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The Analysis of In-Service Teachers' Practices of Implementing Technological Pedagogical Content Knowledge (TPACK)

Imelda P. Soko and Damianus D. Samo

ABSTRACT

Generally this study aims to analyze quantitatively and qualitatively the level of TPACK for teacher students and various factors that influence teachers' TPACK. This study utilized quantitative approach with the help of survey method. The results showed that the teachers' TPACK level was at a poor (1.7%), good (59.3%), and very good level (39.9%). There are four TPACK components that are at the perception level and three components are at the conception level. Correspondingly, three significant differences found in the average of: (a) Teachers' TPACK between each study groups, (b) Teachers' TPACK between each group of teachers with different teaching experiences, and (c) Teachers' TPACK between each group of teachers with different training experiences. In short, both teaching and training experience are able to distinguish teachers' TPACK and have a positive influence on teachers' TPACK. Further research is needed by considering the importance of learning experience and the educational stakeholders should ensure that teacher professional developments are applicative TPACK programs.

Keywords: in-service teacher, teaching experience, technology integration, tpack.

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I. INTRODUCTION

The most prominent advance in education in the last decade is advance in education in the last decade is the integration of technology (Lee & Tsai, 2010). Instructional technology tools such as computers, data collection and analysis software, digital microscopes, hypermedia/ multimedia, and interactive smart boards help students understand the nature of Science and research, and acquire scientific knowledge. Using these tools in classrooms also effectively and appropriately develops students' active participation in the process of generating information, thinking, and learning problem solving skills (Guzey & Roehrig, 2009). Although opportunities to access technology have increased, classroom teaching practices have not shown the expected level of improvement (Inan & Lowther, 2009; Chai *et al.*, 2013). Research findings indicate that pre-service and novice teachers use technology in an inadequate way (Tondeur *et al.*, 2012). Studies related to technology use reveal that teachers have a lack of knowledge about how they can effectively integrate technology into education, and their efforts are limited in terms of content, variety, and depth (Koehler *et al.*, 2014). It is important to link subject-specific technology and pedagogical principles to use technology effectively in the classroom. Starting from this point of view, Mishra and Koehler (2006) extend Shulman's notion of pedagogical content knowledge (PCK) by adding technology to PCK and developing the TPACK framework.

TPACK is a useful framework for researchers to comprehend the integration of technology in learning and teaching. Building on Shulman's (1986) ideas of PCK, Mishra and Koehler (2006) added technology into PCK and described the resulting TPCK as an interweaving of technology, pedagogy, and content. TPACK is a framework that focuses on the complex interaction between teachers' content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK). The combination of technology with pedagogy in a given subject area must take into account dynamic intersections such as technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), and technological content knowledge (TCK). Roblyer and Doering (2013) emphasize the dynamic nature of TPACK as a representation of teacher knowledge that develops and varies (not static), when new technologies emerge to be integrated into specific content areas. Angeli and Valanides (2009) provide two important insights; first, they believe that the use of the word technology is misleading, repeating it as Information and Communication Technology (ICT), and second, they represent TPACK as 'a tool used by its users to reconstruct subject matter from teacher knowledge into teaching content'. They suggest that the development of one or more of its knowledge bases does not guarantee and does not imply the concurrent development of ICT-TPCK. Conceivably, the use of 'technology pedagogical content knowledge' was purposeful in highlighting TPACK as an extension of PCK with the addition of intersection of the technology domain with the

PCK intersection of content and pedagogy (Niess, 2005).

