Measuring Islamic University sent to JSL

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Measuring Islamic University Mathematics and Science Teachers' Perception on Technological Pedagogical Content Knowledge

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ABSTRACT - The purpose of this study was measure the Islamic university mathematics and science teachers (IU-MSTs) perception on TPACK in 21st-century learning. This research utilized the quantitative method with a descriptive survey. CFA and alpha Cronbach methods used to determine the quality of instruments. Furthermore, the descriptive statistics and ANOVA were used to analyze the data obtained, while the correlations were used to test the hypotheses. The result showed that the instrument used were valid and reliable. The results also showed that Islamic university mathematics and science teachers (IU-MSTs) stated TPACK are important competencies for mathematics students and science teachers. The results also showed that there is no relationship between teaching experience (TE) and teaching ability (TA) with TPACK and there were no differences in lecturers' perceptions on TPACK based on teaching subject. This study concluded that TPACK are important competencies for mathematics students and science teachers in Islamic university.

Keywords - TPACK, teaching subject, teaching experience, Islamic university mathematics and science teachers (IU-MSTs)

1. INTRODUCTION

Over the past two decades, educators have determined strategies to prepare students and prospective teachers on how to navigate through the increasingly globalized world and inter-connected landscape associated with the 21st century (Teo, 2019). Prospective teachers need helpful skills in order to deal with the competitive global changes, which are needed by students to prepare themselves after graduating from college (Kaufman, 2013; Larson & Miller, 2011).

TPACK was needed by prospective teacher (Elas, Majid, & Narasuman, 2019; Mulyadi, Wijayatingsih, Budiastuti, Ifadah, & Aimah, 2020; Yigit). According to AACTE (2010), TPACK is a 21st-century skill that needs to be possessed by teachers. Chai, Koh & Tsai (2013) used 74 articles on TPACK, to integrate and transform the skills needed by an ICT teacher in the classroom. Furthermore, Chen & Xie's (2018) showed that this skill needs to be possessed by prospective teachers due to its relationship with their personal characteristics. This explanation also shows that TPACK are hot topics which require adequate studies related to mastering mathematics or science (Geisinger, 2016).

The findings of the study show an opportunity to investigate TPACK together with a variety of determinants and perspectives, such as experience, abilities and study subjects. Previous studies investigated the use of teaching strategies and determine the factors associated with learning mathematics and science. Tondeur, Scherer, Siddiq, & Baran (2020) explored the effectiveness of the strategies by using the synthesis of qualitative evidence (SQD) model used to prepare pre-service teachers for TPACK and found that it

provides recommendations to improve their potential. Kan'an (2018) determined the relationship between Jordanian students' 21st-century skills (Cs21) and academic achievement in science and found that female urban students performed better compared to their rural male counterpart. Tokmak, Incikabi, & Ozgelen (2012) investigated the effect of TPACK on mathematics, science, and literacy education pre-service teachers' and found no significant differences between natural and social science.

However, other factors such as age, gender, number of years and the subject area also influence their ability. According to Allen, Singh, & Rowan (2019), a teacher's personal characteristics tend to affect their professional experience. Fauth et al. (2019) stated that there is a relationship between teacher competency, teaching quality, and student outcomes. This is because teachers with academic education have better experiences (Dijkema, Doolaard, Ritzema, & Boske, 2019). Sladek, Bond, & Phillips (2010) reported that there are gender and age differences in the thinking process, of men, adults, and teenagers. According to Warren, Apps, Hoskins, Azmi, & Boyce (2018), age is positively related to creative performance. However, the research conducted by Liang, Chai, Koh, Yang, & Tsai (2013), and Koh, Chai, & Tsai (2014) showed that it was negatively associated with TK, TPK, and TPCK.

