Chemistry Teacher's Perception About Their Technology, Pedagogical, and Content Knowledge (TPACK)

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ABSTRACT
Education is currently facing the challenges of 21st-century learning. Moreover, covid-19 pandemic has caused all face-to-face learning activities in schools to be replaced with online learning. This phenomenon requires teachers to understand and have competency in technological, pedagogical and content knowledge (TPACK). The aim of this research is to describe the perceptions of TPACK high school chemistry teachers. This research was conducted on 32 chemistry teachers in the province of East Nusa Tenggara using the TPACK questionnaire instrument with seven components. TPACK perception data were analyzed using a descriptive quantitative approach, while the difference in teacher TPACK based on gender and teaching experience was analyzed using the Mann-Whitney U test with SPSS.25 because the sample was small. In accordance with the data analysis carried out states that the chemistry teacher's perception of TPACK is in the "good" category in general and the highest average score is in the PK component. The components that have a strong positive correlation are PK, TPK, TCK, and TPCK which have a significant effect on the perception of TPACK for SMA chemistry teachers. Also, based on gender and teaching experience did not have a significant effect on TPACK perception.

Keywords: TPACK, Gender, Teaching experience.

1. INTRODUCTION

Education is currently facing the challenges of 21st-century learning. The 21st - century learning paradigm requires students to have thinking and learning skills, including problem-solving skills, critical thinking, communication skills, creativity, collaboration, and mastery of science and technology. Moreover, with the covid-19 pandemic, all face-to-face learning activities in schools have been replaced with online learning. This requires teachers to be extra in preparing for the teaching and learning process.

Teaching is a dinamic activity that requires a variety of specific knowledge and skills from a teacher. Teaching activities involve aspects of the personal quality and competence of the teacher himself [1]. Teacher competence is very important in the teaching and learning process. Based on Government Regulation Number 18 of 2017 concerning teachers, the competencies that teachers must possess include pedagogical competence, personality competence, social competence, and professional competence. Of all competencies, pedagogical competence is the most important thing that must be mastered by a teacher during learning. Pedagogic competence is the teacher's ability to carry out the learning process. However, pedagogical competence cannot be separated from mastery of the material (content) because it is mutually sustainable, thus forming the concept of PCK (Pedagogical

Content Knowledge) [2]. A teacher does not only master the material and concept but must master how teaching and learning strategies can be conveyed to students properly. Besides, teachers are required to utilize technology in the process of learning, in line with the initiation of 21st-century learning. Several studies [3], [4], [5] reveal that teachers have difficulty integrating technology or software programs, especially in deciding which tools are the most appropriate to teach good and make student want to learn. Also, teachers sometimes cannot integrate technology with good in teaching and learning process due to a lack of pedagogical knowledge [6]. 21st century learning is characterized by the effective use of information and communication technology that can make students work collaboratively and solve problems [7].

In the context of learning chemistry, the difficulties experienced by students in understanding chemistry are due to chemical material which consists of abstract and complex concepts [8]. Chemical materials that are abstract and complex make chemistry learning difficult for students to understand [9]. Then, [10] stated that one of the important characters of the chemical matter is the existence of a unity that interplay between the macroscopic and microscopic levels in material content. So that this is a challenge for students and educators in understanding and teaching chemistry. Educational technology such as video, animation and simulation can help in to describing learning material [11]. Chemistry teachers who incorporate educational technology into learning can build the creation of innovative learning [12].

