

Research Article

Cite this article: Suwadi, Sulistyowati, E., Hazrullah, & Adira, H. F. (2025). Development of TPACK instrument to measure teacher knowledge in Islamic education for in-service teacher professional training. *Educational Process: International Journal*, 16, e2025193. <https://doi.org/10.22521/edupij.2025.16.193>

Received February 13, 2025

Accepted April 25, 2025

Published Online May 1, 2025

Keywords: In-service training, instrument TPACK, Islamic education, teacher competency, teacher knowledge

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Development of TPACK Instrument to Measure Teacher Knowledge in Islamic Education for In-Service Teacher Professional Training

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Abstract

Background/purpose. Testing Islamic education teacher competency is a complex problem that requires in-depth analysis. This research aims to develop a content, pedagogical, and technological knowledge (TPACK) instrument for Islamic education teachers who graduated from the in-service professional teacher program.

Materials/methods. The development of the TPACK instrument was carried out by adopting Akker's instrument development model. Participants in this research were 905 Islamic education teachers who graduated from a teacher professional program (PPG) from all regions of Indonesia. Data was collected through the TPACK instrument, which covers seven knowledge domains in the TPACK framework. Data analysis was carried out using measurement models, structural models, and correlation tests using the SEM AMOS application. The effectiveness of the TPACK instrument in measuring Islamic education teacher knowledge among PPG graduates in positions at the Ministry of Religion of the Republic of Indonesia was analyzed quantitatively descriptively.

Results. The research results show that the TPACK instrument developed consists of seven components or variables with 65 valid and reliable items. Each variable in the TPACK instrument is strongly and significantly correlated with measuring Islamic education teachers' level of TPACK understanding. Apart from that, the TPACK ability of Islamic education teachers who graduate from PPG in Indonesia still needs to improve when viewed from the working age range and employment status.

Conclusion. This is caused by a lack of monitoring and increasing learning knowledge, not because of teachers' reluctance to innovate. This TPACK instrument can help design longitudinal studies to assess the development of in-service teachers' TPACK.

1. Introduction

The TPACK instrument is a valuable framework for measuring teacher knowledge in integrating content, pedagogy, and technology, including in Islamic Religious Education learning (Miguel-Revilla et al., 2020). The teacher learning framework begins with designing materials, implementing learning and assessment activities, and using technology. Information technology development strengthens teachers' roles, including Islamic Religious Education teachers, in helping students achieve competencies and skills. Although Islamic Religious Education teachers have low self-confidence about integrating pedagogical content and technology, this obstacle can be overcome after intervention. In addition, TPACK contains indicators that reflect professional teacher competencies and efforts to improve teacher quality as the main factors influencing the education system. Strengthening teacher competencies refers to the content taught, so it cannot be adequately assessed by observing learning performance. Professional teacher education programs have a significant and positive impact on teacher performance. Practical training increases teacher productivity and performance by acquiring new, up-to-date knowledge and skills. Thus, teacher quality determines the quality of education, and teacher professional skills determine learning success.

Professional teachers are agents of change and drivers of students who can experience wear and tear due to a lack of current knowledge. Tripon's (2022) research shows that teacher training can develop computational thinking skills as one of the 21st-century skills. The globalization trend sees the importance of increasing technological literacy and teacher competitiveness with good adaptation capital through change. The teacher's thinking framework rejuvenates their ability to implement TPACK. Improving teacher competence requires a commitment to changing a fixed mindset to a growth mindset utilizing technological realities (Jeffs et al., 2023). Today's teachers not only help students learn but also strengthen technological literacy. Teachers must be wise about "what" and "how" to use approaches that utilize technology (Wilujeng et al., 2020).

The growth mindset conveys that intelligence and personality can be nurtured and developed according to the teacher's context (VanGronigen et al., 2023). Today's teachers must be smart about what and how to use approaches that utilize technology. Changes in mindset affect action patterns, making learning fun, exciting, and enlightening. Integrating content, pedagogy, and technology in one Islamic education lesson encourages teacher knowledge developers to use new frameworks in measurable learning (Zainuri et al., 2022). Islamic religious education requires teachers to have the skills to learn by combining content knowledge, pedagogy, and technology. This teacher's ability requires a framework used in TPACK (Akyuz, 2018). The TPACK framework is structured from the intersection of technological and content knowledge, thus giving rise to content-technological knowledge.

The intersection of technological knowledge and pedagogy gives birth to an understanding of pedagogical technology. The intersection of pedagogical and technological expertise gives birth to academic content knowledge. The meeting between these intersections gives birth to the unity of content, pedagogical, and technological expertise (Khoza & Biyela, 2020). However, there needs to be a framework instrument that measures the knowledge of Islamic education teachers in integrating content, pedagogy, and technology (Hussin et al., 2014). Teachers' knowledge of the unity between content, pedagogy, and technology in Islamic education learning has not been well identified by instruments that measure their abilities (Nurhuda et al., 2023). Efforts have been made to integrate Islamic education teacher learning that integrates content, pedagogy, and technology. However, the quality of teacher learning that combines content, pedagogy, and technology in education has not been found (Adesta & Fatimah, 2021). After completing the teacher profession program (PPG), teachers still need to carry out measurements regarding TPACK so that initial data cannot be

obtained, or the condition of teachers regarding TPACK knowledge for continuous competency improvement still needs to be carried out.

So far, studies on TPACK have focused more on technology. Integrating the three components in the study has not been widely carried out (Kulaksız & Karaca, 2024). However, there has been in-depth research on TPACK, but no instrument is suitable for Islamic education teachers. In this study, the basic framework of TPACK is developed based on the balanced integration of content, pedagogy, and technology in Islamic education learning in schools. This paper is based on the argument that teachers' initial ability to master TPACK requires measurement with valid and reliable instruments. In addition, teachers are required to encourage students to develop 21st-century skills by integrating content, pedagogy, and technology. Furthermore, this study aims to create a TPACK instrument that can measure the knowledge of Islamic religious education teachers' content, pedagogy, and technology after participating in the Teacher Professional Education program organized by the Ministry of Religion of the Republic of Indonesia in 2021-2023. In addition, this study also tests the effectiveness of the TPACK instrument to measure the knowledge of Islamic religious education teachers and their families in in-service PPG students at the Ministry of Religion of the Republic of Indonesia by focusing on testing the validity and reliability of the instrument.

