Journal of Research and Advances in Mathematics Education

Volume 8, Issue 4, October 2023, pp. 233 – 242
DOI: 10.23917/jramathedu.v8i4.1675
p-ISSN: 2503-3697, e-ISSN: 2541-2590

The readiness of mathematics teachers in south sumatra province to conduct online learning from the TPACK perspective

Heru[1], Refi Elfira Yuliani[2*], Rieno Septra Nery[3]

Universitas Muhammadiyah Palembang, Indonesia

Citation: Heru, H., Yuliani, R. E., & Septra Nery, R. (2023). The readiness of mathematics teachers in south sumatra province to conduct online learning from the TPACK perspective. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, 8(4), 233-242. https://doi.org/10.23917/jramathedu.v8i4.1675

ARTICLE HISTORY:
Received 3 March 2023
Revised 1 August 2023
Accepted 25 September 2023
Published 30 October 2023

KEYWORDS:
Teacher readiness
Mathematics
Online learning
TPACK

ABSTRACT

Information and Communication Technology (ICT) use in digital-era learning leads to online learning. Implementing online learning requires a combination of skills from teachers in integrating pedagogical knowledge, subject matter mastery, and technological skills to create effective learning. This study aims to investigate the readiness of Mathematics teachers in the South Sumatra Province to conduct online learning from the TPACK perspective. This research is a survey type of study. The research subjects are Mathematics teachers in South Sumatra who teach Mathematics subjects at the primary, secondary, and high school levels. The sample used in this study amounted to 170 people. Based on the results discussed, Mathematics teachers in the South Sumatra Province are ready to conduct online learning based on the TPACK perspective. The highest readiness component for conducting learning is Technological Knowledge (TK), and the lowest is Technological Pedagogical and Knowledge (TPACK).

INTRODUCTION

The online learning policy implemented during the Covid-19 pandemic by the Minister of Education and Culture (Heru et al., 2021) has brought a new dimension to education in Indonesia. Various efforts have been made to ensure that students have the right to learn and that teachers can fulfil their duties fully. These efforts include providing quotas for students and teachers, training to improve teachers' competencies, preparing learning resources needed for online learning by the central and local governments, and many other efforts.

Online learning requires teachers to utilize technology in their teaching. Teachers' experiences, competencies, and knowledge in using technology will affect their attitudes towards technology (Msila, 2015; Termit Kaur & Samli, 2014). The success of integrating technology and learning cannot be separated from the positive attitudes and acceptance of teachers towards technology (Kumar et al., 2008; Msila, 2015). On the other hand, mathematics teachers face the problem of low ability to utilize technology in learning (Bahador et al., 2018; Marbán & Mulega, 2019). It has provided an overview of the challenges faced by teachers in implementing online learning

The complexity of the challenges faced in implementing online learning includes the lack of internet network facilities, hardware limitations, insufficient mastery of open-source applications/software for online learning, weak technological proficiency, limited teacher supervision over students' activities during learning, and low parental supervision over students learning at home due to their work (Asmuni, 2020; Azzahra, 2020; Yuliani & Heru, 2021). It has become a reference for teachers' readiness to conduct online learning.

*Corresponding author: refielfirayuliani@gmail.com

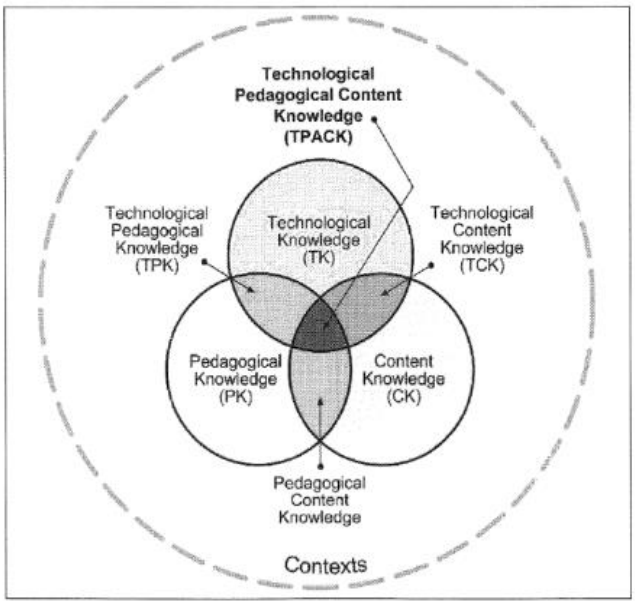


Figure 1. The technological pedagogical and content knowledge ramework (Schmidt et al., 2009)

In addition, proficiency in using technology alone will not result in effective technology integration in learning and may even hinder teachers' ability to view knowledge holistically (Benson et al., 2015). The ability to use technology is not enough to conduct online learning effectively. When not maximized in implementing learning, teachers who focus on utilising technology will view technology as the cause of failure (Benson et al., 2015).