TPACK has been developed and has become a demand for modern learning activities. This knowledge has been provided in the learning process of prospective teachers in separate content. Universitas Terbuka as one of state university that graduates teachers through distance learning open university, has actively provided PCK teachers, especially access to the use of technology that supports teacher TPACK. As the only distance learning open university in Indonesia, Universitas Terbuka required its students to do self-directly learning. In order to meet this mission, Universitas Terbuka provide teaching materials designed to be self-guided learning; in print and digital learning materials, audio/video programs, as well as face to face, online, webinar, radio, and television tutorials. Those support services should be able to motivate students' self-directed learning and TPACK as well. Challengingly, ongoing deviances and issues are arisen with the attempt to engage teachers in TPACK strategic thinking as they plan, implement, and evaluate their teaching with new and emerging technologies. All works should be considered to the way teachers plan and apply their knowledge. The educational studies must truly reflect the intersection of technology, pedagogy, and content-pedagogy of technology and content knowledge or TPACK in the midst of quality teaching and learning in the 21st century, where information and communication technologies are becoming increasingly accessible and assessed for educational goals. This study aims to analyze and determine the TPACK level of student teachers and various factors that influence teachers' TPACK; differences in study groups, teaching, and training experiences.

II. Research Method

This research is a quantitative research with survey method. It is directed to answer the question of how the TPACK of teacher students of Teacher Training and Education Faculty of Kupang Regional Center and designed to reveal teachers' TPACK of as important information for the purpose of improvement and development in learning process. There are several reasons underlying the use of a quantitative approach with survey methods, including; (a) This study seeks to reveal the TPACK level of student teachers which is an actual thing that is important in the era of the industrial revolution 4.0, (b) A quantitative approach with a survey method can provide detailed answers about the background, characteristics, and characteristics that are typical of teachers' TPACK level Kupang region students spread across 43 study groups.

The instruments used in this study were (a) The TPACK instrument, (b) Research sample biodata, (c) Interview guidelines, and (d) Observation guidelines. The TPACK instrument is an adaptation of the TPACK instrument developed by Pamuk *et al*. (2013). The validity test of the instrument used the Product Moment correlation formula. The output of the instrument reliability test with the reliability value of the Cronbach's Alpha statement is 0.670. This value is compared with the R table value at degrees of freedom (df)=n-2 (n is the number of samples) and a probability value of 0.05. The df value in this test is the number of samples (50-2)=48, so based on the R table value on df (48) and the probability of 0.05 is 0.284. Cronbach's Alpha value is 0.670>R table 0.468, so the overall statement item is reliable. Furthermore, the relationship between data collection techniques and research instruments can be seen in Table I.

TABLE I: Relationship Between Data Collection Techniques and TPACK Research Instruments

Measured Aspect	Sources & Data Collection Techniques	Research Instruments
TPACK level	Student teachers Test	TPACK instruments
Research sample biodata	Student teachers Documentation	Sample biodata
Conformity between learning planning & implementation	Student teachers and students Interview and observation	Interview and observation guidelines

The data analysis is divided into 3 parts; (a) TPACK leveling analysis for the TPACK components, (b) One-way ANOVA and two-way ANOVA, and Kruskall-Wallis to test the average difference between each study group, teaching experience and experience following education and training, (c) Multiple linear regressions test the influence between teaching experience and experience participating in training activities on TPACK. The quantitative level of teacher TPACK uses Likert's Summated Rating.

III. Results and Discussions

The findings are sorted by research objectives or research hypotheses. The results do not display the same data in two forms, namely tables/images/graphics and narration. There is no quote in the results section. The level of teachers' TPACK based on the survey results analyzed by Likert's Summated Rating is presented in Table II.

TABLE II: TPACK Knowledge Level

TPACK Level	Quartile Range	TPACK score
Very Good	Quartile 3 x Maximum Score	201.5–248
Good	Median x<Quartile 3	155–201.5
Poor	Quartile 1 x<Median	108.5–155
Very poor	Minimum Score x<Quartile 1	61–108.5

Data on student teachers' TPACK level are 2 teachers (1.7%) are in poor category, 178 teachers (59.3%) are in good category, and 117 teachers (39.9 %) are in very good category. The teachers' TPACK level is presented in Fig. 1.

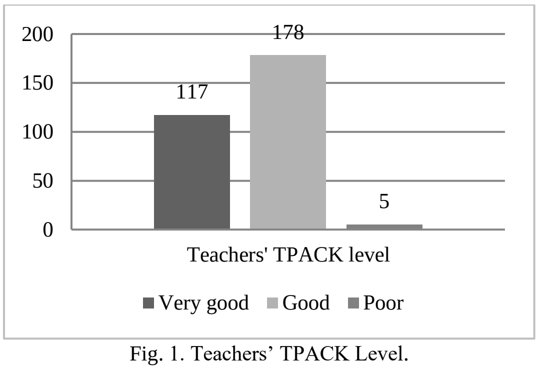

Fig. 1. Teachers' TPACK Level.