In other factors, experience was a determine factor that contribute to TPACK. Liu, Zhang, & Wang (2015) found that teachers with less experience had significantly higher technological integrative knowledge. However, senior teachers had significantly higher PK and CK than those with less experience (Cheng & Xie, 2018). There are indeed studies showing that teaching time is negatively associated with TK, TPK, TCK, and TPCK and positively related to CK and PCK (Koh, Chai, & Tay, 2014). But, in a research carried out by Louws, Meirink, Veen, & Driel (2017) on teachers' years of experience, negative

linear trends were found on their learning activities. The research of Evrim & Feral's (2004) also showed several patterns between the teaching styles of science teachers and their education majors, professional development, and years of experience. According to the results, a large number of science teachers tend to use individual styles in their learning environments. This finding showed that teachers have the responsibility to guide each student throughout the learning process. Furthermore, a study on the relationship between the teacher's chosen learning sphere and experience found that their participation gradually decreases as they become more experienced (Richter, Kunter, Klusmann, Lüdtke, & Baumert, 2011).

In natural, Shulman (1986) introduced the pedagogical content knowledge (PACK), due to the difference between pedagogical knowledge (PK) and content knowledge (CK). Mishra & Koehler (2006) perfected the PACK by adding technological knowledge (TK) to obtain the TPACK terminology to complement the expertise of a teacher. Therefore, TPACK's emphasis lies in the effectiveness of technology, pedagogy and content knowledge (Thompson & Mishra 2007). Mishra & Koehler (2006) stated that the TPACK framework in the seven bodies of knowledge needed for technology integration as shown in Figure 1are as follows (1) Technological knowledge (TK) —knowledge of technology tools, (2) Pedagogical knowledge (PK) —knowledge of teaching methods, (3) Content knowledge (CK) —knowledge of subject matter, (4) Technological content knowledge (TCK) —knowledge of subject matter representation with technology, (5) Technological pedagogical knowledge (TPK) —knowledge of using technology to implement different teaching methods, (6) Pedagogical content knowledge (PCK) —knowledge of teaching methods with respect to subject matter content, and (7) Technological pedagogical content knowledge (TPACK) —knowledge of using technology to implement teaching

methods for different types of subject matter content (Cox & Graham, 2009; Koehler & Mishra, 2009; Mishra & Koehler, 2006).

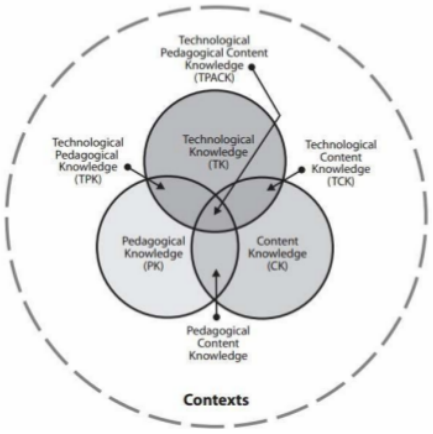

Figure 1. TPACK Framework (Koehler & Mishra, 2009)

However, a clear gap found in the application of integrated learning in Islamic universities is not yet clearly determined the type of skills needed by students. If it is related to the application in class, there are not many reports of studies on the application and type of skills needed by students. So, this study conduct to measure the perception on TPACK post the implementation of integrated learning by Islamic university mathematics and science teachers (IU-MSTs).

In this study, the authors measure the islamic university mathematics and science teachers' perception on technological pedagogical content knowledge based on three; (a) Investigate the results of the Confirmatory Factor (CFA) analysis and the reliability of the TPACK questionnaire; the relationship between teaching experience (TE) and teaching abilities (TA) with TPACK and (c) differences in lecturers' perceptions on TPACK based on teaching subject.