Therefore, to teach effectively in the era of technology, it is important to integrate technology skills with mastery of content and pedagogical skills. The TPACK (Technological Pedagogical and Content Knowledge) framework was introduced to explain the relationship and complexity between the three basic knowledge components: technological knowledge, pedagogical knowledge, and content (Mishra & Koehler, 2006; Mishra, 2019; Schmidt et al., 2009). The intersection of these three types of knowledge can be seen in Figure 1.

The readiness of teachers to conduct online learning is closely tied to their ability to integrate technology. A teacher's online teaching success depends on their readiness to integrate technology into their teaching practices, which is determined by their competence and positive attitude towards technology (Baya'a & Daher, 2012; Msila, 2015). Fajriana and Safriana (2021) stated that the readiness of science and mathematics teachers in North Aceh to conduct online learning needs to be improved, particularly in terms of their concern for implementing online learning in schools and their ability to integrate online learning with offline learning in the classroom.

Identifying the readiness of mathematics teachers to conduct online learning is necessary to obtain data related to their readiness and to address any weaknesses or improve the skills required for implementing online learning. The readiness of teachers to integrate technology into their teaching practices should be viewed from the perspective of the TPACK framework (Heru et al., 2021), which specifically examines whether the readiness factors include Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technology Content Knowledge (TPK), Technology Pedagogical Knowledge (TPK), and Technological Pedagogical Knowledge (TPACK). Additionally, this study will examine significant differences in the respondents' demographics based on gender, age, certification, internet quality, and whether they teach at the elementary, middle, or high school level.

METHODS

Research methods must provide clearly information about how to solve the research problems. Generally consists of type and design of the study, the research setting, research subjects (population, sample and sampling), data collection techniques, the validity of the data (if any), and data analysis techniques.

Table 1. Respondents' demographic profile

Demographics	Respondents	Percentage
Jenis Kelamin		
Male	31	18%
Female	139	82%
Umur		
21 – 30 years old	42	25%
31 – 40 years old	35	21%
41 – 50 years old	22	13%
>50 years old	10	6%
Certification		
Certifed	50	29%
Not Certifed	120	71%
Internet Network Quality		
Very Good	29	17%
Good	87	51%
Less Good	48	28%
Poor	6	4%
Teaching Level		
Primary	47	28%
Junior High School	53	31%
Senior High School	70	41%

This study is a type of survey research. Survey research is used to obtain data from a natural (not artificial) specific location, where researchers distribute questionnaires (Sugiyono, 2016). The subjects of this study were math teachers in Sumatra Selatan who teach at the elementary, junior high, and senior high school levels. The sample used in this study was 170 people, consisting of 44 elementary school teachers, 56 junior high school teachers, and 70 senior high school teachers. The demographic profile of the respondents can be seen in Table 1.

The questionnaire instrument used is the mathematics teacher readiness instrument for online learning from the TPACK perspective, which has been developed by Heru et al. (2021) regarding Schmidt et al. (2009). The aspects looked at in this instrument are Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technology Content Knowledge (TPK), Technology Pedagogical Knowledge (TPK), and Technological Pedagogical Knowledge (TPACK) of mathematics teachers. How to distribute readiness questionnaires Mathematics teachers conduct online learning based on the TPACK perspective using Google Forms from July – October 2021. Data analysis techniques use RASCH modeling (Sumintono & Widhiarso, 2013, 2015).

FINDINGS

Research instrument

The first analysis carried out in this research was to examine the quality of the instruments used. This analysis used the RASCH model with the WINSTEPS Version 3.73 application. The criteria used to check the suitability of the items that are likely to be appropriate (outliers or misfits) are, (1) Accepted Outfit Mean Square (MNSQ): 0.5 < MNSQ < 1.5, (2) Accepted Outfit Z-Standard (ZSTD) value: -0.2 < ZSTD < 2.0 and, (3) Point Measure Correlation (PT Mean Corr) value: 0.4 < PT Measure Corr < 0.85.

