TPACK Component Analysis (Technology, Pedagogics, Content Knowledge) in Elementary School Teachers as a Framework for Teacher Competence in 21st-Century Learning

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Abstract. 21st Century Learning requires teachers to learn that is adaptive to the challenges and needs of the times. TPACK is one type of knowledge that must be mastered by teachers in the 21st century. This study aims to analyze the components of TPACK for elementary school teachers. His research uses a descriptive quantitative approach. The sample used in this study were elementary school teachers who had participated in the Teacher Professional Education Program. This instrument was developed from previous research which has high validity and reliability. Collecting data using a questionnaire with a Likert scale. Data analysis used descriptive statistical analysis test. The results show the average value of the Technology Knowledge component is 3,15, Pedagogical Knowledge is 3,25, Content Knowledge is 3,20, Technological Content Knowledge is 3,35, Pedagogical Content Knowledge is 3,40, Technological Pedagogical Knowledge is 3,41 and Technological Pedagogical Content Knowledge is 3,50. All components are in a good category. TPCK has the lowest average value among other components. The teacher's ability to integrate all components is easy. There needs to be a balance between the knowledge aspects of technology, pedagogy, and content.

Keywords: 21st Century Learning, Teacher Professional Education Program, TPACK.

How to Cite: Handika, R., Agustin, M., and Jakawali, G. (2023). TPACK Component Analysis (Technology, Pedagogics, Content Knowledge) in Elementary School Teachers as a Framework for Teacher Competence in 21st-Century Learning,. *Proceeding The 5th International Conference On Elementary Education*, 5(1). 545-551.

INTRODUCTION

Technology and information are moving very fast in the 21st century. Education is required to be adaptive in responding to the times. The fast pace of change needs to be balanced with educational practices that are in line with the demands of the times (Akhwani, 2020). Education is the main element in improving the quality of human resources. The 21st-century educational framework is experiencing adjustments to the required competencies. *The Partnership for 21st Century Learning* has initiated competencies that students must master, *1) learning and innovative skills* (*Critical Thinking, Creative, Communication, Cooperation*), *2) Knowledge, Media and Technology Skills, and 3) life and career skills* (Battelle for Kids, 2019; Gelen, 2018). To achieve these competencies, professional teachers are needed. Teachers who not only have knowledge but also have skills and attitudes in an integrated manner.

Professional teachers in the 21st century need to prepare for the needs of students in the future. The results of teacher policy and leadership research in the era of globalization state that teachers must be adaptive so they are not out of date, and that teachers must master technology in education (Sofiarini & Rosalina, 2021). Teachers are required to master technological literacy and digital skills as an integrated part of learning in the 21st century. Teaching and learning activities organized by teachers must integrate the use of technology in addition to basic scientific knowledge and skills in teaching. The combination of material knowledge, pedagogy, and skills using technology is known as TPACK (*Technological Pedagogical Content Knowledge*) (Mishra & Koehler, 2006).

At the elementary school level, teachers play a more active role as learning mediators (Munawar, 2019). The learning design presented by the elementary school is different from the junior or senior high school level. Learning activities are adapted to the conditions and potential of students. The methods and media users need to be sorted according to learning objectives so that learning runs optimally (Akhwani & Nurizka, 2021; Kejora, 2020). Professional teachers should master the TPACK components to prepare generations for the 21st century.

TPACK is a framework that integrates the relationship between components of technology, pedagogy, and knowledge content (Spector et al., 2014). Teachers in the 21st century are not teachers who are only able to deliver material using interesting methods. The 21st-century teacher is not just a teacher who is good at technology. Teachers needed in the 21st century are teachers who have competence in harmony between technology, pedagogy, and material content. If one component is not met then it can affect other components.

Nothing guarantees that teachers with a wealth of material knowledge are directly proportional to pedagogical and technological competencies. They may be academically intelligent, but unskilled in teaching and weak in technology. It is also not certain that teachers who have material knowledge and pedagogical knowledge also have competence in the field of technology. TPACK consists of material, pedagogy, and technology components. Competently, the three are separate parts, but the three cannot be separated as professional teachers. The TPACK framework and components consist of *Technology Knowledge* (TK), *Pedagogical Knowledge* (PK), *Content Knowledge* (CK), *Pedagogical Content Knowledge* (PCK), *Technological Content Knowledge* (TCK) *Technological Pedagogical Knowledge* (TPK) *Technological Pedagogical Content Knowledge* (TPCK) (Kim, 2018; Schmidt et al., 2014).