2. Methodology

2.1. General Background

This research is developing an instrument for measuring Islamic education teachers' content, pedagogical, and technological knowledge (TPACK). The instrument developed in this research adopted the Shulman (TPACK) and Puentedura (SAMR) models. Meanwhile, the development research adopted the research and instrument development model from Akker et al. (2006), which consists of four stages. The first stage is preliminary research conducted by literature studies and field surveys. An initial analysis was carried out on the condition of teachers participating in the 2021 professional teacher program (PPG) from Western, Central, and Eastern Indonesia. At this stage, information was obtained that there needed to be a valid and reliable instrument to measure the TPACK competency of Islamic religious education teachers. The next step is to analyze the need to improve the implemented Islamic education teacher TPACK. Next, the second stage is making a prototype by developing and validating instruments to measure Islamic religious education teachers' content, pedagogical, and technological knowledge (TPACK).

This stage also develops an instrument for evaluating teacher performance using TPACK in Islamic education subjects and designing the operationalization of TPACK as a tool for measuring teacher performance. The third stage is a summative evaluation, which tests the TPACK instrument on Islamic education teachers. The trial process was carried out in phases to assess the quality of the TPACK instrument and explore Islamic education teachers' TPACK abilities. Meanwhile, the final stage is systematic reflection and documentation. This stage is carried out by searching for and developing an appropriate diffusion model for Islamic education teacher TPACK testing instruments and reporting the TPACK results of Islamic education teacher PPG graduates based on the instrument developed. The research and development scheme for the TPACK instrument for Islamic education teachers can be presented in Figure 1.

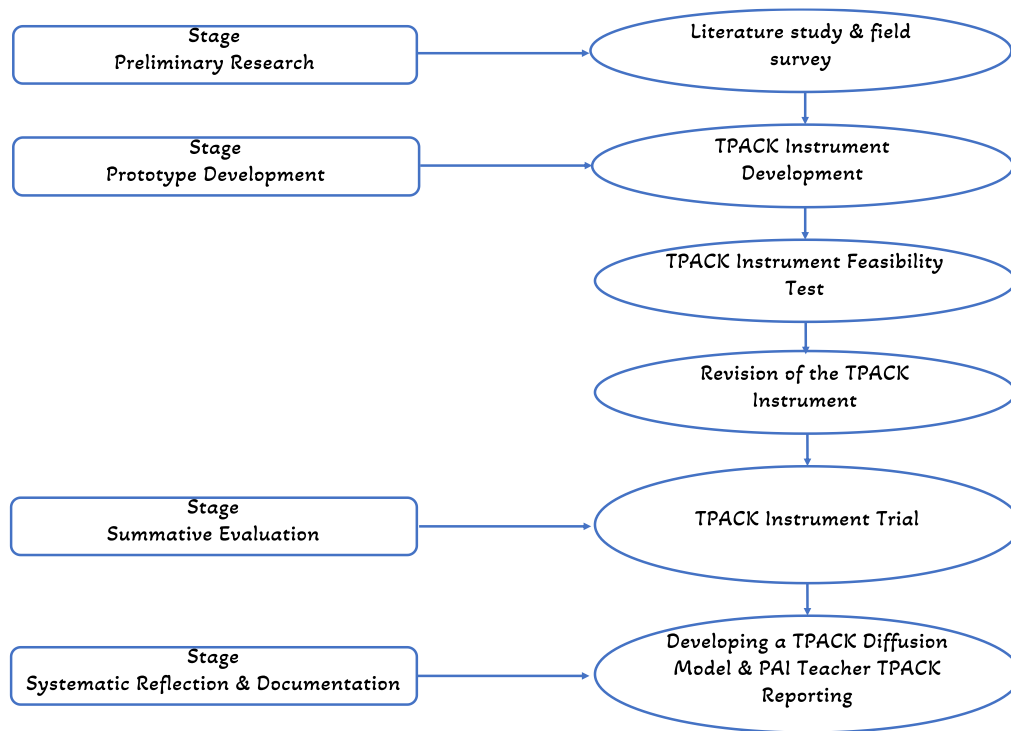


Figure 1. Research and development scheme for TPACK instruments for Islamic education teachers

2.2. Participant

Participants involved in the TPACK test instrument development research were Islamic religious education teachers who had graduated from PPG. The population of this study was 16 thousand Islamic religious education teachers who graduated from PPG in 2021-2023. Given the large population, the sample or participants involved in this study were determined using a purposive sampling technique using the Slovin equation. The sample of this study was obtained from the Slovin equation and consisted of 905 Islamic religious education teachers who graduated from PPG at Sunan Kalijaga State's Islamic University, Yogyakarta. The purposive sampling technique is a sampling technique that is not carried out randomly, but samples are taken based on certain criteria (Khalefa & Selian, 2021). When taking samples, the criteria determined were that Islamic religious education teachers who graduated from the PPG campus came from all over Indonesia. In addition, Islamic religious education teachers who graduated from PPG from this campus in 2021-2023 obtained the highest percentage of passing and average scores compared to Islamic religious education teachers who graduated from PPG from other campuses in Indonesia. In this study, no participants refused to participate. Therefore, all samples used in this study provide valid information.

2.3. Instruments and Data Analysis

Data collection instruments in this research include several types, namely TPACK questionnaires for Islamic education teachers, observation sheets, interview guides, and documentation. Apart from that, notebooks or logbooks and focus group discussion (FGD) activities were also used to support data collection. The initial research stage involved preparing a draft of the TPACK instrument, which experts tested on the material. After that, a trial of the TPACK instrument was carried out by Islamic education teachers who graduated from PPG and continued with improvements to the instrument based on the trial results. The next stage was a limited trial to ensure the instrument's reliability. The results of limited trials were analyzed using the SEM AMOS application. Data analysis is divided into three main parts: measurement model analysis, structural model, and correlation test.

Measurement model analysis is used to assess the validity and reliability of the TPACK instrument, while the structural model describes the relationship between latent variables identified

in this research (van Bork et al., 2021). Correlation tests using SEM AMOS were carried out to measure the magnitude of the correlation between the variables constructed in the research model (Xiong et al., 2015). In addition, the effectiveness of the TPACK instrument in measuring Islamic education teacher knowledge among PPG graduates in positions at the Ministry of Religion of the Republic of Indonesia was analyzed quantitatively and descriptively. This analysis includes testing the validity and reliability of the TPACK instrument and the relationships between variables in the structural model. Thus, this research focuses on developing and testing the instrument and thoroughly analyzing the data obtained to ensure that the instrument used can provide valid and reliable results in measuring Islamic education teacher knowledge.