An item can be categorized as an outlier or misfit if it does not meet 2 of the three criteria (Sumintono & Widhiarso, 2013, 2015).

Item STATISTICS: MISFIT ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
3	628	170	.53	.15	1.27	2.3	1.48	3.2	A .62	.71	61.5	68.3	TK3
16	633	170	.41	.15	1.11	1.0	1.46	3.0	B .62	.71	69.8	68.4	PK16
2	629	170	.50	.15	1.44	3.5	1.44	3.0	C .59	.71	60.4	68.3	TK2
9	630	170	.48	.15	1.18	1.5	1.35	2.5	D .60	.71	65.1	68.3	CK9
7	652	170	-.03	.15	1.27	2.2	1.34	2.2	E .56	.70	70.4	68.7	CK7
41	629	170	.50	.15	.74	-2.5	.70	-2.5	d .79	.71	74.0	68.3	TPACK41
34	626	170	.57	.15	.73	-2.6	.70	-2.5	c .81	.71	75.1	68.2	TPACK34
39	627	170	.55	.15	.70	-2.9	.66	-2.9	b .78	.71	71.6	68.3	TPACK39
35	622	170	.66	.15	.65	-3.5	.62	-3.4	a .81	.71	75.7	68.2	TPACK35
MEAN	650.7	170.0	.00	.15	1.00	-.1	.99	-.2			69.6	68.2	
S.D.	31.3	.0	.73	.00	.18	1.6	.22	1.6			4.0	.4	

Figure 2. Misfit order for OUTFIT ZSTD data that does not meet the criteria (-2.0 < ZSTD < 2.0).

Table 2. Summary of Person and Item Values (Logit).

	Person	Item
N	170	44
Measures (logit)		
Mean	2,90	0,0
SD (standard deviation)	2,12	0,73
SE (standar error)	0,16	0,11
Separation	5,36	4,51
Reliabilitas	0,97	0,95
Outfit Mean Square		
Mean	0,99	0,99
SD	0,61	0,22
Alpha Cronbach: 0,98		

Based on Figure 2, 9 statement items do not meet the criteria (-2.0 < ZSTD < 2.0), namely statement items number 3, 16, 2, 9, 7, 41, 34, 39, 35. Although they do not meet the (-2.0 < ZSTD < 2.0) criteria, these statement items can still be used because they have met the other two criteria.

The analysis results showed that the person measure value of 2.90 indicates that the respondents' assessment is at a good level (above 0.0 logits), and there is a tendency for the respondents' ability to be higher than the difficulty level of the statement items. In addition, Cronbach's alpha value reached 0.98, which is higher than the minimum threshold of 0.67, indicating that the quality of the items and respondents in the assessment is good. The person reliability also reached 0.97, higher than the minimum threshold of 0.67 (Sumintono & Widhiarso, 2013, 2015), indicating that the research respondents are diverse. The item reliability of 0.95 or more than 0.67 (Sumintono & Widhiarso, 2013, 2015) indicates that the instrument items are diverse. The person separation of 5.53 indicates that the respondents are divided into five groups. The item separation of 4.51 indicates that the items are divided into four groups of item difficulty levels. The detailed data can be seen in Table 2.

The readiness of mathematics teachers to implement online learning

The overall data analysis showed that Mathematics teachers in South Sumatra Province are ready to implement online Learning from the TPACK perspective. It can be seen from the average

Table 3. Summary of readiness for online learning from the TPACK perspective

Component	Mean	Standard Deviation
Readiness for Online Learning from a TPACK Perspective	2,90	2,12
Technology Knowledge (TK)	4,04	3,99
Content Knowledge (CK)	9,43	5,10
Pedagogic Knowledge (PK)	3,99	2,54
Pedagogical Content Knowledge (PCK)	3,11	3,49
Technology Content Knowledge (TCK)	4,43	4,66
Technology Pedagogical Knowledge (TPK)	1,82	6,01
Technological Pedagogical and Knowledge (TPACK)	1,50	3,54