According to the decision of the Directorate General of Islamic Education Ministry of Religion of the Republic of Indonesia Number 2498 in year 2019, integrated learning was a characteristic of studying Islamic university in Indonesia. Previously, this integrated instruction was developed independently by each Islamic university in Indonesia. Since 2016, IAIN Batusangkar Indonesia also implemented integrated learning. The application of Integrated instruction during the learning process refers to the university's integrative learning guidelines. The application of this integrated learning improves student skills and learning outcomes. For example, research conducted by Haviz (2016) and Haviz, Lufri, Fauzan, & Efendi (2012). Both studies have integrated embryology with the Quran at Islamic universities. Although with different content, research conducted by Zainuddin & Perera (2017) and Holland & Piper (2014) are integrated instruction researches on their respective content. For example, Zainuddin & Perera (2017) identified the differences between a flipped classroom and a non-flipped classroom instructional model, and the results of the study showed that the out of class activities included the sharing of short video clips uploaded on to the institutional learning management system for students' access before class had successfully established the basic psychological needs of self-determination theory.

2. METHOD

This study utilized the quantitative method with a descriptive survey (Gay, Mills, & Airasian, 2009), and Creswell (2014). Data were obtained from a total of 48 lecturers that have taught at 3 universities located in the province of West Sumatra, Indonesia. These lecturers were within the ages of 30-50 years old with an average age of 38.54, and consist of 26 women and 22 men. Furthermore, a total of 9 and 39 lecturers are doctorate and masters' degree holders, respectively. The subjects taught include

mathematics (13 people or 27.08%), biology (15 people or 31.25%), physics (12 people 25.00%) and chemistry (8 people or 16.67%).

Data were collected by using the instrument was developed by Koh, Chai & Tsai (2010), which was designed based on the previous research conducted by Schmidt et al. (2009b). In line with this, Koh, Chai & Tsai (2010) stated that many other studies also used the instrument to investigate TPACK students, such as the studies conducted by Archambault & Crippen (2009), Graham et al. (2009), Lee & Tsai (2010), Schmidt et al. (2009a), and Schmidt, Sahin, Thompson, & Seymour, (2008). This questionnaire contains positive and negative questions with the scores of 1, 2, 3, 4, and 5 in the very disagree, not agree, neutral, agree and very agree categories. In this study, the validity and reliability tests of the two instruments were carried out using the CFA and Cronbach Alpha tests. The data analysis technique used refers to the survey technique described by Creswell (2014). The steps in analyzing the data are as follows: (1) Make a report on the number of sample members surveyed/not surveyed, (2) Create a table of the number of respondents and their percentages, (3) Discuss and estimate the bias of respondents with the research team and their effects on the study, (4) Calculate data by using descriptive statistics in the form of percentages, averages and standard deviations using SPSS 21 for windows. Furthermore, these data are displayed in tables, graphs or diagrams. (5) The confirmatory factor analysis (CFA) and Cronbach's alpha were widely used by previous researchers such as Suhr (2018), Chai, Deng, Tsai, & Koh (2015), Jia, Oh, Sibuma, LaBanca, and Lorentson (2016) and Sang, Liang, Chai, Dong, & Tsai (2018), to prove the hypothesis, statistics used inferences with ANOVA and correlation. The results of the inference test are interpreted in a tabular form, and the conclusions obtained are tested at 5% and 1% confidence levels.

The validity and reliability tests used the CFA and alpha Cronbach methods to determine the goodness and structure of the instrument used for the research data collection. In this study, the loading factor used was above and below 0.1, on the relevant and irrelevant factors, respectively. The CFA test results on 7 factors, namely CK, PK, PCK, TK, TPK, TCK, and TPACK, are shown in Table 1. The data shows that the validity score is in the range 0.04 - 1.55, with the TPACK coefficients above 0.1. This finding showed that all items of the TPACK questionnaire statement were valid, with the two questionnaires consisting of a good level of reliability. Cronbach's Alpha score for the TPACK questionnaire was *0.920* with *N=30* items. Finally, it was concluded that the two questionnaires in this study were valid and reliable and used to collect further research data. Correlation test was used to determine the relationship between teaching experience and teaching ability with TPACK and Anova test was used to determine differences in teachers' perceptions about TPACK based on teaching subject