The description above illustrates that technology can help teachers teach chemical concepts. This results in the development of teacher knowledge. Teachers do not only have pedagogical and content knowledge, but also technological knowledge that can be integrated into chemistry learning. The teacher's knowledge framework that involves TPC is known as technological pedagogical and content knowledge [13], [14], [15]. The TPACK shows that content knowledge that is integrated into technology and pedagogical skills are an important condition in creating effective and innovative classroom teaching using technology. TPACK is a sound teaching foundation with technology and needs an understanding of conceptual representation with technology, pedagogical ability that use technology in a constructively way to interpret the material,

knowledge of what makes concepts difficult or easy to know, and in various ways technology can help fix something problems faced by students in learning [16], [17], [18]. Therefore, along with the development of 21st-century skills, we need to know the abilities of teachers through descriptions of TPACK.
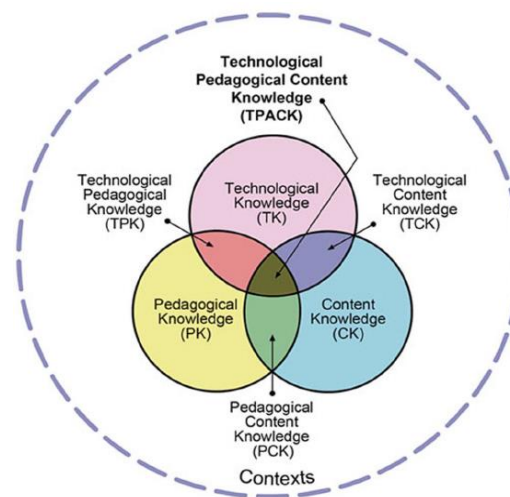

Figure 1 7 Components of TPACK

In Figure 1, it is clear that TPACK consists of three knowledge domains, namely technological knowledge, pedagogy, and content. Besides, there are interactions from each domain, namely technology and pedagogy, technology and content, and pedagogy and content. The three domains also interact with each other and form the TPCK. Thus there are 7 components of TPACK. Each component describes the knowledge that teachers must have in creating effective and innovative learning.

The rapid development of 21st -century technology and can be integrated into classroom learning has made technology one of the domains of knowledge that teachers are must-have. Thus the teacher does not only think about the pedagogy and chemical content taught in the classroom, but also how to apply technology so that effective and efficient learning can be realized to achieve the set learning objectives. Therefore, it is necessary to have an understanding of how teachers perceive their knowledge. TPACK is a knowledge framework that combines technology, pedagogy, and content which is deemed appropriate to assess teachers' perceptions of their knowledge.

Table 1. Descriptions of components in TPACK

Components	Description
TK	The knowledge and skills that include technological knowledge, in this case information processing, communication and problem solving using technology.
CK	The knowledge that must be possessed by a teacher regarding the theory and concept of a subject matter that will be taught to students.
PK	A collection of knowledge about teaching and learning in this case is closely related to learning methods, classroom management, learning design, student assessment, etc.
TCK	Information on the connection between the topic and the innovation used in learning.
TPK	The information on how innovation from a technology can be applied in learning activities.
PCK	The combination of learning materials with pedagogical knowledge.
TPCK	The blending of undestaning of content, pedagogy and technology.

2. RESEARCH METHODS

This research uses a descriptive quantitative approach to describe the chemistry teachers' perceptions of their knowledge seen from TPACK framework. Respondents in this study were 32 chemistry teachers in East Nusa Tenggara Province (10 male and 22 female). The sample selection was done by using the purposive sampling technique. The data collection process was carried out online using a google form containing a TPACK questionnaire and distributed through the Whatsaap group to chemistry teachers as respondents. Analysis of teacher perceptions of TPACK using the TPACK questionnaire. Overall the questionnaire consisted of 45 statement items covering the 7 TPACK sub-domains. Details of the distribution of statement items, namely 6 TK items, 16 PK items, 2 CK items, 6 TPK items, 2 TCK items, 9 PCK items, and 4 TPCK items. The instrument uses 5 Likert scales consisting of; 1) strongly disagree; 2) disagree; 3) hesitated; 4) agree, and 5) strongly agree. All instrument items have been tested for validity and reliability. The validity test used the pearson product moment correlation with all valid results. While reliability was tested using cronbach's alpha with a result of 0.933. Meanwhile, the analysis used to determine whether there is a different in the TPACK of teachers based on gender and teaching experience is the Mann Whitney U test with SPSS.25 because the sample small.

