation, questionnaires, and interviews. Based on the research that has been conducted, the results show that the application of TPACK in lesson plans in elementary schools in Gunungsitoli City is included in the good criteria, with an average score of 77.50%. It is hoped that this research can be an evaluation and material for the development of other researchers, teachers, schools, and the government regarding learning methods and can be used to explore the use of technological advances as modernization in the field of education, especially in the education sector.

Keywords: *TPACK, lesson plan, elementary school, mixed methods*

1. INTRODUCTION

The industrial revolution 4.0 resulted in technological developments that are developing very quickly. Technological developments have been utilized in all areas of life, as well as in the field of education. Education in the 21st century considers technology as important, just like content and pedagogy (Haleem et al., 2022). In addition to mastery of learning content and teaching methods, teachers must be able to integrate technology into learning activities. Before starting learning activities, the teacher must have a learning implementation plan containing systematic steps that will later be applied during learning activities. Lesson plans are needed before teachers carry out learning (Iqbal et al., 2021). The learning implementation plan is in the form of steps arranged by the teacher systematically and is in the form of learning scenarios which will later be used as a reference in implementing learning activities.

There is a framework that can help teachers integrate technology in lesson plans. The framework is the TPACK framework. The TPACK (Technological, Pedagogical, Content Knowledge) framework is a framework that combines three forms of knowledge, which include technological, pedagogical, and content knowledge. This TPACK is a development framework from the PCK (Pedagogical Content Knowledge) framework introduced by Koehler et al. (2014). TPACK is a framework that includes the use of technology in the learning process, the pedagogical knowledge, and knowledge related to the content to be taught (Nilsson, 2022). The TPACK framework is in accordance with 21st century education where the use of technology is indispensable in the learning process.

There are several components that make up TPACK, including technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and pedagogical content knowledge (PCK). TCK is the utilization of developing technological science to help achieve an effective learning process. PK is the teacher's knowledge of the implementation of learning. CK is the teacher's knowledge of the content that will be delivered to students. TCK is a knowledge that integrates technological knowledge and content knowledge. TPK is knowledge for integrating technological knowledge and pedagogical knowledge. Furthermore, PCK is an integration between pedagogical knowledge and content knowledge.

Kapici and Akcay (2023) as well as König et al. (2022) state that the teacher's mastery of TPACK can be seen from the teacher's lesson plan. Lesson plan based on TPACK is an arrangement of learning designs that will later be used by teachers when learning activities take place which includes planning for the use of technology as well as determining models or ways of managing the learning activities and learning content. The application of TPACK is very necessary in lesson plans because it will create a learning plan that is loaded according to the times, namely integrating technology, pedagogy, and content in the process of learning activities. Based on interviews with third grade teachers in elementary schools in Gunungsitoli City, the teacher stated that they already understood the TPACK framework and the teacher was aware of the importance of implementing TPACK in the lesson plan. The teacher even stated that applying TPACK in lesson plans can make learning in class more focused and effective.

Teachers will find it easier to deliver material by utilizing existing technology (Belda-Medina & Calvo-Ferrer, 2022; Harefa, 2023). Additionally, in line with what was conveyed by Lachner et al., (2021), the advantage of implementing TPACK is being able to create independent and interactive learning for students. Teachers must be able to use technology so that learning is carried out creatively and innovatively. The application of TPACK to each teacher is of course different. The different applications of TPACK and the importance of the TPACK framework in learning make researchers want to do further research related to the application of TPACK in learning implementation plans. Research related to the application of TPACK has been carried out by Putri et al., (2020), this research examines the teacher's pedagogical knowledge (PK) with the results of the research showing that the teacher only knows two learning theories, two learning models, and four learning methods. Other related research has also been carried out by Schmid et al. (2021) which shows the results in which there are still several TPACK components that have not been integrated into the lesson plan. Another study by Akyuz (2018) found that the average ability related to TPACK of teachers in state elementary schools in Tengaran district, Semarang regency was in the acceptable criteria.