3. Results

The TPACK instrument used in this research comes from a testing instrument model developed by Shulman (and his colleagues in 2009). This model was further developed based on the TPACK concept from Ruben R. Puentedura in 2018. Both models were explicitly adapted to measure Islamic education teacher TPACK. The main focus of this development is to create an instrument that can evaluate teachers' abilities to integrate technology, pedagogy, and content effectively in the Islamic education learning context. The TPACK concept, which is the basis for developing this instrument, includes these seven main components: Technological Knowledge or TK, Content Knowledge or CK, Pedagogical Knowledge or PK, Pedagogical Content Knowledge or PCK, Technological Content Knowledge or TCK, Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK).

To measure teacher performance using the TPACK instrument, this instrument is designed to be easily understood by the teachers who are the research targets. This instrument is also prepared with a particular difficulty level adjusted to the Islamic education teacher's competency. Meanwhile, the operationalization of TPACK as a measuring tool was carried out through several stages of modifying and deleting survey items. In this study, 65 survey items were modified or deleted to increase the reliability and validity of the instrument. This process was carried out carefully to ensure that each remaining item was relevant and could accurately measure teachers' TPACK abilities. This modified instrument was tested to ensure it could be used as a reliable measuring tool in further research. The use of this modified TPACK instrument allows educators to design longitudinal studies. This kind of study helps assess the development of in-service teachers' TPACK on an ongoing basis.

3.1. TPACK Instrument for Islamic Education Teachers of the In-Service Professional Teacher Program

The TPACK measurement instrument for Islamic religious education teachers who are graduates of teacher professional education (PPG) consists of seven topics with 65 questions developed in this study. This is because there is no TPACK measurement instrument for Islamic religious education teachers in the Ministry of Religion. Each topic in this instrument assesses teachers' knowledge and skills in integrating technology, pedagogy, and content in the Islamic religious education learning process. This instrument aims to provide a comprehensive picture of the ability of Islamic religious education teachers to use technology effectively in the context of religious education. After the instrument's preparation was completed, a trial was conducted involving 927 respondents to test the validity and reliability of the instrument. The respondents were selected using the Slovin equation with a purposive sampling technique. This testing process ensures that each question in the instrument can measure the intended aspect correctly. The results of this trial were then analyzed and formulated into seven parts, each reflecting a TPACK topic. Table 1 presents the results of this analysis, thus providing a clear picture of the effectiveness and accuracy of the instrument in measuring the TPACK abilities of Islamic religious education teachers who are graduates of PPG.

Table 1. Seven knowledge domains of the TPACK instrument

Domain	Knowledge Aspect	Point	Indicator	Function
1	Content Knowledge (CK)	15	1. Knowledge or skills of Islamic education material and its families that students must study and study 2. Teachers must know the content to be taught, and the nature of knowledge differs for different aspects of the material	Testing teacher content knowledge in Islamic education material (Al-Qur'an Hadith, Aqidah Akhlak, Fiqh and History of Islamic Culture)
2	Pedagogical Knowledge (PK)	7	1. Processes or methods that enable effective learning to occur 2. This indicator includes knowledge in classroom management, assessment, lesson plan development, and student learning	Testing teachers' pedagogical knowledge in learning
3	Technological Knowledge (TK)	11	1. Appropriate use of e-resources to improve knowledge and learning processes for Islamic education and its communities 2. This instrument refers to knowledge about low-tech technology to digital technology	Testing teachers' technological knowledge in Islamic education learning and its aspects
4	Pedagogical Content Knowledge (PCK)	5	1. Knowledge or skills of Islamic education material and its topics that are expected from students in learning 2. Teachers combine content and pedagogy to develop better teaching practices	Testing teachers' technology content knowledge in Islamic education learning and its aspects
5	Technology Content Knowledge (TCK)	9	1. Knowledge or skills of Islamic education material and its topics that are expected from students in using technology 2. Teachers combine content and technology by referring to knowledge about technology that can create new representations	Testing teachers' technological knowledge in Islamic education learning and its aspects
6	Technological Pedagogical Knowledge (TPK)	9	1. Various technologies can be used in teaching 2. Teachers understand that the use of technology can change the way teachers teach	Testing teachers' technological pedagogy knowledge in Islamic education learning and its families
7	Technological Pedagogical Content Knowledge (TPACK)	9	1. The knowledge teachers need to integrate technology into instruction in any content area. 2. Teachers intuitively understand the complex interactions between the three basic components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods and technologies.	Testing teachers' technological pedagogical content knowledge in Islamic education learning and its aspects

Based on Table 1, the TPACK measurement instrument for Islamic education teachers graduating from Teacher Professional Education (PPG) consists of 65 questions to evaluate teacher knowledge in integrating technology, pedagogy, and content. Each item allows respondents to respond using a Likert scale from (1) Strongly Disagree to (5) Strongly Agree. After respondents had filled out this instrument, the collected data was analyzed using AMOS Structural Equation Modeling (SEM). This analysis aims to test the effectiveness of the TPACK instrument in measuring the knowledge of Islamic education teachers who are PPG graduates who work at the Ministry of Religion of the Republic of Indonesia. Based on 927 respondents initially involved in the instrument testing, data from 905 respondents were finally used in the AMOS SEM analysis because data from 22 respondents did not show a normal distribution.

Several questions in the instrument, such as number 6 from the Pedagogical Knowledge (PK) questionnaire and number 2 from the Technological Knowledge (TK) questionnaire, were discarded because they did not meet the validity requirements or could not be adequately identified by the AMOS program. After this deletion stage, the data was analyzed further to produce findings in three main aspects: measurement model analysis, structural model, and correlation test between variables in the context of TPACK. The results of the SEM AMOS analysis show a path map that describes the relationship between latent variables in the measurement and structural models, as well as the correlation between variables constructed in the TPACK instrument, as presented in Figure 2.