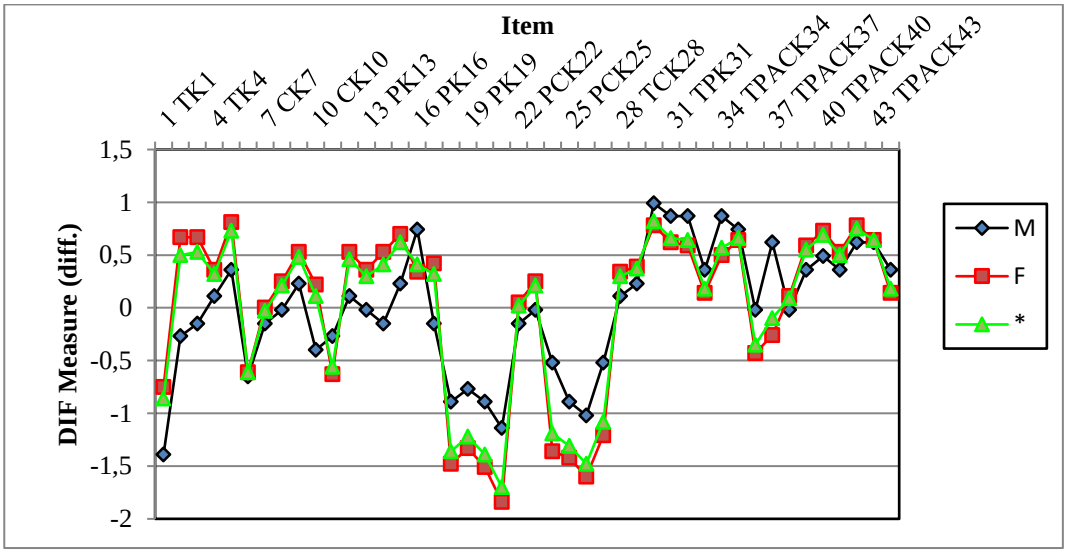


Figure 3. DIF plot items for demographic based on gender.

score of Readiness to Implement Online Learning from the TPACK Perspective at +2.90 logits (SD = 2.12), which is higher than zero logits (Sumintono & Widhiarso, 2013, 2015).

The TPACK components show that the highest average score of teachers is in the Content Knowledge (CK) component, with an average score of 9.43 (SD = 5.10). Next is Technological Content Knowledge (TCK), with an average of 4.43 (SD = 4.66). The next order is Technology Knowledge (TK), with an average of 4.04 (SD = 3.99). Meanwhile, the component with the lowest average score is Technological Pedagogical and Knowledge (TPACK), with an average score of 1.50 (SD = 3.54). The readiness of teachers to implement online Learning can be seen in Table 3.

Differences in demographic factors of teacher readiness in online learning

Differences in demographic factors such as gender, age, certification status, internet quality, and teaching level (elementary, junior high, senior high) on mathematics teacher readiness in online learning were analyzed using Differential Item Functioning (DIF) analysis.

Figure 3 shows the DIF plot items based on gender. For the gender-based demographic, four items are identified as having significant differences. These items are TK2 (I am familiar with new technology and its features), TK3 (I have the technical skills needed to use technology), PCK24 (I support critical thinking for students in learning mathematics), and TPACK37 (I use several websites that provide supporting information for students regarding the learned mathematics material during online learning).

For item TK2, it was found that female teachers are more familiar with new technology and its features than male teachers. Similarly, for item TK3, female teachers have greater technical skills in using technology compared to male teachers. However, for item PCK24, male teachers are more supportive of critical thinking for students than female teachers. In addition, for item TPACK37, male