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The next analysis is to find out the level of each TPACK components, TK, PK, and CK. The level of teachers' TK is presented in Table III.

TABLE III: TECHNOLOGICAL KNOWLEDGE (TK) LEVEL

TPACK Level	Quartile Range	TK score
Very Good	Quartile 3 x Maximum Score	22.75–28
Good	Median x<Quartile 3	17.5–22.75
Poor	Quartile 1 x<Median	12.25–17.5
Very poor	Minimum Score x<Quartile 1	7–12.25

The data on teachers' TK level are 123 teachers (55%) are in very good category, 177 teachers (38.2%) in good category. The teachers' TK level is presented in Fig. 2.

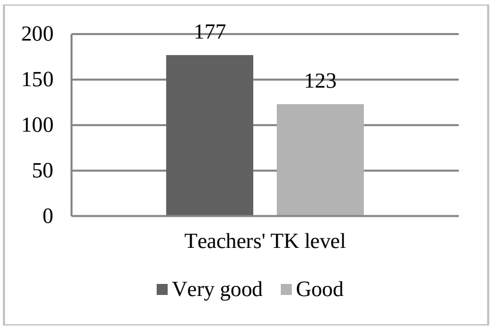

Fig. 2. Teachers' Technological Knowledge Level.

The teachers' content knowledge (CK) level based on the survey results analyzed by Likert's Summated Rating is presented in Table IV.

TABLE IV: CONTENT KNOWLEDGE (CK) LEVEL

TPACK Level	Quartile Range	CK score
Very Good	Quartile 3 x Maximum Score	26–32
Good	Median x<Quartile 3	20–26
Poor	Quartile 1 x<Median	14–20
Very poor	Minimum Score x<Quartile 1	8–14

The data on teachers' CK level are 195 teachers (59.3%) are in very good category, 105 teachers (39.9%) are in good category. The teachers' CK level is presented in Fig. 3.

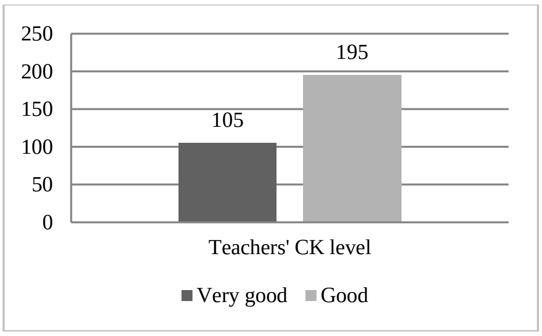

Fig. 3. Teachers' CK Level.

The level of teachers' pedagogical knowledge (PK) based on the survey results analyzed by Likert's Summated Rating is presented in Table V.

The data on the level of teachers' PK were at a good level of 154 people (51.3%) and very good as many as 146 people (48.6%). The teacher PK level is presented in Fig. 4.

TABLE V: PEDAGOGICAL KNOWLEDGE (PK) LEVEL

TPACK Level	Quartile Range	PK score
Very Good	Quartile 3 x Maximum Score	26–32
Good	Median x<Quartile 3	20–26
Poor	Quartile 1 x<Median	14–20
Very poor	Minimum Score x<Quartile 1	8–14

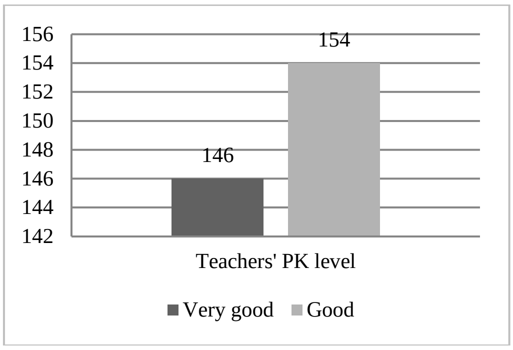

Fig. 4. Teachers' PK Level.

