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Relationships Between Teaching Experience and Teaching Ability with TPACK: Perceptions of Mathematics and Science Lecturers at an Islamic University

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ABSTRACT The purpose of this study was to measure Islamic university mathematics and science lecturers (IU-MSLs) perception of technological pedagogical content knowledge (TPACK) in 21st-century learning. This research utilized a quantitative method derived from a descriptive survey collected from 48 lecturers at a single university. Confirmatory factor analysis (CFA) and alpha Cronbach methods were applied to determine the quality of the instruments used in this study. Furthermore, descriptive statistics and ANOVA were used to analyze the data obtained, while correlations were used to test the hypotheses. The results showed no relationship between teaching experience (TE) and teaching ability (TA) with TPACK. In addition, there were no differences in lecturers' perceptions of TPACK based on the material being taught. This study concluded that TPACK is an essential competency for mathematics and science lecturers in an Islamic university.

Keywords Technological pedagogical content knowledge (TPACK), Teaching subject, Teaching experience, Islamic university of mathematics and science lectures (IU-MSLs)

1. INTRODUCTION

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

Technological pedagogical content knowledge (TPACK) was needed by the teacher (Elas, Majid, & Narasuman, 2019; Mulyadi, Wijayatingsih, Budiastuti, Ifadah, & Aimah, 2020; Yigit, 2014). According to AACTE (2010), TPACK is a 21st-century skill that teachers must possess. Chai, Koh & Tsai (2013) used 74 articles on TPACK to integrate and transform the skills needed by an information communication and technology (ICT) teacher in the classroom. Furthermore, Chen & Xie (2018) showed that prospective teachers' skill needs to be possessed due to its relationship with their characteristics. This explanation also shows that TPACK is a hot topic that requires adequate studies related to mastering mathematics or science (Geisinger, 2016).

The study's findings 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 determined the factors associated with learning mathematics and science. Tondeur, Scherer, Siddiq, & Baran (2020) explored the strategies' effectiveness by using the synthesis of qualitative evidence (SQD) model used to prepare preservice 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 than their rural male counterparts. Tokmak, Incikabi, & Ozgelen (2012) investigated the effect of TPACK on mathematics, science, and literacy education preservice teachers' and found no significant differences between natural and social science.

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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 characteristics affect their professional experience. Fauth et al. (2019) stated a relationship between teacher competency, teaching quality, and student outcomes. This result 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 technological knowledge (TK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPCK).

In other factors, the experience was a determining factor that contributes 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 technological knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPCK) and positively related to content knowledge (CK) and pedagogical content knowledge (PCK) (Koh, Chai, & Tay, 2014). However, in 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 (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, many 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 a teacher's expertise. 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 the 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 concerning 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).

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 of TPACK post the implementation of integrated learning by Islamic university mathematics and science lectures (IU-MSLs).

In this study, the authors measure the Islamic university mathematics and science lectures' (IU-MSLs) perception on technological pedagogical content knowledge based on two; the relationship between teaching experience (TE) and teaching abilities (TA) with TPACK, and differences in lecturers' perceptions on TPACK based on teaching the subject.

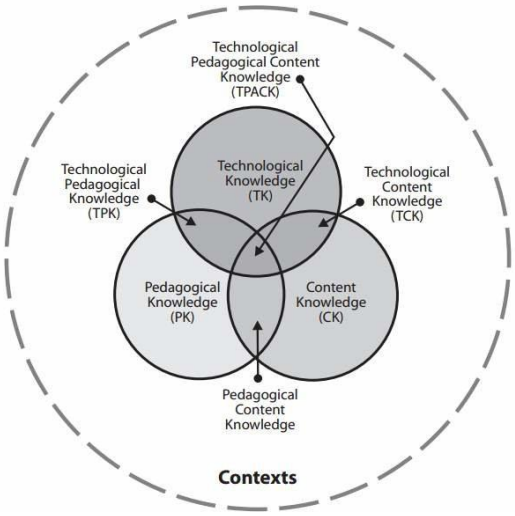

Figure 1 TPACK framework (Koehler & Mishra, 2009)

According to the Directorate General of Islamic Education Ministry of Religion of the Republic of Indonesia Number 2498 in the 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 has 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 is 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 are integrated instruction researches on their respective content. The differences identified 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 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; Creswell, 2014). Data were obtained from 48 lecturers that have taught at IAIN Batusangkar, West Sumatra, Indonesia. These lecturers were between the ages of 30-50 years old with an average age of 38.54 and 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 using the instrument 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 scores of 1, 2, 3, 4, and 5 in the very disagree, not agree, neutral, agree,