3. RESULT AND DISCUSSION

3.1. Chemistry Teacher's Perception of TPACK

In this research, the identification and description of the TPACK Chemistry teachers perceptions on the TPACK framework was conducted. The results of this study can be shown in table 2.

Table 2. Results of descriptive statistics for all components

Components of TPACK	Mean	Standard Deviation	Category
TK	3.79	0.901	Good
PK	4.035	0.667	Good
CK	3.89	0.758	Good
TPK	3.985	0.536	Good
TCK	3.875	0.454	Good
PCK	3.96	0.558	Good
TPCK	3.95	0.544	Good

As shown in the table and using a likert scale category is seen that the value of the mean for all the components with the most number of "agree" options on the scale. This score also means that the chemistry teacher feels that he or she has a "good" TPACK level in general. It can also be seen that chemistry teachers in East Nusa Tenggara have the highest total average in the PK component of 4.035, meaning that chemistry teachers have a good understanding of how to learn and carry out learning in the classroom which includes everything related to planning, process, and evaluation learning. Meanwhile, for the other components, namely TPK, PCK, TPCK, TCK and TK respectively the average value was 3.985; 3.96; 3.95; 3.89; 3.875 and 3.79.

TPACK development depends on many factors, including experience in using the right technology in the learning process [19]. TPACK improvement also relies on the learning environment to increase competence in integrating technology [20], [21], [22].

Therefore, the overall level of understanding of the TPACK Chemistry teacher still needs to be improved to produce integrated and effective technology, pedagogy, and learning content.

It is indicated that there is a result relationship between TPACK components. This is known from the correlation analysis formed between TPACK components can shown in Figure 2, at a significant level of 0.05. There is a strong positive correlation, namely PK is correlated with PCK (r = 0.602), TCK (r = 0.620), PCK (r = 0.650), TPCK (r = 0.514), CK is correlated with PCK (r = 0.675), PCK is correlated with TPCK (r = 0,529), TCK correlated with TPCK (r = 0.559), TPK correlated with TCK (r = 0.521), TPK correlated with PCK (r = 0.545), and TPCK (r = 0.644). While an association of positive correlation moderate namely TK correlated with PK (r = 0.381), CK (r = 0.386), and TPK (r = 0.473), PK correlated with CK (0.487), CK correlated with TCK (0.367), TPK (r = 0.223), and TPCK (r = 0.260), TCK

correlates with PCK (0.434), TK correlates with TCK (r = 0.230). Meanwhile, others have a weak correlation.

Thus in this study, the components that had the most significant influence on the development of TPACK in chemistry teachers were PK, TPK, TCK, and TPCK. This is in line with research [23] where PK is the most influential component. The results of this study are also in line with the results of research conducted [24], where the connection between TPK and TPCK, and TCK and TPCK has a significant connection.

Based on the research results, it can be said that the development of TPACK cannot be seen separately from PK, CK, and TK. [25] stated that understanding of TPACK differs from CK, PK and TK when understood separately. Therefore, the development of TPACK for teachers should be done ceaselessly and not separately but in a unity.

Correlations		TK	PK	CK	TPK	TCK	PCK	TPCK
TK	Pearson Correlation	1	,456**	,387*	,506**	,270	,376*	,359*
	Sig. (2-tailed)		,009	,029	,003	,135	,034	,044
	N		32	32	32	32	32	32
PK	Pearson Correlation		1	,464**	,546**	,563**	,523**	,466**
	Sig. (2-tailed)			,008	,001	,001	,002	,007
	N			32	32	32	32	32
CK	Pearson Correlation			1	,075	,313	,511**	,213
	Sig. (2-tailed)				,682	,081	,003	,241
	N				32	32	32	32
TPK	Pearson Correlation				1	,444*	,425*	,612**
	Sig. (2-tailed)					,011	,015	,000
	N					32	32	32
TCK	Pearson Correlation					1	,323	,467**
	Sig. (2-tailed)						,071	,007
	N						32	32
PCK	Pearson Correlation						1	,517**
	Sig. (2-tailed)							,002
	N							32
TPCK	Pearson Correlation							1
	Sig. (2-tailed)							
	N							