The teachers' TPK level based on the survey results analyzed by Likert's Summated Rating is presented in Table VI.

TABLE VI: TPK LEVEL

TPACK Level	Quartile Range	TPK score
Very Good	Quartile 3 x Maximum Score	37.5–44
Good	Median x<Quartile 3	27.5–35.75
Poor	Quartile 1 x<Median	19.25–27.5
Very poor	Minimum Score x<Quartile 1	11–19.25

The data on the teachers' TPK level are 79 teachers (24.5%) are in very good category and 221 teachers (68.6%) are in good category. The teachers' TPK level is presented in Fig. 5.

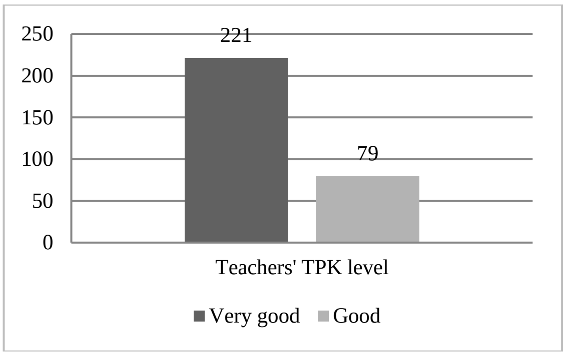

Fig. 5. Teachers' TPK Level.

The teachers' TCK level based on the survey results analyzed with Likert's Summated Rating is presented in Table VII.

TABLE VII: TCK LEVEL

TPACK Level	Quartile Range	TCK score
Very Good	Quartile 3 x Maximum Score	22.75–28
Good	Median x<Quartile 3	17.5–22.75
Poor	Quartile 1 x<Median	12.25–17.5
Very poor	Minimum Score x<Quartile 1	7–12.25

The data on teachers' TCK level are 79 people (24.5%) very good category and 221 teachers (68.6%) in good category. The teachers' TCK level is presented in Fig. 6.

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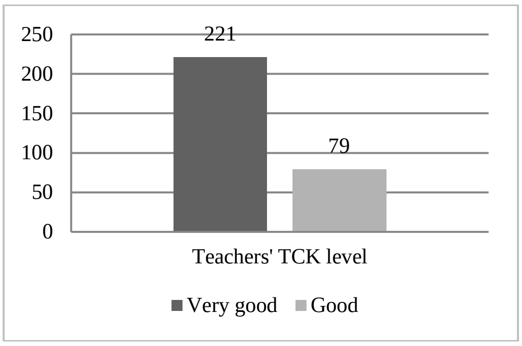

Fig. 6. Teachers' TCK Level.

The teachers' PCK level based on the survey results analyzed by Likert's Summated Rating can be seen in Table VIII.

TABLE VIII: PCK LEVEL

TPACK Level	Quartile Range	PCK score
Very Good	Quartile 3 x Maximum Score	37.5–44
Good	Median x<Quartile 3	27.5–35.75
Poor	Quartile 1 x<Median	19.25–27.5
Very poor	Minimum Score x<Quartile 1	11–19.25

The teachers' PCK level were at a good level of 46 people (14.3%) and very good at 254 people (78.9%). The teacher's PCK level is presented in Fig. 7.

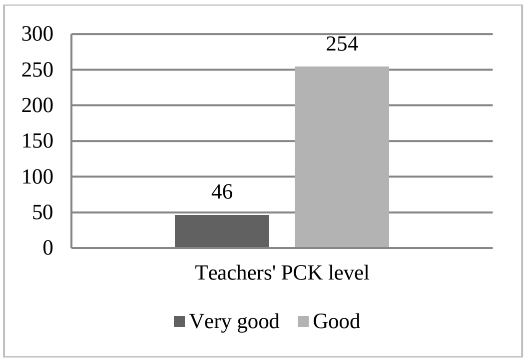

Fig. 7. Teachers' PCK Level.