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

Table 2 Correlation between the TE and TA of IU-MSLs and the factors of 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

Table 3 Differences in Islamic university mathematics and science lectures (IU-MSLs) about TPACK based on teaching subject (TS)

	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							

and very agree on categories. In this study, the two instruments' validity and reliability tests 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 inference test results 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 instrument's goodness and structure for the research data collection. In this study, the loading factor used was above and below 0.1, respectively, on the relevant and irrelevant factors. 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 the TPACK questionnaire statements 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. A 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

3. RESULT AND DISCUSSION

3.1 The correlation between teaching experience (TE) and teaching ability (TA) of Islamic university mathematics and science lectures (IU-MSLs) with technological pedagogical content knowledge (TPACK)

The study results about the relationship between TE and TA of IU-MSLs 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 that the lowest TA score in CK, at -0,138, and the highest in the PCK factor, at 0.680. The correlation test results showed that there is no relationship between TE and TA with the TPACK factors.

3.2 Differences in Islamic university mathematics and science lectures (IU-MSLs) perceptions about TPACK based on teaching subject (TS)

The studies on IU-MSLs perceptions about TPACK based on teaching subject (TS) 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 showed that there is no relationship between mathematics and science with TPACK. This finding also showed that mathematics, biology, physics, and chemistry considered TPACK a critical competency to be mastered by Islamic university mathematics and science lectures (IU-MSLs).

In this study, the results of the validity and reliability of the TPACK questionnaires were valid and reliable. This finding, according to the TPACK was developed in previous research. Koh, Chai & Tsai (2010) wrote 27 items that measure 5 factors of technology: knowledge, content, pedagogy, teaching, and critical reflection. This questionnaire results from the development of previous research conducted by Schmidt et al. (2009b). This study, regarding the benefits and use of instruments, is also similar to others previous studies as follows: (a) survey of preservice 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 also 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 showed that Cronbach's Alpha is relevant for reliable testing instruments used to collect the data. The results of other studies showed 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 finding of the relationship between TE and TA of IU-MSLs with TPACK showed that different teaching abilities and experiences still consider TPACK as an essential competency to be mastered by IU-MSLs. Teaching abilities and teaching experience was no relationship between TPACK. Because TPACK was a part of the 21st-century skill. This finding assumed that the lectures with old age show less or no competencies technology content, such as information and communication skill. Thus, these results also showed that 21st-century skills and TPACK need to be integrated into learning, which focuses not only on knowledge (Herde, Wüstenberg & Greiff, 2016; Silva, 2009). This finding also showed that TPACK is competencies will be used to increase students' ability to master information and communication technology (ICT). This finding is also found in various articles that have been written by previous researchers. For example, the articles were writing by Koh, Chai, & Tsai (2010), Koh (2013), Koh & Chai (2014), Koh, Chai, & Tay (2014). Cai, Koh, Tsai, & Tan (2011) stated a clear link between both as part of the 21st-century skills. This statement has also supported the finding of this study.

In this study, the result about relationships between teaching ability of IU-MSLs with TPACK showed that factor age, numbers of years, and the subject area is negatively associated with TPACK. This finding accordingly with previous research. Sladek, Bond, & Phillips (2010) reported gender and age differences in men, adults, and teenagers' thinking processes. 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 lecturers had significantly higher PK and CK than those with less experience (Cheng & Xie, 2018). Studies show that teaching time is negatively associated with TK, TPK, TCK, and TPCK and positively related to CK and PCK (Koh, Chai, & Tay, 2014). In research carried out by Louws, Meirink, Veen, & Driel (2017) on teachers' years of experience, negative linear trends were found in their learning activities. Evrim & Feral's (2004) research also showed several patterns between the teaching styles of science lectures and their education majors, professional development, and years of experience. According to the study results, many science lecturers tend to use individual styles in their learning environments. This finding showed that lecturers have the responsibility to guide each student throughout the learning process. Furthermore, for this implication, a study on the relationship between the lectures chosen to learn sphere and experience found that their participation gradually decreases as they become more experienced (Richter, Kunter, Klusmann, Lüdtke, & Baumert, 2011).

4. CONCLUSION

The resulting study showed that Islamic university mathematics and science lectures (IU-MSLs) stated TPACK are essential competencies for mathematics and science lectures in Islamic University. The results also showed 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 the subject. This study recommended that TPACK are needed competencies for mathematics and science lectures in Islamic University.

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