Table 1 Pattern/structure coefficients for TPACK

	Factor 1 CK	Factor 2 PK	Factor 3 PCK	Factor 4 TK	Factor 5 TPK	Factor 6 TCK	Factor 7 TPACK
CK1	0.62						
CK2	0.92						
CK3	0.55						
PK1		0.67					
PK2		0.44					
PK3		0.57					
PK4		0.70					
PK5		0.46					
PK6		0.52					
PCK1			0.61				
PCK2			0.76				
PCK3			0.81				
TK1				0.04			
TK2				1.01			
TK3				0.65			
TK4				0.56			
TK5				0.08			
TK6				0.19			
TPK1					0.60		
TPK2					0.50		
TPK3					0.87		
TPK4					0.90		
TPK5					0.92		
TCK1						0.18	
TCK2						1.55	

TCK3	0.50	
TPACK1		0.76
TPACK2		0.73
TPACK3		0.82
TPACK4		1.00

3. RESULTS AND DISCUSSION

3.1 The Correlation between teaching experience and teaching ability with TPACK

The results of the study of the relationship between TE and TA with TPACK are shown in **Table 2**. This study found the lowest TE scores in the TK factor, at -0.340, and the highest in the TPACK at 0.128. The study also found the lowest TA score in CK, at -0,138, and the highest in the PCK factor, at 0.680. The correlation test results show that there is no relationship between TE and TA with the TPACK factors.

Table 2. Correlation between the teacher experience, teaching ability and the factors TPACK

	CK	PK	PCK	TK	TPK	TCK	TPACK
Teaching experience	-0.202	0.032	0.184	-0.340	0.116	0.021	0.128
Teaching ability	-0.138	-0.111	0.680	-0.309	0.063	0.144	0.043

* P<.05, **p<.01

3.2 Differences in teachers' perceptions about TPACK based on teaching subject

The results of the studies on teacher perceptions on TPACK based on teaching subject are shown in **Table 3**. In mathematics, the lowest and highest scores of 3.09 (0.98) and 4.02 (0.98), were found in PCK and PK, respectively. In biology, the lowest and highest scores of 3.24 (0.50) and 4.07 (0.54) were found in PCK and CK, respectively. In physics, the lowest and highest scores of 2.67 (0.76), and 3.50 (0.50) were found in PCK and the PK, respectively. In chemistry, the lowest and highest scores were 3.58 (0.52), and 3.8 (0.72), respectively. This finding also shows that there is no relationship between mathematics and science with TPACK. In addition, it also shows that mathematics, biology, physics, and chemistry consider TPACK as an important competency to be mastered by prospective students and science teachers.

Table 3. Differences in teachers' perceptions about TPACK based on teaching subject

	CK (M, SD)	PK (M, SD)	PCK (M, SD)	TK (M, SD)	TPK (M, SD)	TCK (M, SD)	TPACK (M, SD)
Math	3.52 (0.74)	4.02 (0.45)	3.09 (0.98)	3.69 (0.45)	3.54 (0.61)	3.57 (0.46)	3.32 (0.67)
Bio	4.07 (0.54)	3.89 (0.30)	3.24 (0.50)	3.67 (0.46)	3.76 (0.53)	3.77 (0.28)	3.53 (0.55)
Phys	3.44 (0.35)	3.50 (0.50)	2.67 (0.76)	3.42 (0.31)	3.20 (0.94)	3.17 (0.86)	2.96 (1.01)
Chemist	3.78 (0.39)	3.72 (0.19)	3.44 (0.51)	3.50 (0.17)	3.80 (0.72)	3.78 (0.84)	3.58 (0.52)
F (Anova)	2.078	2.122	1.072	0.664	0.967	1.555	0.931
Scheffe test							

The results of the validity and reliability of the TPACK questionnaires are valid and reliable. The TPACK was developed by Koh, Chai & Tsai (2010) with 27 items used to measure 5 factors of technology, namely knowledge, content, pedagogy, teaching, and critical reflection. This questionnaire is the result of the development of previous research conducted by Schmidt et al. (2009b).