A. Qualitative Leveling

The TPACK instrument consists of 7 components with varying number of items. The results of the TPACK survey for student teachers with 4 answer options (strongly agree, agree, disagree, and strongly disagree) were grouped into two large groups namely agree which includes the agree category and strongly agree and disagree which includes the disagree category and strongly disagree. The results are presented in Table IX.

TABLE IX: CATEGORIZATION OF TPACK COMPONENT LEVELS

Component	No item	(%)		Level
TK	1-7	26.33	73.67	Pn
CK	8-15	47	53	Pn
PK	16-23	69	31	Cn
PCK	24-34	52.67	47.33	Cn
TPK	35-44	33.67	66.33	Pn
TCK	45-52	54.33	45.67	Cn
TPACK	53-62	48	52	Pn

Based on Table IX, there are four TPACK components that are at the Pn level, and three components are at the Cn level. Thus, it can be concluded that the participants' TPACK ability is in the perception category (Pn). Participants have a perception towards the alignment of the TPACK component because participants are able to identify content difficulties, feel the need for content transformation and are able to identify teaching methods that are appropriate to the use of technology. However, participants were unable to explain how to use technology to change content and support student learning.

B. Teachers' TPACK differences

The next analysis is to examine the differences in the average teachers' TPACK by reviewing the differences in study groups, teaching experience, and experience following the training. This provides an illustration of how the different conditions of the teacher affect the teacher's TPACK. Descriptive statistics on the average TPACK knowledge of teachers based on differences in study groups are presented in Table X.

TABLE X: TPACK DESCRIPTIVE STATISTICS BY STUDY GROUP

Study groups	N	Mean	Std. Dev
A	25	194.28	13.20
B	25	210.44	9.35
C	25	198.04	4.87
D	25	195.88	3.54
E	25	194.64	8.09
F	25	199.80	8.64
G	25	196.24	6.80
H	25	194.44	7.91
I	25	196.80	6.18
J	25	186.16	21.73
K	25	197.12	7.40
L	25	195.60	8.05
Valid N (listwise)	25		

The descriptive data in Table X illustrates that the average of teachers' TPACK is not significantly different. The highest average is in study group B, which is 210.44, while the lowest is in study group J, which is 186.16. Furthermore, it will be tested the difference in the average teachers' TPACK based on differences in study groups by first testing the normality of the TPACK data for each study group. With the criteria, if the probability (sig.)>0.05 then H_0 is accepted, meaning that the sample comes from a normally distributed population. Two groups of data were obtained that were not normally distributed. Because there are two groups of data that are not normally distributed, the analysis of the difference in the mean of the twelve data groups uses the Kruskall-Wallis test.

The tested hypotheses are:

H_0 : There is no significant difference in the average of teachers' TPACK between each study group.

H_1 : There is a significant difference in the average teachers' TPACK between each study group.

Or in statistical hypothesis:

$$H_0 : \mu_1 = \mu_2 = \mu_3 = ... = \mu_{12} \quad (1)$$

H_1: not all μ_i equal, i = 1,2,3, …, 12

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With the criteria if $\chi^2_{count} > \chi^2_{\alpha;K-1}$ then H_0 is rejected or if the probability value (sig.)<0.05 then H_0 is rejected. The results of hypothesis testing are presented in Table XI.

TABLE XI: TEST OF DIFFERENCES IN TEACHERS' TPACK AVERAGE BASED ON STUDY GROUPS
Test Statistics, b

	TPACK value
Chi-Square	57,536
df	11
asymp. Sig.	0.000

a. Kruskal Wallis Test
b. Grouping Variable: Study groups

Based on Table XI, the value of count=57,536 and value=5.99. Because value count>then H_0 is rejected or based on the probability value, the probability value (sig) is obtained.<0.05 so H_0 is rejected, which means that there is a significant difference in the average teacher TPACK between each study groups.

Furthermore, testing the average difference in teachers' TPACK with a review of teaching experience is based on the length of time teaching with an ordinal data scale based on three categories, namely under five years (level 1), between 5–10 years (level 2) and above 10 years (level 3). Testing the difference in teachers' TPACK based on their teaching experience using the Kruskall-Wallis test.
The tested hypotheses are:

H_0 : There is no significant difference in the average of teachers' TPACK between the three groups of teaching experiences.
H_1 : There is a significant difference in the average teacher TPACK between the three groups of teaching experiences.