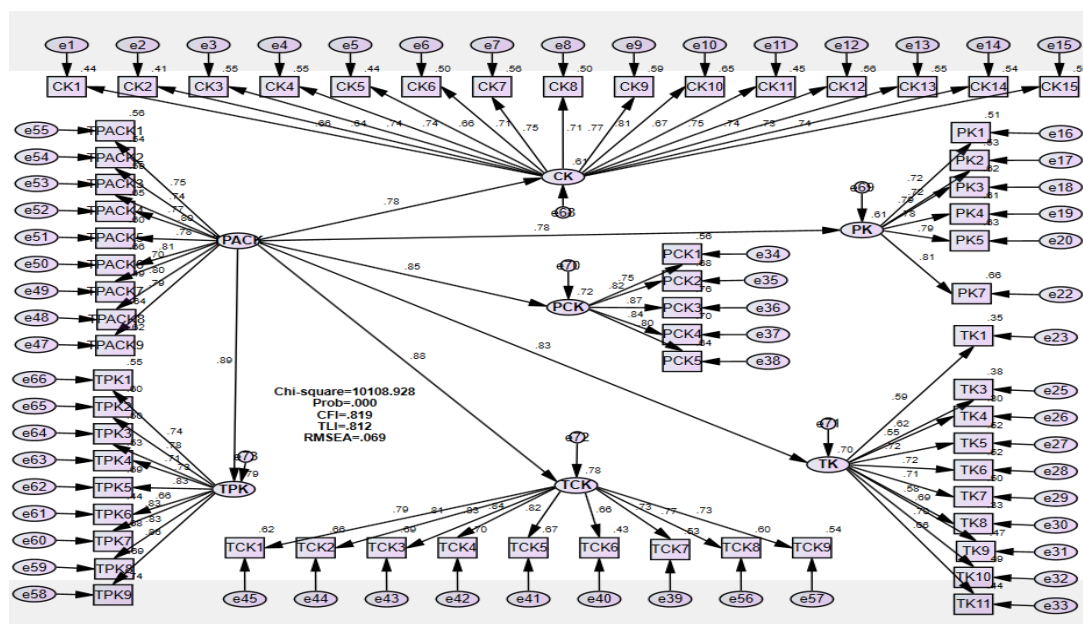


Figure 2. TPACK instrument path map

Figure 2 shows the use of the TPACK instrument in measuring and testing the knowledge of Islamic education teachers who are PPG graduates. The Comparative Fit Index (CFI) value of 0.819 indicates that the measurement model has a pretty good level of suitability. The Tucker-Lewis Index (TLI) value of 0.812 confirms that this model fits adequately. In addition, the Root Mean Square Error of Approximation (RMSEA) value of 0.069 indicates that the TPACK instrument has an acceptable level of approximation error. These findings show that the TPACK instrument agrees with empirical data from Islamic education teachers who graduated from PPG. This indicates that the TPACK instrument developed is valid and reliable in measuring the TPACK knowledge of Islamic education teachers who are PPG graduates. However, there is room for further improvement in model suitability.

3.2. Results of TPACK Instrument Model Measurement Analysis

The measurement model analysis in this research aims to test the effectiveness of the TPACK instrument, which is designed to measure the knowledge of Islamic education teachers in Teacher

Professional Education (PPG) students in positions at the Ministry of Religion of the Republic of Indonesia. The main focus of this analysis is to test the validity and reliability of the TPACK instrument. A measurement model provides a relationship between the observed values of a measurement instrument (indicator variables) and the constructs it is designed to measure (latent variables). In other words, this analysis ensures that each item in the instrument accurately measures a specific aspect of TPACK knowledge. To analyze the measurement model, this research uses Confirmatory Factor Analysis (CFA) with the help of AMOS software. In this study, the variable indicators detailed in Table 1 have been tested for validity using CFA on AMOS. The validity of the indicator is determined based on the Critical Ratio (CR) value, which must be greater than 1.96, and the probability value (p), which must be less than 0.05. Indicators that meet these criteria are considered valid, indicating that this instrument can accurately measure the desired TPACK construct. The results of this validity test are detailed in Table 2, which shows that all indicators meet the specified validity requirements.

Table 2. CR value and probability in the CFA test

			Estimate	S.E.	CR.	p				Estimate	S.E.	CR.	p
CK	<---	TPACK	.651	.035	18.359	***	PCK1	<---	PCK	1.000			
PK	<---	TPACK	.614	.032	19.292	***	PCK2	<---	PCK	1.153	.045	25.649	***
PCK	<---	TPACK	.696	.032	21.742	***	PCK3	<---	PCK	1.211	.044	27.397	***
TK	<---	TPACK	.598	.035	16.872	***	PCK4	<---	PCK	1.175	.045	26.214	***
TCK	<---	TPACK	.788	.033	23.672	***	PCK5	<---	PCK	1.196	.048	24.811	***
TPK	<---	TPACK	.889	.034	26.283	***	TCK7	<---	TCK	1.025	.043	23.719	***
CK1	<---	CK	1.000				TCK6	<---	TCK	1.061	.051	21.015	***
CK2	<---	CK	.826	.046	17.808	***	TCK5	<---	TCK	1.070	.039	27.600	***
CK3	<---	CK	1.037	.051	20.166	***	TCK4	<---	TCK	1.091	.039	28.281	***
CK4	<---	CK	1.093	.054	20.262	***	TCK3	<---	TCK	1.109	.039	28.146	***
CK5	<---	CK	1.047	.057	18.320	***	TCK2	<---	TCK	1.104	.041	27.232	***
CK6	<---	CK	.938	.048	19.355	***	TCK1	<---	TCK	1.000			
CK7	<---	CK	1.124	.055	20.395	***	TPACK9	<---	TPACK	1.000			
CK8	<---	CK	1.034	.053	19.400	***	TPACK8	<---	TPACK	.972	.036	27.192	***
CK9	<---	CK	1.102	.053	20.826	***	TPACK7	<---	TPACK	.977	.043	22.931	***
CK10	<---	CK	1.209	.056	21.747	***	TPACK6	<---	TPACK	.972	.035	27.785	***
CK11	<---	CK	1.187	.064	18.461	***	TPACK5	<---	TPACK	.976	.037	26.191	***
CK12	<---	CK	1.133	.056	20.350	***	TPACK4	<---	TPACK	.851	.031	27.380	***
CK13	<---	CK	1.178	.058	20.293	***	TPACK3	<---	TPACK	.886	.034	25.704	***
CK14	<---	CK	1.028	.051	20.058	***	TPACK2	<---	TPACK	.940	.039	24.393	***
CK15	<---	CK	1.152	.057	20.206	***	TPACK1	<---	TPACK	.849	.034	25.063	***
PK1	<---	PK	1.000				TCK8	<---	TCK	1.107	.043	25.541	***
PK2	<---	PK	1.049	.050	20.916	***	TCK9	<---	TCK	1.036	.043	23.927	***
PK3	<---	PK	1.106	.049	22.748	***	TPK9	<---	TPK	1.000			
PK4	<---	PK	1.163	.051	22.620	***	TPK8	<---	TPK	.957	.029	32.491	***
PK5	<---	PK	1.180	.052	22.859	***	TPK7	<---	TPK	.986	.031	31.927	***
PK7	<---	PK	1.142	.049	23.494	***	TPK6	<---	TPK	.927	.041	22.812	***
TK1	<---	TK	1.000				TPK5	<---	TPK	.954	.030	32.231	***
TK3	<---	TK	1.251	.082	15.311	***	TPK4	<---	TPK	.864	.033	26.272	***
TK4	<---	TK	1.492	.107	13.951	***	TPK3	<---	TPK	.797	.032	24.975	***
TK5	<---	TK	1.573	.092	17.138	***	TPK2	<---	TPK	.873	.030	28.769	***
TK6	<---	TK	1.460	.085	17.091	***	TPK1	<---	TPK	.821	.030	26.964	***
TK7	<---	TK	1.460	.086	16.954	***							
TK8	<---	TK	1.314	.090	14.558	***							
TK9	<---	TK	1.215	.073	16.561	***							
TK10	<---	TK	1.225	.073	16.828	***							
TK11	<---	TK	1.095	.068	16.189	***							