Based on this explanation, the researcher wants to dig deeper information regarding to the application of TPACK in the implementation of learning plans at elementary schools in Gunungsitoli City. There is a novelty in this current research, in which it analyzes all components of the TPACK and shows the percentage of its application in the lesson plans. The differences of this current research with previous research are in the research focus, research methods, and research locations. Previous research conducted by Malva et al. (2020) focused only on applying teacher pedagogical knowledge (PK), while this current research focuses on implementing all components, namely TK, PK, CK, TCK, TPK, PCK, and TPACK. Meanwhile research conducted by Schmid et al., 2021) used a descriptive qualitative research method, and research by Ay et al. (2015) used a quantitative research method, this curent research used a mixed method research design. Thus the research results can be presented in the form of percentages and in-depth explanations. The purpose of this study was to analyze the application of TPACK in the learning implementation plan in elementary schools in Gunungsitoli City. The benefits of this research for school principals is that it can be used as a basis for follow-up actions such as holding training related to the application of TPACK in lesson plans. Besides, for the teacher, this research result was hoped to be an insight and evaluation material for the lesson plan that has been made if there are TPACK components that are still not appropriate, so that later the teacher will be able to prepare an appropriate TPACK-based lesson plan. This research is also expected to be useful for future researchers as a reference in research related to TPACK.

2. METHODS

This research is a mixed methods research. According to Creswell (2017), mixed methods is a research method used to collect data and analyze data by combining two types of research methods, namely quantitative methods and qualitative methods. The type of mixed methods research used is explanatory sequential. Explanatory sequential is a research that goes through two stages of data collection, namely by collecting quantitative data first and then followed by collecting qualitative data.

The population of this study were six class teachers at elementary schools in Gunungsitoli City, where each teacher had 24 lesson plans for each learning theme. The sampling technique in this study used a purposive sampling technique. The sample in this study refers to the sampling rules which states that the sample is 20% of the total population (Thomas, 2021). The population of lesson plans in this study were 144 lesson plans. The sample lesson plans used were 5 lesson plans from each teacher. Data collection in this study consisted of three types of techniques namely, documentation, questionnaires, and interviews. The research instruments used were document check-lists, questionnaires and interview guidelines, as shown in Tables 1, 2, and 3. The document check-list contains a rubric that is used as a reference for analyzing the implementation of TPACK in the learning implementation plan and can be used to measure the implementation of TPACK in the learning implementation plan that has been analyzed. The questionnaire used consisted of two types of statements, namely positive statements and negative statements using a Likert scale.

Table 1. Document Check-list instrument grids

Variable	Indicator	Completeness	
		Yes	No
TK	Technology-based learning media		
PK	● Learning approaches ● Learning strategies/models ● Learning methods ● Cognitive assessment guidelines ● Affective assessment guidelines ● Psychomotor assessment guidelines		
CK	● Learning content ● Conformity between learning objectives and learning content ● References inclusion to learning resources		
TCK	Compatibility between digital technology used and learning content		
TPK	The use of technology in the learning process		
PCK	Conformity between learning methods and learning content		
TPACK	Integrating TK, PK, CK, TCK, TPK, PCK in learning steps		

Data analysis for quantitative data used descriptive statistics, while qualitative data was analyzed using the Miles and Huberman (1994) model. Descriptive statistical analysis in this study was in the form of the results of a document checklist and a questionnaire for the implementation of learning plans for first-grade teachers to sixth-grade teachers. After obtaining the questionnaire scores and document checklist scores, then the results of the two scores will be averaged and will be interpreted with the interpretation guidelines shown in Table 4.