With the criteria if $\chi^2_{count} > \chi^2_{\alpha;K-1}$ then H_0 is rejected or if the probability value (sig.)<0.05 then H_0 is rejected. The result of hypothesis testing is presented in Table XII.

TABLE XII: TEST OF DIFFERENCES IN TEACHERS' TPACK BASED ON TEACHING EXPERIENCES
Test Statistics, b

	TPACK value
Chi-Square	207,743
df	2
asymp. Sig.	0.000

a. Kruskal Wallis Test
b. Grouping Variable: Teaching_experience

Based on the results of statistical tests, the value of count=207.743 and value=5.99. Because value count>then H_0 is rejected or based on the probability value, which means that there is a significant difference in the average teachers' TPACK between each group of teachers with different teaching experiences.

The next test is the teachers' TPACK difference test with training experience with an ordinal data scale based on three categories; 1–3 times (level 1), 4–5 times (level 2) and more than 5 times (level 1). Testing the difference in TPACK based on experience following the training using the Kruskall-Wallis test.

The tested hypotheses are:

H_0 : There is no significant difference in the average teacher TPACK between the three groups of experience following the training.
H_1 : There is a significant difference in the average teacher TPACK between the three groups of experience following the training.

Or in statistical hypothesis:

$$H_0 : \mu_1 = \mu_2 = \mu_3 \qquad (2)$$

H_1: not all μ_i equal, i=1,2,3

With the criteria if count>then H_0 is rejected or if the probability value (sig.)<0.05 then H_0 is rejected. The result of hypothesis testing is presented in Table XIII.

TABLE 13: TESTING TEACHERS' TPACK BASED ON TRAINING EXPERIENCE
Test Statistics, b

	TPACK value
Chi-Square	215,613
df	2
asymp. Sig.	.000

a. Kruskal Wallis Test
b. Grouping Variable: Training experiences

Based on the results of statistical tests, the value of χ^2 count=215.613 and value $\chi^2_{0.05;2}$ =5.99. Because value χ^2 count> $\chi^2_{0.05;2}$ then H_0 is rejected or based on the probability value, the probability value (sig) is obtained.<0.05 so H_0 is rejected, which means that there is a significant difference in the average teacher TPACK between each group of teachers with different training experiences.

C. The Effect of Teaching and Training Experience on Teachers' TPACK

The next analysis is to examine the effect of teaching experience and experience following training activities on teachers' TPACK. This analysis uses simple linear regression analysis and multiple linear regressions which begins with the analysis prerequisite test. The test results that will be displayed consist of a correlation test of teaching experience and experience following training on teachers' TPACK, testing the effect of teaching experience and training experience on teacher TPACK, as well as testing the significance of the regression value. The results of the correlation test of teaching experience and experience following training on teacher TPACK are presented in Table XIV.

Table XIV shows that the correlation value between teaching experience and teachers' TPACK is 0.685 or moderate correlation, while the correlation value between training experience and teachers' TPACK is 0.644 or in moderate correlation. The significance value for the relationship between each independent variable and the dependent variable is 0.00<0.05. This indicates that H_0 is rejected, which means that there is a significant correlation between teaching experience and teachers' TPACK and there is a significant correlation with training experience and teachers' TPACK.

TABLE XIV: CORRELATION TEST OF TEACHING AND TRAINING EXPERIENCE ON TEACHERS' TPACK

Correlations				
		TPACK value	Teaching experience	Training experience
Pearson	TPACK value	1,000	0.685	0.644
	Teaching experiences	0.685	1,000	0.841
	Training experiences	0.644	0.841	1,000
Sig.	TPACK value	.	0.000	0.000
	Teaching experience	0.000	0	0.000
	Training experiences	.000	.000	.
N	TPACK value	300	300	300
	Teaching experience	300	300	300
	Training experiences	300	300	300

The results of the test output for the effect of teaching and training experience on teachers' TPACK are presented in Table XV.