Note: *** = $p < 0,001$

The CR (Critical Ratio) value is more significant than 1.96, and the probability value is less than 0.05 from Table 2, indicating that each variable indicator has met the validity requirements. Apart from looking at the CR value and probability, validity testing can also be done by looking at the standardized loading estimate or loading factor value greater than 0.5. If the loading factor value is more than 0.5, then the indicator significantly contributes to the latent variable. Meanwhile, Table 3 in this study shows that each indicator of the research variable has exceeded the required loading factor value, which means each indicator has adequate validity.

Table 3. Standardized loading estimate value

Estimate				Estimate			
CK	<---	TPACK	.781	TK10	<---	TK	.702
PK	<---	TPACK	.780	TK11	<---	TK	.664
PCK	<---	TPACK	.851	PCK1	<---	PCK	.751
TK	<---	TPACK	.834	PCK2	<---	PCK	.823
TCK	<---	TPACK	.883	PCK3	<---	PCK	.873
TPK	<---	TPACK	.891	PCK4	<---	PCK	.839
CK1	<---	CK	.664	PCK5	<---	PCK	.800
CK2	<---	CK	.642	TCK7	<---	TCK	.728
CK3	<---	CK	.739	TCK6	<---	TCK	.659
CK4	<---	CK	.743	TCK5	<---	TCK	.820
CK5	<---	CK	.663	TCK4	<---	TCK	.835
CK6	<---	CK	.705	TCK3	<---	TCK	.832
CK7	<---	CK	.749	TCK2	<---	TCK	.811
CK8	<---	CK	.707	TCK1	<---	TCK	.785
CK9	<---	CK	.767	TPACK9	<---	TPACK	.789
CK10	<---	CK	.808	TPACK8	<---	TPACK	.800
CK11	<---	CK	.668	TPACK7	<---	TPACK	.700
CK12	<---	CK	.747	TPACK6	<---	TPACK	.813
CK13	<---	CK	.745	TPACK5	<---	TPACK	.777
CK14	<---	CK	.735	TPACK4	<---	TPACK	.804
CK15	<---	CK	.741	TPACK3	<---	TPACK	.766
PK1	<---	PK	.717	TPACK2	<---	TPACK	.735
PK2	<---	PK	.725	TPACK1	<---	TPACK	.751
PK3	<---	PK	.789	TCK8	<---	TCK	.772
PK4	<---	PK	.784	TCK9	<---	TCK	.733
PK5	<---	PK	.792	TPK9	<---	TPK	.858
PK7	<---	PK	.815	TPK8	<---	TPK	.833
TK1	<---	TK	.594	TPK7	<---	TPK	.825
TK3	<---	TK	.616	TPK6	<---	TPK	.663
TK4	<---	TK	.546	TPK5	<---	TPK	.830
TK5	<---	TK	.721	TPK4	<---	TPK	.731
TK6	<---	TK	.718	TPK3	<---	TPK	.706
TK7	<---	TK	.709	TPK2	<---	TPK	.775
TK8	<---	TK	.576	TPK1	<---	TPK	.744
TK9	<---	TK	.686				

The results obtained from Table 3 strengthen the finding that each variable indicator is declared valid. With a high loading factor value, namely more than 0.5, this instrument has adequate statistical and practical validity in measuring TPACK knowledge. The high validity of these indicators ensures that the research results are reliable and provide accurate insight into Islamic education teachers' TPACK knowledge and skills. Apart from validity testing, instrument reliability testing was also carried out to ensure the constructs' internal consistency. Reliability testing uses construct reliability and variance extracted tests on each latent variable, which can be presented in Table 4.

Table 4. Construct reliability and variance extracted values

No	Knowledge Aspect	Construct Reliability	Variance Extracted
1	Content Knowledge (CK)	0.942	0.523
2	Pedagogical Knowledge (PK)	0.898	0.595
3	Technological Knowledge (TK)	0.915	0.518
4	Pedagogical Content Knowledge (PCK)	0.910	0.669
5	Technology Content Knowledge (TCK)	0.932	0.604
6	Technological Pedagogical Knowledge (TPK)	0.931	0.603
7	Technological Pedagogical Content Knowledge (TPACK)	0.930	0.595

Based on Table 4, it can be seen that the Content Knowledge (CK) variable has a construct reliability value of 0.942. The Pedagogical Knowledge (PK) variable has a construct reliability value of 0.898, while Technological Knowledge (TK) reaches 0.915. Pedagogical Content Knowledge (PCK) shows a construct reliability value of 0.910, Technological Content Knowledge (TCK) of 0.932, Technological Pedagogical Knowledge (TPK) of 0.931, and Technological Pedagogical Content Knowledge (TPACK) of 0.930. The construct reliability values of these seven variables are all greater than the cut-off value of 0.70, which shows that the indicators for each variable have perfect internal consistency. This means that the instrument used is reliable in measuring the construct. The variance extracted (VE) value for each variable has also been calculated and is displayed in Table 4. The Content Knowledge (CK) variable has a VE value of 0.523, Pedagogical Knowledge (PK) of 0.595, Technological Knowledge (TK) of 0.518, Pedagogical Content Knowledge (PCK) of 0.669, Technological Content Knowledge (TCK) of 0.604, Technological Pedagogical Knowledge (TPK) of 0.603, and Technological Pedagogical Content Knowledge (TPACK) of 0.595.