Qualitative data analysis using the Miles and Huberman (xxx) model consists of data reduction, data display, and conclusion drawing/verification. In the data reduction stage, the researcher will

sort out the appropriate data, while inappropriate data will not be used. Furthermore, at the data display stage, the researcher will present data related to the application of TPACK in the implementation of learning plans in elementary schools in Gunungsitoli City. The final stage, namely conclusion drawing/verification, is reviewed based on the results of data reduction and data display. The validity of the data in this study uses triangulation. Triangulation is a process of examining data that has been obtained using a variety of different data collection techniques and from a variety of different data sources (Sugiyono, 2019). The type of triangulation used in this study was technical triangulation.

Table 2. Questionnaire instrument grids

Variable	Indicator	Item Number in Instrument	
		Positive Item	Negative Item
TK	Ability to use digital technology	2	1
PK	Knowledge of learning implementation and learning evaluation knowledge	5, 6, 7, 8	3, 4
CK	Material suitability and material development	9, 10	11
TCK	Ability to integrate digital technology in learning content	12	13
TPK	Ability to integrate digital technology in learning activities	15	14, 16, 7
PCK	Ability to determine learning methods	18	
TPACK	Implementation of TPACK	19, 20	

Table 3. Interview instrument grids

No.	Question
1	What digital technologies are used by teachers as learning media?
2	What are the approaches used in learning?
3	What are the strategies/models used in learning?
4	What are the methods used in learning?
5	What are the types of assessment of students?
6	What is used as a reference in limiting learning content?
7	Does the teacher pay attention to learning objectives in compiling content?
8	Does the teacher include references to learning resources in the lesson plan?
9	What digital technologies are used in learning activities?
10	Does the teacher pay attention to learning content in determining a learning method?
11	Has the teacher integrated each TPACK component in the lesson plan?

Table 4. Score interpretation criteria

Criteria	Interpretation
0.00% – 20.00 %	Very poor
21.00% – 40.00%	Poor
41.00% – 60.00%	Acceptable
61.00% – 80.00%	Good
81.00% – 100.00%	Very Good

3. RESULTS & DISCUSSION

The data collection process consists of two stages. The first stage is collecting quantitative data using documentation and questionnaires. The second stage is the collection of qualitative data by using interviews. Data collected in the first stage was in the form of the percentage of TPACK implementation in the implementation of learning plans in elementary school in Gunungsitoli City. The collected data from the second stage was in the form of explanatory information related to the application of TPACK in the implementation of learning plans in elementary schools in Gunungsitoli City. The results are presented in detail based on 7 components, namely TK, PK, CK, TCK, TPK, PCK, and TPACK.

3.1 Application of Technological Knowledge (TK) in Lesson Plan

The results in the form of percentages came from the results of the documentation analysis of 5 lesson plans for each class level and the results of the questionnaire on the TK indicator. In addition, a more in-depth explanation regarding the application of TK in lesson plans comes from interviews with teachers. It is known that the implementaion of TK in the lesson plan in elementary schools in Gunungsitoli had a minimum score of 40.00%, while the maximum score was 65.00% with an average score of 50.80% which was in the acceptable criteria. In more detail, based on Table 5, it is known that the application of TK in the lesson plans, out of 6 teachers, 2 teachers (33.3%) were in the poor criteria, 3 teachers (50.00%) were in the acceptable criteria, and only 1 teacher (16.67%) was in good criteria. The average score for applying TK was included in the acceptable criteria because teachers rarely use digital technology-based media.

Table 5. Frequency distribution of implementation of TK in lesson plan

Criteria	Interpretation	Frequency	Percentage
0.00% – 20.00 %	Very poor	0	0.00%
21.00% – 40.00%	Poor	2	33.33%
41.00% – 60.00%	Acceptable	3	50.00%
61.00% – 80.00%	Good	1	16.67%
81.00% – 100.00%	Very Good	0	0.00%

The application of TK in the learning plan is considered important because TK is the main component in integrating the other TPACK components. Szymkowiak et al. (2021) explained that generation Z is a generation that is familiar with technological developments and the digital world, so it is necessary to utilize technology in the educational process. Lesson plan is a learning plan that is used as a reference in implementing learning. The application of technology as a learning medium has the advantage of being able to make students more interested in learning and can enrich student learning experiences. Therefore, if the lesson plan contains the application of TK properly, it will provide a good design in learning and in accordance with the current needs of students. In line with the results of the interviews conducted with the teachers of class I to class VI, where the class I teacher stated that they more often used book-based learning media, and only occasionally used technology-based media in the form of pictures and videos.