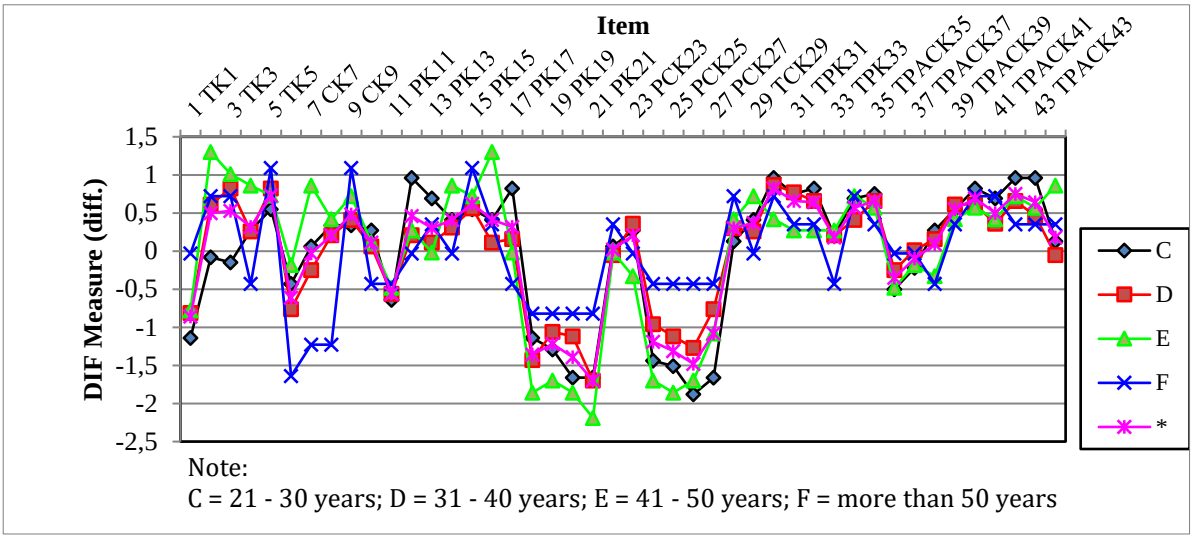


Figure 4. DIF item plot for demographics based on Age.

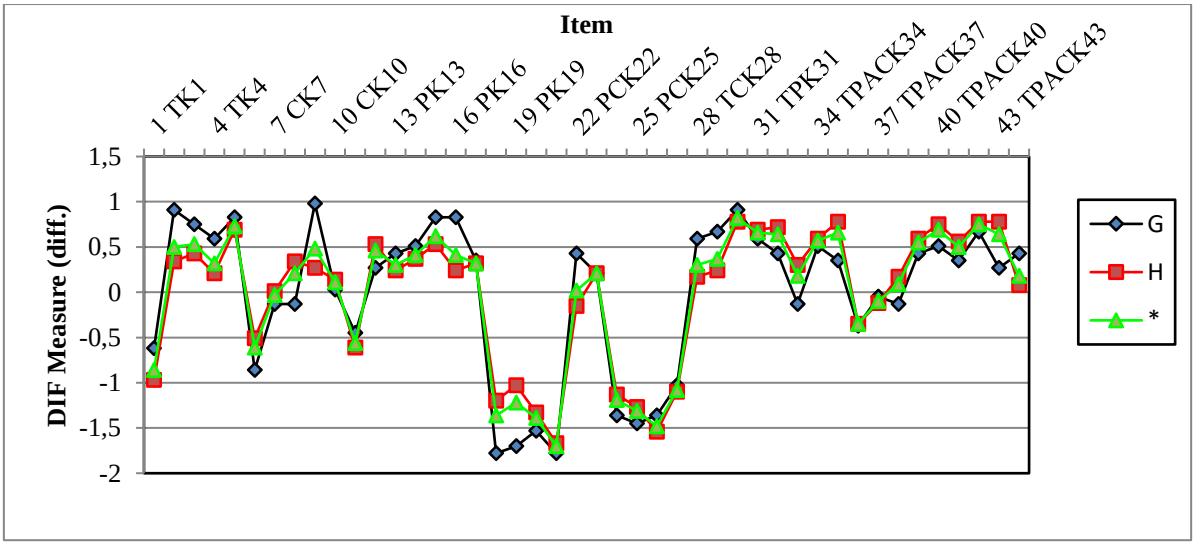


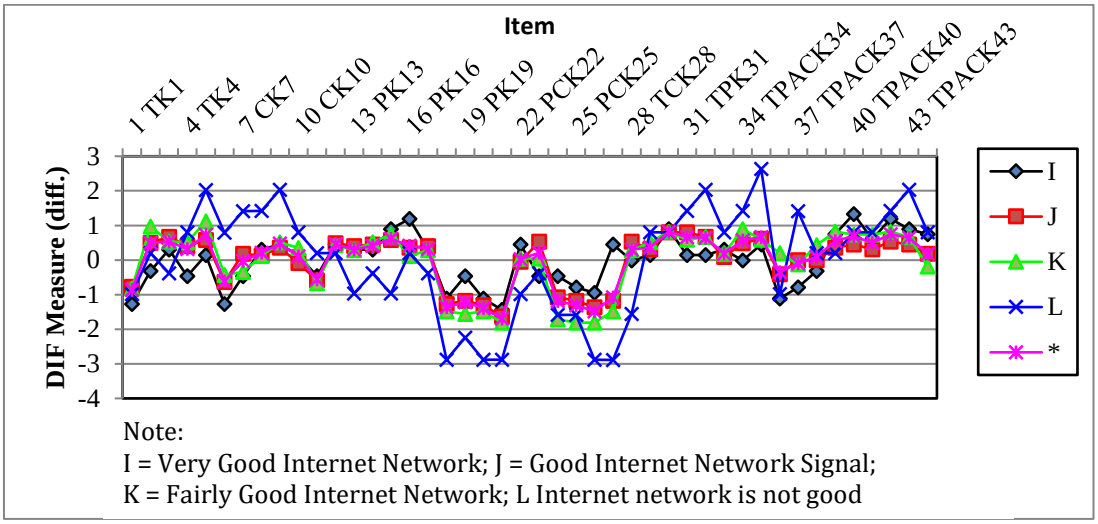
Figure 5. DIF item plot for demographics based on teacher certification.