TABLE XV: TPACK TESTING THE EFFECT OF TEACHING AND TRAINING EXPERIENCE ON TEACHERS' TPACK

Model	T	Sig.
(Constant)	176,15	0
Teaching experience	-16,22	0
(Constant)	169,66	0
Training experience	-14,54	0
(Constant)	174.44	0
Teaching experience	-6,34	0
Training experience	-3.04	0.003

Based on Table XV, the regression model for teaching experience on teachers' TPACK is Y=9,879X1+214,913 which shows that teaching experience has a positive effect on teachers' TPACK. The regression model of the training experience on the teachers' TPACK is Y=8,268X2+213,486 which shows that the training experience has a positive effect on the teachers' TPACK. The regression model of teaching and training experience on teachers' TPACK is Y=7,033X1+3.005X2+215,785 which shows that teaching and training experience have a positive effect on teachers' TPACK.

Furthermore, the results of the significance test of the effect of teaching and training experience on teachers' TPACK are presented in Table XVI.

TABLE XVI: SIGNIFICANCE TEST OF REGRESSION VALUE

Model	df	F	Sig.
Regression	1	263.118	0.000b
Residual	298		
Total	299		
Regression	1	211.532	0.000bc
Residual	298		
Total	299		
Regression	2	139,855	0.000d
Residual	297		
Total	299		

a. Dependent Variable: TPACK value
b. Predictors: (Constant), Teaching experience
c. Predictors: (Constant), Training experience
d. Predictors: (Constant), Teaching experience, training experience

Based on the output of the regression value significance test, it is known that the significance value is 0.00<0.05, then H_0 rejected which means:

1) There is a significant effect of teaching experience on the student teachers' TPACK.
2) There is a significant effect of the training experience on the student teachers' TPACK.
3) There is a significant effect of teaching and training experience on the student teachers' TPACK.

Based on the results of triangulation of the TPACK instrument, observation of learning activities, and interviews, it is known that the experience of participating in tutorial webinars, assigning assignments, and conducting end-of-semester exams with take home examination (THE) scheme have contributed significantly to the improvement of TPACK and the use of technology in class.

Regarding technological knowledge, teachers who participate in webinar tutorial activities as Universitas Terbuka students have knowledge of developing learning activities using technology, such as computers and gadgets. Most teachers, especially senior teachers, have problems using technology due to limited facilities and abilities, but teachers find solutions by asking for help from other parties while still based on instructions and directions from the teacher. This finding is aligned with existing studies (Celik *et al*., 2014; Pamuk *et al*., 2015) that having sufficient knowledge of technology is necessary for teachers in order to enhance their technological content knowledge, which then affects teachers' TPACK. In general, student teachers already have knowledge of several types of technology that they or the school have for various purposes, such as communication, searching for teaching materials, accessing the internet, and so on. But unfortunately most teachers only use technology at school or in their working hours. Since 88% of the research subjects were elementary school teachers who acted as classroom teachers, most of the teachers had a fairly good knowledge of explaining the relationships between concepts in the subjects they taught. The subjects in elementary school are thematic learning and the teacher recognizes the characteristics of elementary school students who are starting to show conservation abilities (number, area, volume, orientation) and cannot think abstractly. There are topics that really need to be taught using concrete objects but there are certain topics that need to use technology-based learning media such as heat transfer; the difference between land breezes and sea breezes, the solar system, or anti-bullying which should not be taught by the indoctrination method. Teachers tend to obey the rules of sequences or sequences of topics because teachers think that things related to the curriculum cannot be changed at all, even though one of the goals of mastering content knowledge is that if necessary and important, teachers can modify the sequence or sequence of topics of learning activities. An example of a case in this study is when the teacher is going to teach the topic about vectors, it turns out that most students still experience misconceptions about quantities and units, so teachers need to modify the sequence of learning activities to overcome these problems.