The results of the study related to the TPACK ability of teachers at the elementary level in the *Technological Knowledge* (TK) component of 72.2, *Pedagogical Knowledge* (PK) of 70.1, and *Content Knowledge* (CK) of 73.6 (Fauziyah, 2021). These results indicate that there is no balance between one component and another, it's just that the value does not measure TPACK competence as a whole. Research conducted by Ariani (2015) and Wahyuni & Pratiwi (2019) states that the TPACK level of elementary school teachers is at a modest level with *a range of values of* $3.21 \leq x \leq 4.11$. This research indicates that the teacher's TPACK competency is not optimal. The two studies above have not explicitly classified the intersection between each component and its comparison with TPACK as a whole.

The 21st-century teacher must have the ability to collaborate on experiences in using technology, facilitate learning and improve learning outcomes (Rahmadi, 2019). Based on the data above it appears that the expectations of professional teachers still cannot be fulfilled to the fullest. Further research is needed specifically on the framework and components of the TPACK for elementary school teachers. *Technology Knowledge* (TK), *Pedagogical Knowledge* (PK), and *Content Knowledge* (CK) are separate parts, although separate, between one component and the other components giving rise to slices that form the framework of *Technological Content Knowledge* (TCK), *Technological Pedagogical Knowledge* (TPK), *Pedagogical Content Knowledge* (PCK), and harmony all components namely *Technological Pedagogical Content Knowledge* (TPACK). This study aims to analyze and compare the components of the TPACK of elementary school teachers as a framework for professional teachers in the 21st century.

METHOD

The type of research used is descriptive with a quantitative approach. The study presents descriptive data in the form of numbers from each component of TPACK *Technology Knowledge* (TK), *Pedagogical Knowledge* (PK), *Content Knowledge* (CK), *Pedagogical Content Knowledge* (PCK), *Technological Content Knowledge* (TCK) *Technological Pedagogical Knowledge* (TPK) and *Technological Pedagogical Content Knowledge* (TPACK). The results of the description of the TPACK components are then compared between one component and another. Respondents in this study were students of the Elementary School Teacher Professional Program (PPG SD) in positions at Nahdlatul Ulama University Surabaya in 2020. The sample in this study was 30 elementary school teachers from various regions in East Java Province.

The instrument was developed from research by Schmidt et al., (2014) and Desstya (2018). The instrument created by Schmidt et al., (2014) was specifically designed to measure teachers' TPACK abilities. The instrument has been tested for its validity and reliability. Instruments have been widely used to measure teachers' TPACK abilities. While the instrument made by Desstya (2018) apart from having high validity and reliability, the instrument was specifically designed for teachers at the elementary school level. The instrument can be used to map the teacher's TPACK ability.

Data was collected using a closed questionnaire using a Likert scale. The questionnaire was filled in by respondents via *Google Forms*. The filling is done voluntarily and previously explained that the data provided is purely for research purposes. Filling in the instrument does not affect the PPG value and is guaranteed confidentiality. This is done so that respondents fill in honestly and the data provided is valid. Research indicators are measured using a scale: strongly agree (4), agree (3), disagree (2), and strongly disagree (1). Data were analyzed using descriptive statistics. The research test used SPSS assistance through *Analyse Descriptive Statistics*. The research is closed by drawing conclusions and suggestions for the analysis that has been done.

RESULTS

Based on Law No. 14 of 2005 it is explained that teachers are professional educators who have the task of educating, teaching, guiding, directing, training, assessing, and evaluating students (Indonesia, 2005). It should be underlined that teachers are professional educators. That is, the term teacher has various competencies attached to it which shows that the person concerned is a professional. Competencies that must be possessed by teachers include pedagogical, personality, social and professional competencies.

The learning framework in the 21st century requires professional teachers. TPACK as a basic framework for 21st-century learning is a runway for teachers to achieve learning goals. In Akhwani's research (2020) it was stated that there was no gap between TPACK and pedagogic, personality, social and professional competencies. On the contrary, TPACK is aligned with the teacher's main competence. Some similarities and slices have the same intent and purpose.