3.2 Application of Pedagogical Knowledge (PK) in Lesson Plan

The results in the form of percentages came from the results of the documentation analysis of 5 lesson plans for each class level and the results of the questionnaire on the PK indicator. In addition, a more in-depth explanation regarding the application of PK in lesson plans came from the results of interviews with teachers. Exposure to the distribution of the frequency of implementing PK in lesson plans is presented in Table 6. It is known that implementing PK in lesson plans in elementary schools in Gunungstoli City has a minimum score of 83.00%, while the maximum score is 100% with an average score of 95.00% which is at very good criteria. In more detail, based on Table 6 it is known that the application of PK in lesson plans, 6 out of 6 teachers (100.00%), are in very good criteria. The average PK was good because the teacher was able to include learning approaches, models, and methods in lesson plans.

Table 6. Frequency distribution of PK implementation in lesson plan

Criteria	Interpretation	Frequency	Percentage
0.00% – 20.00 %	Very poor	0	0.00%
21.00% – 40.00%	Poor	0	0.00%
41.00% – 60.00%	Acceptable	0	0.00%
61.00% – 80.00%	Good	0	0.00%
81.00% – 100.00%	Very Good	6	100.00%

Based on the results of interviews conducted with elementary school teachers, it was stated that the learning approach used by the teacher was a scientific approach. An approach that is structured so that students can be active in constructing a particular concept or principle through a scientific approach is called the scientific approach (Harefa, 2023b). Interview activities with class I, III, and IV teachers revealed that the learning model applied was cooperative learning. While the class II teacher and class VI teacher in the interview activities stated that they used the discovery learning model. During the interview with the class V teacher, he said that he used problem-based learning and cooperative learning models. The learning model chosen by the teacher is the appropriate learning model to be applied at this time (Aldalur & Perez, 2023; Huang et al., 2017).

3.3 Application of Content Knowledge (CK) in Lesson Plan

The results in the form of percentages came from the results of the documentation analysis of 5 lesson plans for each class level and the results of the questionnaire on the CK indicator. In addition, a more in-depth explanation regarding the application of CK in lesson plans came from the results of interviews with teachers. An overview of the distribution of the frequency of applying CK in the lesson plan is presented in Table 7. Based on the description of the application of CK in the lesson plan in Table 7, it is known that the application of CK in the lesson plan in elementary schools has a minimum score of 86.50% and a maximum score of 100.00% with an average score of 93.33% which was in very good criteria. It is known that the application of CK in lesson plans, 6 out of 6 teachers (100.00%), are included in the very good criteria. The average result was very good because the teacher was able to describe the learning content used. The teacher also included references to learning resources used in the lesson plans.

Table 7. Frequency distribution of implementation of CK in lesson plan

Criteria	Interpretation	Frequency	Percentage
0.00% – 20.00 %	Very poor	0	0.00%
21.00% – 40.00%	Poor	0	0.00%
41.00% – 60.00%	Acceptable	0	0.00%
61.00% – 80.00%	Good	0	0.00%
81.00% – 100.00%	Very Good	6	100.00%

Learning content and learning resources are mandatory components in lesson plans (Hatch & Clark, 2021; Iqbal et al., 2021). Based on the results of interviews with class teachers, when compiling learning content, the teacher refers to core competencies and basic competencies. In line with this, the class III teacher said that the teacher refered to core competencies and basic competencies so that the learning content delivered later was in accordance with the learning objectives.