Regarding the benefits and use of instruments, it is similar to previous studies as follows: (a) survey of pre-service teacher knowledge and technology (Schmidt et al., 2009a), (b) survey of pedagogical knowledge and technology content (Sahin, 2011), (c) assessing students' perceptions about PCK of college teachers (Jang, Guan & Hsieh, 2009; Jang & Tsai, 2012), and (d) TPACK in science survey questions (Graham et al. 2009). These four surveys were used as a basis by Lee & Kim (2017) to develop their survey questionnaire. The TPACK survey modified by Lee & Kim (2017) contains 55 items used to measure 7 TPACK knowledge domains: 16 TK items, 8 CK items, 9 PK items, 7 PCK items, 6 TCK items, 5 TPK items, and 4 items TPACK.

According to Taber (2017), the results of this study show that the use of Cronbach's Alpha is relevant for reliable testing instruments used to collect. The results of other studies show that surveys on students' perceptions of critical thinking, creative thinking and authentic problem solving were dominant predictors in 21st-century learning practice

(Chai, Deng, Tsai, & Koh, 2015; Jia, Oh, Sibuma, & Lorentson, 2016; Ercikan & Oliveri, 2016).

The relationship between TE and TA with TPACK shows that lecturers with different teaching abilities and experience still consider TPACK as an important competency to be mastered by prospective mathematics students and science teachers. These results show that 21st-century skills and TPACK need to be integrated into learning which is not only focused on knowledge (Herde, Wüstenberg & Greiff, 2016; Silva, 2009). TPACK is competent for prospective teachers with TPACK used to increase students' ability to master information and communication technology (ICT). The results are found in various articles that have been written by Koh, Chai, & Tsai (2010), Koh (2013), Koh & Chai (2014), Koh, Chai, & Tay (2014) and Cai, Koh, Tsai, & Tan (2011) with a clear link between both as part of the 21st-century skills.

In this study, the result about teachers' ability on TPACK show that factor age, numbers of years and the subject area is negatively assosicated with TPACK. Although, Sladek, Bond, & Phillips (2010) reported that there are gender and age differences in the thinking process, of men, adults, and teenagers. According to Warren, Apps, Hoskins, Azmi, & Boyce (2018), age is positively related to creative performance. However, the research conducted by Liang, Chai, Koh, Yang, & Tsai (2013), and Koh, Chai, & Tsai (2014) showed that it was negatively associated with TK, TPK, and TPCK. In others, Liu, Zhang, & Wang (2015) found that teachers with less experience had significantly higher technological integrative knowledge. However, senior teachers had significantly higher PK and CK than those with less experience (Cheng & Xie, 2018). There are indeed studies showing that teaching time is negatively associated with TK, TPK, TCK, and TPCK and positively related to CK and PCK (Koh, Chai, & Tay, 2014). In a research carried out by

Louws, Meirink, Veen, & Driel (2017) on teachers' years of experience, negative linear trends were found on their learning activities. The research of Evrim & Feral's (2004) also showed several patterns between the teaching styles of science teachers and their education majors, professional development, and years of experience. According to the results, a large number of science teachers tend to use individual styles in their learning environments. This finding showed that teachers have the responsibility to guide each student throughout the learning process. Furthermore, a study on the relationship between the teacher's chosen learning sphere and experience found that their participation gradually decreases as they become more experienced (Richter, Kunter, Klusmann, Lüdtke, & Baumert, 2011).

4. CONCLUSION

The result study showed that Islamic university mathematics and science teachers (IU-MSTs) stated TPACK are important competencies for mathematics students and science teachers. The results also showed that there is no relationship between teaching experience (TE) and teaching ability (TA) with TPACK and there are no differences in lecturers' perceptions on TPACK based on teaching subject. This study concluded that TPACK are important competencies for mathematics students and science teachers.

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