Variance extracted values greater than 0.50 for all of these variables indicate that the variance extracted from the indicators is greater than the error variance. These results suggest that the TPACK instrument developed to measure the knowledge of Islamic education teachers who are PPG graduates in positions at the Ministry of Religion of the Republic of Indonesia has high validity and reliability. The TPACK instrument was also analyzed using a structural model to describe the relationship between latent variables. In this analysis, the validity of the structural model is evaluated by reviewing the Goodness of Fit (GOF) values, which include various model fit indices. These indices explain how well the obtained data fits the hypothesized model. To assess the feasibility of a structural model, the achievability of the suitability criteria for the index and its cut-off value must be considered. These suitability criteria include various indices such as Chi-square, RMSEA, CFI, and TLI, each with specific cut-off values that must be met for the model to be considered reasonable. Meanwhile, RMSEA, TLI, and CFI are more valid and robust to different sample conditions and model complexity and, therefore, more reliable in modern SEM reports. The Goodness of Fit values obtained from this analysis are displayed in Table 5.

Table 5. The goodness of fit indices

Goodness of Fit Indices	Cut-Off Value	Analysis Results	Model Evaluation
RMSEA	$\leq 0,08$	0.069	Fit
TLI	$\geq 0,95$	0.812	Marginal Fit
CFI	$\geq 0,95$	0.819	Marginal Fit

Based on Table 5, the structural model analysis in this study shows that RMSEA (Root et al. of Approximation) and CFI (Comparative Fit Index) are two essential criteria for determining the level of model acceptance. In this research, the CFI value obtained was 0.819, and the RMSEA value was 0.069. These two values indicate that the model used has a high level of acceptance because the CFI is close to 1, and the RMSEA is within acceptable limits. Meanwhile, the TLI (Tucker-Lewis Index) value of the TPACK instrument in this study was 0.812. Even though this TLI value is slightly below the recommended critical value, namely ≥ 0.95 , the model acceptance requirements criteria can still be met. In the AMOS SEM analysis, a correlation test was also carried out to determine the magnitude of the correlation between the latent variables constructed. The correlation test is carried out by looking at the CR and p-values in the output regression weights table, as presented in Table 6.

Table 6. Regression weight output

			Estimate	S.E.	CR.	P	Label
CK	<---	TPACK	.651	.035	18.359	***	par_57
PK	<---	TPACK	.614	.032	19.292	***	par_58
PCK	<---	TPACK	.696	.032	21.742	***	par_59
TK	<---	TPACK	.598	.035	16.872	***	par_60
TCK	<---	TPACK	.788	.033	23.672	***	par_61
TPK	<---	TPACK	.889	.034	26.283	***	par_62

Note: *** = $p < 0,001$

Based on Table 6, each variable in the TPACK instrument has a significant correlation and powerful influence on each other. This is indicated by a Critical Ratio (CR) value greater than 1.96 and a p-value less than 0.05. In particular, the Content Knowledge (CK) instrument shows a significant correlation in measuring the level of teacher understanding of TPACK with a CR value of 18.359 and $p < 0.001$. Furthermore, the Pedagogical Knowledge (PK) instrument also significantly correlates with the level of teacher understanding of TPACK, with a CR value reaching 19.292 and $p < 0.001$. The Pedagogical Content Knowledge (PCK) instrument shows a robust correlation with a CR value of 21,742 and $p < 0.001$. The Technological Knowledge (TK) instrument also shows a significant correlation with the level of teacher understanding of TPACK, with a CR value of 16,872 and $p < 0.001$. The Technological Content Knowledge (TCK) instrument shows a robust correlation with a CR value of 23,672 and $p < 0.001$. The Technological Pedagogical Knowledge (TPK) instrument shows the strongest correlation with a CR value of 26,283 and $p < 0.001$. Thus, these findings indicate that all components in the TPACK instrument are strongly and significantly correlated in measuring the level of teacher understanding of TPACK.

3.3. Results of TPACK Islamic Education Teachers Graduates of the In-Service Professional Teacher Program

The TPACK instrument, which had gone through the validity and reliability testing stages with analysis using SEM AMOS, was then distributed to respondents of Islamic Education teachers who had graduated from PPG. The purpose of distributing this instrument is to evaluate the TPACK abilities of these teachers. Islamic education teachers were asked to work on this instrument to measure their TPACK ability level. The data collected from these respondents was then analyzed further to

understand their TPACK capabilities. The data obtained from respondents was differentiated based on two main categories: age range and teachers' employment status. This categorization aims to understand how various demographic and professional factors influence teachers' TPACK abilities. The results of the analysis of the TPACK abilities of Islamic education teachers who graduated from PPG based on the age range of the work period are shown in Figure 3.

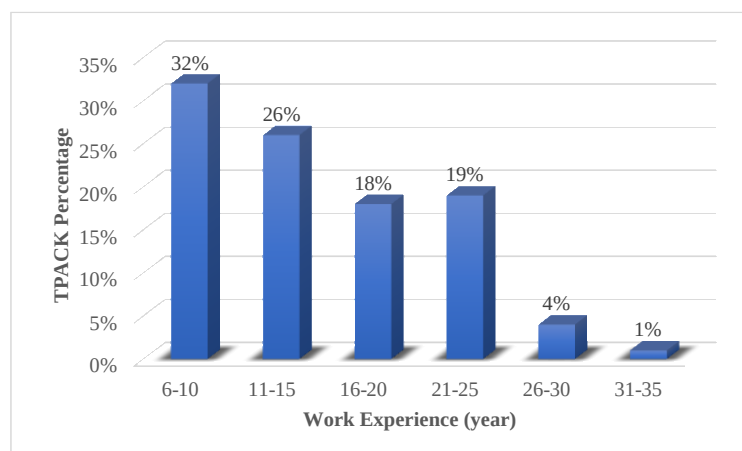


Figure 3. TPACK Islamic education teachers who are PPG graduates based on work experience

Based on Figure 3, the distribution of TPACK abilities among Islamic education teachers with various levels of work experience shows exciting variations. Islamic education teachers with work experience between 6-10 years show the highest TPACK ability at 32%. On the other hand, Islamic education teachers with 31-35 years of work experience show the lowest TPACK ability, namely only 1%. In addition, the working age ranges of 16-20 years and 21-25 years show almost the same percentage of TPACK ability, namely 18% and 19%, respectively. Even though the percentages are nearly the same, teachers with 21-25 years of service have a slight advantage in TPACK abilities compared to teachers who have served for 16-20 years. Meanwhile, the results of the analysis of the TPACK abilities of Islamic education teachers who graduated from PPG based on teacher employment status can be shown in Figure 4.