3.4 Application of Technological Content Knowledge (TCK) in Lesson Plan

The results in the form of percentages came from the results of the documentation analysis of 5 lesson plans for each class level and the results of the questionnaire on the TCK indicator. In addition, a more in-depth explanation regarding the application of the TCK variable in the lesson plans came from interviews with teachers. It is known that the application of TCK in lesson plans in elementary schools in Gunungsitoli City has a minimum score of 40.00% and the maximum score is 60.00% with an average score of 49.20% which is in the acceptable criteria. In more detail, based on Table 8 it is known that the application of TCK in lesson plans out of 6 teachers, 3 teachers (50.00%) were in the poor criteria and as many as 3 teachers (50.00%) were in the acceptable criteria. The results of implementing TCK were in the acceptable criteria because there were still teachers who did not integrate technology in the delivery of learning content. The application of TK and CK was interrelated, if the teacher did not apply TK properly, it will affect the results of applying TCK.

Table 8. Frequency distribution of implementation of TCK in lesson plan

Criteria	Interpretation	Frequency	Percentage
0.00% – 20.00 %	Very poor	0	0.00%
21.00% – 40.00%	Poor	3	50.00%
41.00% – 60.00%	Acceptable	3	50.00%
61.00% – 80.00%	Good	0	0.00%
81.00% – 100.00%	Very Good	0	0.00%

In accordance with the results of interviews with grades I to VI teachers, the teachers revealed that not every time they use technology-based learning media. Teachers need to improve the application of TCK in lesson plans. In accordance with the explanation by Bai et al. (2016) and Chauhan (2017) which states that strengthening students' understanding of learning content can be supplemented by using technology-based learning media.

3.5 Application of Technological Pedagogical Knowledge (TPK) in Lesson Plan

The results in the form of percentages come from the results of the documentation analysis of 5 lesson plans for each class level and the results of the questionnaire on the TPK indicator. In addition, a more in-depth explanation regarding the implementation of TPK in lesson plans comes from the results of interviews with teachers. The presentation of the frequency distribution of TPK in the lesson plan is presented in Table 9. It is known that the application of TPK in lesson plans in elementary schools in Gunungsitoli City has a minimum score of 35.00%, while a maximum score of 63.00% with an average score of 47.50% which is in the acceptable criteria. In more detail, based on Table 9 it is known that the application of TPK in the lesson plan, out of 6 teachers as many as 3 teachers (50%) are in the poor criteria, 2 teachers (33.33%) are in the acceptable criteria, and as many as 1 teacher (16.67%) are in good criteria. The application of TPK is in the acceptable criteria because the teacher is unable to integrate technology in learning activities. TK components and PK components are interrelated, if teachers are unable to integrate technology in the learning process, then the application of TPK will also have an effect.

Table 9. Frequency distribution of implementation of TPK in lesson plan

Criteria	Interpretation	Frequency	Percentage
0.00% – 20.00 %	Very poor	0	0.00%
21.00% – 40.00%	Poor	3	50.00%
41.00% – 60.00%	Acceptable	2	33.33%
61.00% – 80.00%	Good	1	16.67%
81.00% – 100.00%	Very Good	0	0.00%

This is consistent with the results of interviews with grade I teachers who stated that teachers more often used blackboards in delivering learning material. Integrating technology in learning in elementary school is a must (Al-Hariri & Al-Hattami, 2017; Chen et al., 2020). Based on the results of interviews conducted with class I to class VI teachers, it is known that the digital technology used by teachers in learning activities was laptops and LCD projectors. Laptops or digital technology was also not always used by teachers in learning activities.

3.6 Application of Pedagogical Content Knowledge (PCK) in Lesson Plan

The results in the form of percentages came from the results of the documentation analysis of 5 lesson plans for each class level and the results of the questionnaire on the PCK indicator. In addition, a more in-depth explanation regarding the application of PCK in lesson plans came from the results of interviews with teachers. An overview of the distribution of the frequency of implementing PCK in the lesson plan is presented in Table 10. It is known that the application of PCK in lesson plans in elementary schools in Gunungsitoli City has a minimum score of 80.00% and a maximum score of 100.00% with an average score of 95.00% which was in very good criteria. In more detail, based on Table 10 it is known that the application of PCK in lesson plans, 1 out of 6 teachers (16.67%) was in good criteria and 5 teachers (83.33%) were in very good criteria. The average results of applying PCK were in very good criteria, meaning that it is known that the teacher has been able to determine a method that is appropriate to the learning content.