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Figure 2 Correlation results between TPACK components

3.2. Chemistry Teacher's Perception of TPACK by Gender

Teacher's TPACK perceptions of 7 components by gender were analyzed using the Mann Whitney U test with SPSS.25. Table 3 show the results of the analysis. The results seems that there is no significant difference

in gender on the components of TK, PK, CK, TCK, PCK, TPK, and TPCK. This result is by following under the research that in the development of TPACK between male and female teachers there is no significant difference [26]. Other studies have also stated that there is no significant impact of gender on TPACK [27].

Table 3. Descriptive statistics of TPACK in terms of gender

Components	Male		Female		U	P	Result
	Mean Rank	Sum of Ranks	Mean Rank	Sum of Ranks			
TK	20.55	205.50	14.66	322.50	69.50	0.098	No diference
PK	14.70	147.00	17.32	381.00	92.00	0.463	No diference
CK	17.00	170.00	16.27	358.00	105.00	0.829	No diference
TPK	18.60	186, 00	15.55	342.00	89.00	0.367	No diference
TCK	16.15	161.50	16.66	366.50	106.50	0.869	No diference
PCK	16.85	168.50	16.34	359.50	106.50	0.886	No diference
TPCK	16.05	160.50	16.70	367.50	105.50	0.845	No diference

3.3. Perceptions of TPACK Based On the Experience of Teaching

Teachers' perceptions of TPACK can also be seen from the teacher's teaching experience. The results of the analysis using Mann Whitney U test according to SPSS.25 were carried out to compare teachers' TPACK perceptions of 7 components can be seen in table 4. The results showed that teachers who have teaching experience more than equals 3 years and less than 3 years did not have a significant difference in the perception of TPACK. Similar research also states that teaching experience does not affect TPACK perceptions [28]. Another study said that expert teachers have a high level of experience and professionalism compared to new teachers who tend to be less confident with their abilities and understanding that have just been formed in a short time in teaching [29]. In other words, the more years a teacher has taught, the teacher's knowledge and skills in planning, implementing, managing, and evaluating teaching and learning activities will also increase.

Table 4. Descriptive statistics for total scores of TPACK in terms of the experience of teaching

Components	< 3 years		≥ 3 years		U	P	Result
	Mean rank	Sum of Ranks	Mean rank	Sum of Ranks			
TK	17.00	323.0	15.77	205.0	114.00	0.714	No diference
PK	15.74	299.0	17.62	229.0	109.00	0.577	No diference
CK	19.03	361.50	12.81	166.50	75.50	0.050	No diference
TPK	15.84	301.0	17.46	227.00	111.00	0.612	No diference
TCK	17.76	337.50	14.65	190.50	99.50	0.286	No diference
PCK	16.68	317.00	16.23	211.00	120.00	0.892	No diference
TPCK	16.66	316.50	16.27	211.50	120.500	0.902	No diference

4. CONCLUSION

In the research results obtained, it can be stated that the level of ability of chemistry teachers in East Nusa Tenggara province is in the good category in general and has the highest average score on the PK component, meaning that chemistry teachers have a good understanding of how to learn and implement learning in classrooms includes everything related to planning, process, and evaluation of learning. The components that have a strong positive correlation are PK, TPK, TCK, and TPCK which have a significant effect on the perception of TPACK for SMA chemistry teachers. Besides, based on gender and length of teaching did not have a significant effect on TPACK perception. The implication or recommendations of the results of this study can be further elaborated.

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