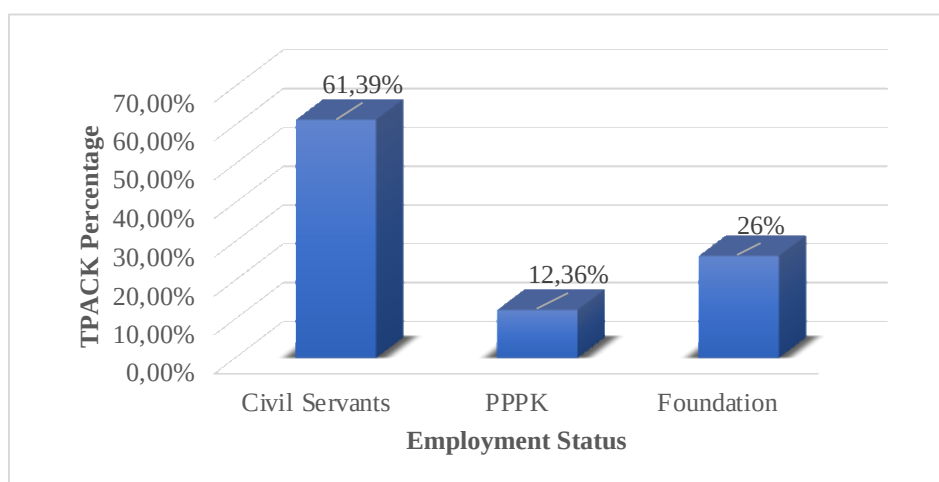


Figure 4. TPACK of Islamic Education teachers who graduate from PPG based on employment status

Figure 4 shows that the distribution of TPACK abilities among PPG Islamic education teacher graduates varies based on their employment status. This data indicates that Islamic education teachers with civil servant status have the highest percentage of TPACK abilities, 61.39%. In contrast, teachers with government employees with work agreements (PPPK) status have the lowest percentage of TPACK abilities, 12.36%.

4. Discussion

The TPACK instrument developed in this research is on the variables Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK) all produce construct reliability values that are greater than the cut-off value of 0.70. In addition, each variable's variance extracted (VE) value is more significant than 0.50, indicating that the variance extracted from the indicators is greater than the error variance. This suggests that the latent construct is quite strong in explaining the variance of the indicators (Bollen & Diamantopoulos, 2017). A high construct reliability value indicates that this instrument is consistent in its measurement, while a high variance extracted value suggests that it can effectively reflect the measured construct (Clark & Watson, 2019). In other words, this TPACK instrument has high validity and reliability for measuring the knowledge of Islamic education teachers who are PPG graduates in positions at the Ministry of Religion of the Republic of Indonesia.

The TPACK instrument was also analyzed using a structural model to describe the relationship between latent variables. This structural model analysis aims to understand how latent variables interact and influence each other in measuring TPACK knowledge. In this analysis, the validity of the structural model is evaluated by reviewing the Goodness of Fit (GOF) values, which include various model fit indices. To assess the feasibility of the structural model, the achievability of the suitability criteria for the Chi-square index, RMSEA, CFI, and TLI, as well as their cut-off values, must be considered (Groskurth et al., 2023). The Goodness of Fit values obtained from this analysis show that RMSEA (Root et al. of Approximation) and CFI (Comparative et al.) are essential criteria for determining the level of model acceptance. The condition for CFI is to have a value range between 0 and 1, where the closer to 1, the higher the level of model acceptance. RMSEA has a value criterion that must be less than or equal to 0.08 (Xia & Yang, 2019). Meanwhile, in this study, the CFI value obtained was 0.819, and the RMSEA value was 0.069. These two values indicate that the model used has a high level of acceptance because the CFI is close to 1, and the RMSEA is within acceptable limits.

Apart from CFI and RMSEA, the TLI (Tucker-Lewis Index) is also used to measure the research model's suitability. The acceptance criteria for TLI is between 0 and 1, with the recommended critical value being ≥ 0.95 (Perry et al., 2015). The results of this research analysis show a TLI value of 0.812. Although this TLI value is slightly below the recommended critical value, the model acceptance requirements criteria can still be met. This shows that even though the TLI does not reach the optimal level, the model can still be considered quite fit to the observed data (Yaşlıoğlu & Yaşlıoğlu, 2020). Overall, the analysis results based on CFI, RMSEA, and TLI values indicate that the structural model used in this research has an adequate level of acceptance. CFI and RMSEA provide strong evidence that the model fits the data. Meanwhile, although the TLI is slightly lower than the critical value, it is still within acceptable limits. Thus, this structural model can be considered valid for describing the relationship between latent variables in measuring TPACK knowledge in Islamic education teachers.

In the AMOS SEM analysis, a correlation test was also carried out to determine the magnitude of the correlation between the constructed latent variables. This correlation test is essential to understand how these variables are interconnected and influence each other in the research model (Petter et al., 2013). The correlation test is carried out by looking at the Critical Ratio (CR) and p-values in the output regression weights table. The conditions for accepting the correlation hypothesis are that the CR value must be greater than 1.96, and the p-value must be less than 0.05 (Greenland et al., 2016). A high CR value indicates a significant correlation between variables, while a low p-value indicates that the results did not occur by chance.

Meanwhile, the TPACK instrument developed obtained a Critical Ratio (CR) value greater than 1.96 and a p-value less than 0.05. In particular, the Content Knowledge (CK) instrument shows a

significant correlation in measuring the level of teacher understanding of TPACK with a CR value of 18.359 and $p < 0.001$. This indicates that the CK variable is essential in assessing how teachers integrate content in TPACK-based teaching practices. Furthermore, the Pedagogical Knowledge (PK) instrument also significantly correlates with the level of teacher understanding of TPACK, with a CR value reaching 19.292 and $p < 0.001$.

This confirms that pedagogical understanding is a critical component in TPACK assessment. The Pedagogical Content Knowledge (PCK) instrument shows a robust correlation with the CR value of 21.742 and $p < 0.001$, which shows that the combination of pedagogy and content is essential in understanding teachers' TPACK knowledge. This correlation shows how important it is to deeply understand how content and teaching methods are interconnected (Kleickmann et al., (2013). The Technological Knowledge (TK) instrument also shows a significant correlation with the level of teacher understanding of TPACK, with a CR value of 16.872 and $p < 0.001$. The Technological Content Knowledge (TCK) instrument shows a robust correlation with a CR value of 23.672 and $p < 0.001$, which shows that technology and content have a significant role in TPACK knowledge. In addition, the Technological Pedagogical Knowledge (TPK) instrument shows a strong correlation, with a CR value of 26.283 and $p < 0.001$. This confirms that understanding technology in a pedagogical context is critical to measuring teachers' TPACK knowledge. Thus, all components in the TPACK instrument are strongly and significantly correlated in measuring teachers' understanding of TPACK.