Table 10. Frequency distribution of implementation of PCK in lesson plan

Criteria	Interpretation	Frequency	Percentage
0.00% – 20.00 %	Very poor	0	0.00%
21.00% – 40.00%	Poor	0	0.00%
41.00% – 60.00%	Acceptable	1	16.67%
61.00% – 80.00%	Good	5	83.33%
81.00% – 100.00%	Very Good	0	0.00%

The results of interviews with grade I to VI teachers suggested that teachers always pay attention to learning content when determining learning methods. Presentation of learning content to students must be followed by learning methods that are appropriate to the students' circumstances (Ribosa & Duran, 2022). In line with the results of interviews with the third grade teachers who stated that choosing the right method can help convey learning content properly. Based on the presentation during interviews with class I to class VI teachers, the researchers noted that the learning methods used varied. In line with Hirsh et al. (2022) and Tran and Duong (2023) who state that not all learning methods are suitable for use, teachers must be able to determine certain methods that are appropriate to students' circumstances and the content being taught.

3.7 Application of Technological Pedagogical Content Knowledge (TPACK) in Lesson Plan

The results in the form of percentages came from the results of the documentation analysis of 5 lesson plans for each class level and the questionnaire results. In addition, a more in-depth explanation regarding the application of TPACK in lesson plans came from interviews with teachers. The presentation of frequency distribution of the application of TPACK in the lesson plan is presented in Table 11. it is known that the application of TPACK in lesson plans in elementary schools in Gunungsitoli City has a minimum score of 68.20% and a maximum score of 83.70% with an average score of 77.50% which was in good criteria. In more detail, based on Table 11, it is known that in the application of TPACK in lesson plans, 3 teachers (50.00%) were in good criteria and the other 3 teachers (50.00%) were in very good criteria. The average score was in good criteria because the teacher has integrated knowledge of technology, pedagogy, and content, although several TPACK components are still in acceptable criteria.

Table 11. Frequency distribution of implementation of TPACK in the lesson plan

Criteria	Interpretation	Frequency	Percentage
0.00% – 20.00 %	Very poor	0	0.00%
21.00% – 40.00%	Poor	0	50.00%
41.00% – 60.00%	Acceptable	3	50.00%
61.00% – 80.00%	Good	3	50.00%
81.00% – 100.00%	Very Good	0	0.00%

Based on interviews with grades I to VI teachers, they stated that they had integrated each TPACK component in the lesson plans. However, there were still components whose average were in the

acceptable criteria. Components that were in the acceptable criteria included TK, TCK, and TPK. The application of components that fall within the acceptable criteria influences the application of other TPACK components so that it also influenced the implementation of TPACK as a whole. The application of each component will affect the application of TPACK because TPACK is an interaction or combination of each component (Koehler et al., 2013). Implementing education in schools should ideally be able to bridge the integration of information, communication, and technology in the learning process (Luo & Zou, 2022; Nilsson, 2022).

4. CONCLUSION

Based on the results of research on the analysis of the application of TPACK in the implementation of learning plans in elementary schools in Gunungsitoli City, it can be concluded that the application of TPACK in the implementation of learning plans in elementary schools in Gunungsitoli City is in good criteria with an average score of 77.50%. Details of the results of the implementation of each indicator, among others; TK was 50.80%, PK was 95%, CK was 93.33%, TCK was 49.2%, TPK was 47.50%, and PCK was 95.00%. The component with the lowest average score was TPK of 47.50%. In comparison, the components that get the highest average score were PK and PCK at 95.00%.

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