teachers have a higher level of utilization of several websites that provide supporting information for mathematics learning during online learning compared to female teach.

Figure 4 shows the DIF person plot based on Age. In the demographic based on Age, three items are identified to have significant differences. These items are TK2 (I am familiar with new technology and its features), TK3 (I have the technical skills needed to use technology), and CK7 (I can use mathematical thinking). For item TK2, a surprising fact was found that teachers in the age range of 41-50 tend to be more familiar with new technology and its features. Similarly, for item TK3, teachers aged 41-50 have greater technical skills in using technology. Additionally, for item CK7, teachers in the age range of 41-50 have greater use of mathematical thinking than teachers in the age range of 21-30, 31-40, and over 50, respectively.

Figure 5 shows the DIF item plot based on teacher certification. One item is identified as a significant difference in the demographic based on teacher certification. For item CK9 (I have various ways and strategies to develop mathematical understanding), certified teachers have higher methods and strategies to develop mathematical understanding than non-certified teachers.

Figure 6 shows the DIF item plot based on Internet network quality. In this demographic, there is one item identified to have significant differences, namely item PCK27 (I support reflective thinking in learning mathematics). In this item, teachers with better internet network quality can more support reflective thinking in learning compared to teachers with poor internet network quality.



Note:
I = Very Good Internet Network; J = Good Internet Network Signal;
K = Fairly Good Internet Network; L Internet network is not good

Figure 6. DIF item plot for demographics based on Internet network quality.

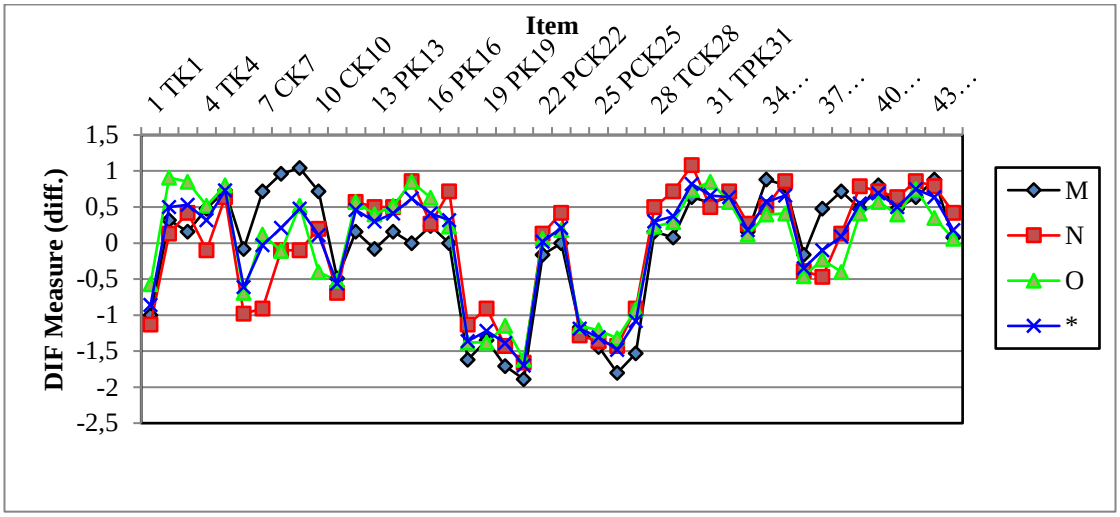


Figure 7. DIF item plot for demographics based on elementary/middle/high school teachers

Note:
M = Elementary School Teacher; N = Middle School Teacher; O = High

Figure 7 shows the DIF item plot based on elementary/middle/high school teachers. Item CK7, elementary school teachers are more able to use mathematical thinking, and in CK8, elementary school teachers have more knowledge related to the school mathematics curriculum. Additionally, for CK9, elementary school teachers have ways and strategies to develop mathematical understanding, and for CK10, elementary school teachers follow the latest information related to school mathematics materials and curriculum.