This valid and reliable instrument was tested on Islamic education teachers who graduated from PPG to determine their TPACK abilities. Islamic education teachers with work experience between 6-10 years show the highest TPACK ability of 32%. This is due to the balance between work experience and openness to new technology. They already have a strong foundation in teaching and are easy to adapt to technological developments (Ertmer & Ottenbreit-Leftwich, 2013). In contrast, Islamic education teachers with 31-35 years of work experience show the lowest TPACK ability, namely only 1%. This may indicate that teachers with extended work experience need help with the latest technological developments. This finding also aligns with research by Koh et al. (2013), who stated that more experienced teachers are often more attached to traditional teaching methods and less flexible in adopting new technology than younger teachers. Technology integration in teaching requires ongoing support and training for all teachers, regardless of their experience.

The working age ranges of 16-20 years and 21-25 years show almost the same percentage of TPACK ability, 18% and 19%, respectively. Even though the percentages are nearly the same, teachers with 21-25 years of service have a slight advantage in TPACK abilities compared to teachers with 16-20 years of service. This suggests that after reaching a certain point in their careers, the ability to integrate technology in teaching may stabilize or increase slightly, but more slowly than the increase seen in teachers with 6-10 years of work experience. Meanwhile, the distribution of TPACK abilities among Islamic education teachers who graduated from PPG varies based on their employment status. In Indonesia, Islamic education teachers have three main employment statuses, namely civil servants (PNS), government employees with work agreements (PPPK), and teachers employed by foundations (Idris et al., 2022). Data shows that Islamic education teachers with civil servant status have the highest TPACK abilities, namely 61.39%. This indicates that PNS teachers dominate the Islamic education teacher population. PNS teachers also have better access to resources and training that improve their TPACK abilities (Zuhro & Rindanigsih, 2023). Teachers who work under foundations and usually teach in private schools have the highest percentage of TPACK abilities. Although smaller than civil servant teachers, this percentage is significant because many private schools rely on foundation teachers to manage Islamic education teaching.

Private schools often provide in-house training and have initiatives to improve their teachers' TPACK capabilities, allowing them to remain competitive and effective in technology-based teaching (Bose, 2013). In contrast, teachers with PPPK status have the lowest percentage of TPACK ability,

namely 12.36%. This can be caused by several factors, such as the number of PPPK teachers in Indonesia still needing to be bigger than that of PNS teachers and foundation teachers. In addition, PPPK status is a relatively new category in the Indonesian education system, so few training programs and resources are available (Srikanti, 2021). Furthermore, these findings generally show that the TPACK ability of Islamic education teachers who are PPG graduates in Indonesia in terms of working age range and employment status is still relatively low.

This occurs because teachers cannot integrate material, pedagogy, and technology, not because of a reluctance to innovate but because there is no supervision and improvement of learning knowledge. This is supported by findings from research by Tondeur et al. (2020), which emphasizes the importance of ongoing support and training to improve teachers' TPACK abilities. Continuous professional development is essential to help teachers integrate technology effectively into their teaching practices. Apart from that, teacher professionalism is not necessarily able to improve the quality of learning because the tendency to repeat old methods is still strong. This is confirmed by research by Valverde-Berrocoso et al. (2021), who found that teachers need appropriate intervention and ongoing support to revert to traditional teaching practices despite their technological knowledge. Therefore, measuring the effectiveness of the TPACK instrument and post-program supervision is essential to encourage the transformation and creativity of Islamic education teachers in their duties as agents of change in the 21st-century education era.

5. Conclusion

The development of the TPACK instrument model functions as a measuring tool for evaluating teacher performance by modifying and deleting 65 questionnaire items. This instrument was tested for its effectiveness in measuring the knowledge of Islamic education teachers and their families among PPG students in positions at the Ministry of Religion of the Republic of Indonesia, with a focus on the validity and reliability of the instrument. The validity of TPACK items is determined through the Critical Ratio (CR), probability (p), and standardized loading estimate or loading factor values, indicating that this instrument is valid for measuring the TPACK abilities of Islamic education teachers who are PPG graduates. Instrument reliability tests based on construct reliability and variance extracted show that the indicators consistently describe highly reliable latent constructs. The results of the structural model analysis by reviewing the Goodness of Fit (GOF) values through the suitability criteria of the Chi-square index, RMSEA, CFI, and TLI show that the model used has a high level of acceptance. Thus, this model can be considered valid for describing the relationship between latent variables in measuring TPACK knowledge in Islamic education teachers. The SEM correlation test shows that each variable or component in the TPACK instrument is strongly and significantly correlated in measuring Islamic education teachers' level of TPACK understanding based on the CR value and p-value in the output regression weights table. Measuring the TPACK ability of Islamic education teachers who graduated from PPG using this instrument shows that teachers with a working age range of 6-10 years have the highest TPACK ability, while teachers with a working age range of 31-35 years have the lowest TPACK ability. The distribution of TPACK abilities based on employment status shows that Islamic education teachers with civil servant (PNS) status have the highest TPACK abilities, followed by Foundation teachers, and the lowest are government employees with work agreements (PPPK) teachers. These findings indicate that the TPACK ability of Islamic education teachers who are PPG graduates in Indonesia is still low when viewed from the working age range and employment status. This is caused by a lack of monitoring and increasing learning knowledge, not because of teachers' reluctance to innovate.

6. Suggestion

This research provides an essential contribution to the Ministry of Religion in testing teachers' TPACK knowledge through the instruments that have been developed. This instrument can be used

as a reference in the in-service Teacher Professional Education Program (PPG). With this instrument, the Ministry of Religion has a valid and reliable tool to measure the TPACK abilities of Islamic education teachers. Using this standardized instrument will help map teacher competencies so that the training and development programs provided can be more focused and effective. The development of this instrument should be focused on primary education, with various adjustments to suit the context and needs of the field. With the TPACK instrument specific for primary education, teachers' abilities can be measured more precisely so that the results can be used to improve the quality of primary education. In addition, the TPACK instrument in the religious sector needs to be expanded to include other religions so that it has a higher level of reliability and is relevant for all religious teachers in Indonesia. By increasing the scope of this instrument, the Ministry of Religion can ensure that all spiritual teachers have adequate TPACK competencies, not just Islamic education teachers.

Declarations

Author Contributions. S.: Literature review, conceptualization. E.S.: methodology, data analysis. H.: review-editing and writing. H.F.A: Original manuscript preparation. All authors have read and approved the published on the final version of the article

Conflicts of Interest. The authors declare no conflict of interest.

Funding. No funding

Ethical Approval. (All data collection and storage procedures were approved by the Institutional Review Board as an exempt study for program improvement. Participant identifiers were removed to ensure anonymity.

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