Teachers must realize that TPACK is not just adding or presenting technology in the classroom, but integrating technology completely and appropriately with content and pedagogical knowledge. Planning learning activities for any subject as part of TPACK, is a very complex cognitive activity because teachers must apply knowledge from several domains (Leinhardt & Greeno, 1986; Resnick, 1987; Magnusson *et al.*, 1999). The teacher's ability to design lesson plans is a combination of the teacher's experience in carrying out learning activities, knowledge, and experience gained in the training courses that have been passed. These activities make it easier for teachers to design lesson plans that characterize TPACK. Based on the results of interviews with several teachers, it was found that teachers with little teaching experience need and can learn to design and implement learning activities from senior teachers or experienced teachers (Buaraphan *et al*., 2007; Loughran *et al*., 2008; Etkina, 2010; Hume & Berries, 2011). This is in line with the opinion of Abell (2008), that the TPACK research leads us to correctly understand the type of knowledge experienced teachers use when they plan and implement teaching in preparing or developing teacher professionals.

Regarding the use of ICT, a series of training activities, especially in developing lesson plans and peer teaching, teachers use culture-based learning media so that the application of ICT in the form of computer-based learning media is only used by a small number of teachers in the form of powerpoint presentations. This finding is in line with the results of research by Nguyen *et al*. (2012), that the most developed ICT trend is the use of powerpoint, software, photos or images, and other ICT tools, which are able to simulate and visualize physics phenomena and experiments to help students learn. Most teachers use ICT in learning activities to involve students in learning, seek information, support group work, group discussions, and build student knowledge.

The qualitative level of the teachers' TPACK of Kupang region belongs to the perception level category, which means that the teacher already has a perception towards the alignment of the TPACK component, but the teacher cannot explain and demonstrate in classroom teaching practice how to use technology to change content and support the student learning process. This is in line with the results of research that seeks to reveal the TPACK of elementary school science teachers (Küçükaydin & Sağir, 2016) with an inquiry approach which shows that knowledge of subject matter and teacher TPACK is low. Teachers cannot fully assess the importance of teaching certain ideas/concepts which result in the teacher's low TPACK, even though knowledge of subject matter should be the basis for developing teacher TPACK (Thompson & Schmidt, 2010). This results in teachers not being able to use effective teaching strategies. In line with this research, Widodo (2017) suggests that many biology teachers have a limited teaching repertoire, as evidenced by the teacher being only able to identify one or two methods to teach certain concepts. This shows that the participation of teachers in a number of trainings has not been able to contribute significantly to the development of teacher PCK. TPACK may not be directly related to the quality of teacher teaching, but TPACK can be a good indicator of a teacher's potential to provide quality teaching. Future professional development of teachers should focus on integrating TPACK, not technology, content or pedagogy separately.

Also, there are differences in PCK between senior or experienced teachers and inexperienced teachers. Experienced teachers have been able to develop unique concepts about teaching strategies that help students learn more optimally, while inexperienced teachers have not been able to develop their own teaching strategies, but this deficiency can be overcome through collaboration in professional development activities. Most teachers still do not have adequate TPACK to support student learning, therefore research aimed at developing effective strategies to increase teacher TPACK is still very much needed.

IV. Conclusion

The teachers' TPACK level is in good category, which means that teachers have knowledge regarding the use of technology to present experiences in everyday life, examples, and analogies of certain topics. In addition, teachers are also able to use technology to make certain topics more acceptable to students with different characteristics. Most of the teachers are in the perception level category, which means teachers have a perception towards the alignment of the TPACK component because they are able to identify content difficulties, feel the need for content transformation and are able to identify teaching methods that are suitable for the use of technology. However, the teacher cannot prove the TPACK in the use of technology to change the content and support the student learning process in the classroom.

The results of the study show that teaching and training experiences have the potential to significantly shape or influence the teachers' TPACK. Thus, students must increase their experience in participating in competency development training. There is also a necessary that the educational stakeholders need to take into account teachers' TPACK in order to ensure that the program is considered beneficial to teachers' professional growth when designing teacher professional development program. For future studies, we suggest examining the impact of teachers' TPACK to students' learning achievement and self-directed learning. Also, future studies are required to describe teachers' teaching trajectories in developing knowledge, skills and dispositions to incorporate new and emerging technologies as learning and teaching tools in various subject areas.

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