On the other hand, for item PK15, elementary school teachers must gain more knowledge in evaluating and assessing the process and results. For item 37, elementary school teachers tend to utilize several websites that provide supporting information for students related to the mathematics material learned during online learning. It is also evident in item 38, where elementary school teachers utilize other ICT-based mathematics learning media to make it easier for students to understand the material.

DISCUSSION

This study aims to investigate the readiness of mathematics teachers in South Sumatra province to conduct online learning based on the TPACK perspective. The research results show that teachers are ready to conduct online learning from the TPACK perspective. It is consistent with a study conducted by Rahayu et al. (2022), which found that teachers have a positive paradigm

towards online learning. According to Phan and Dang (2017), factors such as training, attitude, technical competence, time constraints, pedagogy, and methodology are important elements in distance education (online learning). Therefore, the government should increase training to improve teacher competence and improve school facilities and online learning platforms to increase their capacity.

The readiness of teachers to conduct online learning from the TPACK perspective can be observed based on the TPACK components. The CK component is quite high, with an average of 9.43 (SD=5.10). Gess-Newsome (2015) stated that mastery of mathematical content is considered an important element of teachers' professional competence because what teachers know can affect how they facilitate student learning and what students learn. It is also emphasized by the National Council of Teachers of Mathematics (NCTM), where teachers must have a deep understanding of the mathematics content they teach to facilitate effective learning and deliver that knowledge flexibly in teaching tasks (NCTM, 2000). Many studies have emphasized that PCK depends on the content knowledge base (Venkat & Spaull, 2015).

In the TK and TCK components, teacher readiness is moderate. It indicates that teachers' readiness for technology skills and mastery of the material is good. It shows that teachers are familiar with technology and can use it to improve their mastery of teaching materials. This TK and TCK ability is supported by the pandemic, which requires teachers to access technology from home due to the Indonesian government's Work from Home policy.

Meanwhile, teacher readiness is lower in the PK and PCK components compared to TK and TCK. If we look at the average CK = 9.43, PK = 3.99 and PCK = 3.11. It shows that there needs to be attention from the government to launch a program to improve teachers' pedagogical competence. In addition, Kind (2009) also identified three general factors that contribute to the growth of PCK in early career teachers. The first factor has good subject matter knowledge; the second is classroom experience; and the third is having emotional attributes such as personal confidence and providing a supportive work environment where collaboration is encouraged.

Teacher readiness in online learning in the TPK and TPACK components is relatively low compared to other components, with averages of 1.82 and 1.50, respectively. If we look at the TK component of teachers with an average of 4.04, it shows that teachers have good knowledge of technology. However, let us look at the average integration of technology skills, mastery of the material, and pedagogical knowledge. Teachers still need to optimize their knowledge of technology in online learning.

Based on this, teacher training in integrating technology and content mastery in online learning needs to be intensified. The training should provide teachers with experience in implementing online learning. A study conducted by Wuryaningsih et al. found that web-based teacher training (online and blended learning) was more effective than face-to-face training in improving teachers' achievement in their training (Wuryaningsih et al., 2019).

CONCLUSIONS

Based on the results discussed, mathematics teachers in South Sumatra province are ready to conduct online learning based on the TPACK perspective. The readiness to learn from the highest TPACK components is the readiness in Technological Knowledge (TK), and the lowest component is Technological Pedagogical and Knowledge (TPACK).

ACKNOWLEDGMENT

Thank you to LPPM Muhammadiyah University of Palembang for funding this research.

AUTHOR'S DECLARATION

Authors' contributions	All author's contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.
Funding Statement	This research was funded by LPPM Universitas Muhammadiyah Palembang

Availability of data and materials All data are available from the authors.

Competing interests The authors declare that the publishing of this paper does not involve any conflicts of interest. This work has never been published or offered for publication elsewhere, and it is completely original.

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