TPACK is a component framework that introduces the complex relationship between technological knowledge, pedagogy, and material content (Farikah et al., 2019). These three components have interactions and relationships with one another. The intersection between one component and another creates a new component. Mishra & Koehler (2006, 2008) provide an illustrative description of TPACK which is divided into seven knowledge domains which include 1) *Content Knowledge* (CK); 2) *Pedagogical Knowledge* (PK); 3) *Technological Knowledge* (TK); 4) *Pedagogical Content Knowledge* (PCK); 5) *Technological Content Knowledge* (TCK); 6) *Technological Pedagogical Knowledge* (TPK), and 7) *Technological Pedagogical Content Knowledge* (TPACK).

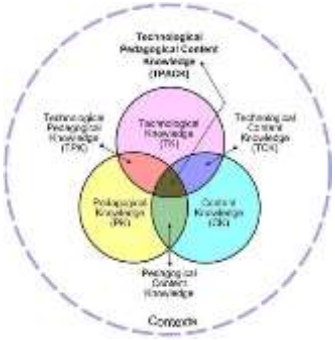

Figure 1. TPACK Component Framework

Research conducted by Baran et al., (2011) stated that TPACK is an effective tool and component that can be used to explore teachers' abilities to master technology, pedagogy, and mastery of the material in the learning. The challenges for teachers in the future will continue to increase. Professional teachers must master the TPACK components that are qualified because TPACK is in the realm of the four main teacher competencies which include personality, social, pedagogic, and professional (Nofrion et al., 2012).

To measure the ability of teachers based on the TPACK component framework, the category assignment follows the Likert scale that has been compiled by Widoyoko (Purnomo & Palupi, 2016). Scale interval criteria of 4 are used to categorize the abilities of each TPACK component.

Table 1 . TPACK Level Criteria

Interval	Kategori
1,75 < x ≤ 2,50	Sedang
2,50 < x ≤ 3,25	Baik
3,25 < x ≤ 4,00	Sangat Baik

The instrument consists of 35 questions that have been tested for validity and reliability. Each TPACK component is represented by 5 questions. With a total of 30 elementary school teachers, each respondent answered 5 questions for each component, bringing the total to 150.

Table 2. Descriptive Statistical Test

	TK	PK	CK	TCK	PCK	TPK	TPCK
NValid	150	150	150	150	150	150	150
Missing	0 3.01	0 3.00	0 2.98	0	0	0	0
Mean	25 1	.418 2	.549 2	3.00	3.13	3.14	2.94
Std. Deviation	4	4	4	.518	.482	.505	.452
Minimum				2	2	2	2
Maximum				4	4	4	4
Sum	451	450	447	450	469	471	441

Based on the results of the descriptive analysis it appears that the TPACK ability of elementary teachers from each TPACK component is. In general, there are not too many significant differences between one component and another. The difference between the teacher's ability in the fields of technology, pedagogy, and balanced material content is not too high. The *mean* for *Technological Knowledge* (TK) is 3.01; *Pedagogical Knowledge* (PK) of 3.00 and Content *Knowledge* (CK) of 2.98. The highest score of the three components is in *Technological Knowledge* (TK), with only a 0.1 difference from *Pedagogical Knowledge* (PK). This means that knowledge related to integrating technology in learning is superior to pedagogy and materials.

Component *Technological Knowledge* reveals technological knowledge that refers to low technology such as pencil and paper to digital technology such as the internet, digital-based video, software, and other digital media (Schmidt et al., 2014). The teacher's abilities revealed are related to the use of ICT in learning such as *Classroom, Google form, Sway and Zoom, Google Meet,* and others. In the Kindergarten component, the teacher's ability to use technology appears and not stutter technology. The high kindergarten component compared to other components appears to be in line with Zulfitria et al.'s research, (2020) that the effects of the Covid-19 pandemic required the use of technology and the internet in learning so teachers' skills in technology increased.

Pedagogical Knowledge (PK) refers to learning methods and processes that include planning, management, learning, development to evaluation (Mishra & Koehler, 2008). Teachers are required to have a strategy for increasing student understanding by using learning models or media. In learning the teacher also needs to understand the conditions of students and their learning styles. In the PK component, the average score that appears is 3.00. This figure is in a good category.

The content *Knowledge* (CK) component indicates knowledge related to the subject matter being taught to students. Teachers must master the material to be taught (Mishra & Koehler, 2006). In the PK component, teachers are required to be able to guide students for independent learning, teachers plan lessons, identify the material, and teach students to be able to monitor learning. Mastery of PK components is in line with the mandate of Law Number 14 of 2015 concerning Teachers and Lecturers that teachers must have professional competence. This

means that the teacher must be able to master the material in depth, master the subject competency standards, and develop the subject matter.

The results of the analysis on the components resulting from the slices of technological knowledge, pedagogy, and material content show scores that are not much different. In the *Technological Content Knowledge* (TCK) component, the average value is 3.0 or in the good category. The knowledge extracted is in the form of using appropriate technology in conveying material, and the ability of teachers to choose the right material to be integrated with ICT. In learning, teachers can use digital devices independently and use technology that can facilitate students in learning.

The combination of knowledge related to material components and pedagogy is known as *Pedagogical Content Knowledge* (PCK). The PCK component reveals the teacher's ability to develop a syllabus, create learning tools, organize interactive learning and conduct learning evaluations. The teacher's average score on the PCK component is 3.13. While the component that has the highest average score is *Technological Pedagogical Knowledge* (TPK) of 3.14 or a 0.01 point difference from the PCK component. The teacher's ability in the TPK component includes the ability to adapt technology to different learning activities, being able to think critically about using technology in class, using technology as active learning, and designing ICT-based learning for students according to learning objectives.

Different conditions arise when the three components are integrated, namely *Technological Pedagogical Content Knowledge* (TPCK). Compared to the other six components, three separate components (TK, PK, CK) and three sliced components (TPK, CPK, PCK) in the TPCK or TPACK aspects have the lowest average value, namely 2.94. TPACK refers to teachers' knowledge of content, pedagogy, and technology that is integrated into learning in any content. Teachers who master TPACK teach material using appropriate methods and technology (Schmidt et al., 2014).

Reflecting on the data from the ability analysis of each TPACK component, it appears that the TPK component is the component with the highest average with an average value of 3.14. This means that the slices of technological and pedagogical capabilities are superior to the other components. On the other hand, TPACK is in the lowest position with an average value of 2.94. This means that the teacher's ability is at a low score when the content knowledge components, pedagogy, and technology are integrated. There needs to be a strengthening of teacher knowledge to be able to have all three components in an integrated manner.

Based on Table 2. In the descriptive Statistical Test, the average value of the TPACK component ranges from 2.94 to 3.14. Concerning the categorization of Table 1. Criteria for the TPACK Level, all *Technological Knowledge* (TK) components; *Pedagogical Knowledge* (PK); content knowledge (CK); *Technological Content Knowledge* (TCK); *Pedagogical Content Knowledge* (PCK); *Technological Pedagogical Knowledge* (TPK); and *Technological Pedagogical Content Knowledge* (TPCK) are in the "Good" category.

The results of the study provide a new picture related to the analysis of the TPACK component as a whole for elementary school teachers. Comparisons between separate, sliced , and combined components of the whole component. In table 2 it is known that there are similarities in the results of the teacher's TPACK abilities which are in the good category with the research results (Ariani, 2015; Wahyuni & Pratiwi, 2019) which are in the medium category. The difference in this study is that it only uses four scales while previous studies used five scales. Research provides studies related to comparisons between TPACK components.

TPACK's research is more complete concerning the TPACK component study which analyzes the components as a whole and compares one with the other components. The TK, PK, CK aspects and the TCK, PCK, and TPK slices give different results when all components are combined in the TPCK form. The ability of teachers' TPCK needs to be strengthened again. Further research can examine TPACK more deeply including the relationship between components, besides that the relationship between TPACK and teacher competence is by the mandate of the law. Respondents with a large.

CONCLUSION

TPACK consists of a *Technological Knowledge* (TK) component; *Pedagogical Knowledge* (PK); content knowledge (CK). The components intersect and intersect to create a new component consisting of *Technological Content Knowledge* (TCK); *Pedagogical Content Knowledge* (PCK); *Technological.*

Pedagogical Knowledge (TPK). The integration of all components is called *Technological Pedagogical Content Knowledge* (TPCK) or known as TPACK. Analysis of the ability of elementary school teachers who participated in the PPG program in positions in each component was in the good category with a value range of 2.94 to 3.14. The ability of teachers in each component is relatively the same. TPACK has the lowest score among the other six components. Teachers need to improve their learning abilities, especially in the TPCK aspect. TPCK requires a balance of aspects of technological knowledge, pedagogy, and material content. It is not easy to balance these three aspects. The next researcher can complete the research by analyzing the relationship between one component and another. Besides that, it can increase the number of respondents who are more focused and specific.

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