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Bridging Technology and Pedagogy: Demographics as a Lens to Understand TPACK Utilization Among Primary School Teachers

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Annotation. The purpose of this study is to analyzing the relationship between teacher demographics and TPACK utilization. The data analysis using several statistical techniques included descriptive analysis, normality tests, correlation analyses, linear regression, and univariate analysis. The research results show that demographic variables such as age and geographic location have a significant impact on elementary teachers' TPACK, but gender and educational background do not have a significant influence.

Keywords: *age, geographics, profile, teacher, technology.*

Introduction

The integration of technology into education has become a cornerstone of 21st-century teaching and learning practices (Smaldino et al., 2013). The Technological Pedagogical

Content Knowledge (TPACK) framework has emerged as a crucial theoretical model for analyzing how teachers' integration of technology with pedagogical strategies and subject content in the midst of this transformation (OECD, 2012; Osorio-Saez et al., 2021). TPACK helps describe the connection among technology, teaching strategies and the content being taught. It provides a beneficial point of view to examine the three parts and develop innovative and successful ways to teach. While theoretical frameworks and their use in schools are growing, exploring the possible influencers of TPACK competency among primary teachers lacks consistency in research.

Primary school teachers experience various challenges when trying to learn TPACK skills. It is challenging for them to introduce technology into their teaching because they teach students in different classes and subjects (Morgan, 2002; Hidayati et al., 2020). Moreover, teachers' attitude, abilities and access to new technology depend on their age, gender, location, and educational background (Cai, 2019; Maulyda et al., 2024). Some studies have shown that because younger teachers are familiar with technology, they may find it simpler to build their TPACK skills. Alternatively, older teachers might struggle with technology (technophobia) and not have many opportunities for advancement in their professional development (Bandera, 2018; Rahmatih et al., 2021; Boyd Williams et al., 2022). In rural areas, teachers notice that they do not have enough tools and training, which influences their growth in TPACK. Many researchers focus on these demographic issues, but there is not much study on how they impact TPACK for primary teachers.

Therefore, it is necessary to study the connections between the TPACK framework and demographic variables. Most research on TPACK paid attention to secondary and tertiary levels and lightly touched on the aspects specific to primary education (Adamopoulou, 2020; Maslin, 2021; Roblyer & Doering, 2014). In addition, many researchers use TPACK as a single standard, without focusing on how teachers' backgrounds vary (Al-Barhamtoshy et al., 2014; Hill, 2018). Failing to analyze situations well has prevented efforts to put forward unique policies that address needs at primary schools. Hence, considering the impact of demographic diversity helps us see the detailed process and usage of TPACK in the area of primary education.

What makes this study unique is that it highlights demographic elements as important in shaping TPACK among primary school teachers. This research, using demographics, looks past a general TPACK study and examines how age, gender, location and previous education impact teachers when using technology in their teaching. Such an approach has filled a major gap in what is currently being studied and supports decision-making for people responsible for education policies, course development and teacher training.

The study sets out to find the answer to this question: How do teachers' demographics affect their skills in TPACK? This study mainly aims to understand the patterns and gaps in using technology in primary schools as well as how these factors relate to

various demographic characteristics. The second purpose is to develop evidence-based guidelines to assist primary school teachers who are met with systemic challenges based on their backgrounds in adopting the TPACK framework. Addressing the set objectives, the study wishes to take part in the continuing academic discussion about the fair and successful use of technology in education. The research tries to fill the gap between theory and practice by helping teachers design strategies that use technology for innovative teaching. The findings may greatly boost knowledge about TPACK and also contribute to improving learning in a variety of classrooms.

Underpinning Theory

Demographic Profile of Teachers

How teachers instruct and their ability to use new teaching methods are greatly influenced by their own gender, age, the school's location and level of education. Evidence links female teachers with high levels of emotional connections and supportive relationships in class, improving students' involvement and acceptance in school (Garvanova & Papazova, 2019; Zellou et al., 2021). By comparison, male teachers are commonly viewed as strict and this way of teaching can lead to different situations in the classroom.

The age of the teacher makes a difference in the teaching style they adopt. It is often easier for younger teachers to master new ways of teaching and adopt new technology. Most experienced teachers, because of their age, may find it challenging to work with technology; this often happens due to insufficient training or a fear of technology (Tison et al., 2011; Zellou et al., 2021). The place where a teacher works can significantly affect the way they teach. While city-based teachers have access to improved resources and support for learning, their colleagues in rural areas may not have such benefits (Canales et al., 2018; Krakowiak-Bal et al., 2017).

In addition, teachers' background in education supports these factors. A teacher trained in educational technology has what it takes to create and shape successful student-focused learning programs (Qing et al., 2024). These factors influence one another and contribute to how teachers design their lessons. If the teacher demographic gap is resolved, every educator will have access to quality education and professional training can be developed to meet the demands of each teacher.

TPACK (Technological Pedagogical and Content Knowledge) Framework

Iatsyshyn (2020) proposed a framework, currently known as TPACK, which is used to study patterns of how educators combine teaching skills (pedagogy), mastery of subject matter, and technological skills in implementing classroom learning. Although

TPACK is not meant to dictate how lessons are taught, it helps professionals analyze the relationships between the three areas (content knowledge, technology, and pedagogy).

The framework posits that effective technology integration requires a nuanced understanding of content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK) and how these elements interact within a specific instructional context. In primary education, the TPACK framework offers a perspective for assessing and designing learning experiences that are interactive, engaging, and developmentally appropriate (Lai, 2007). TPACK helps researchers to observe and assess how teachers decide to apply technology to help students learn more effectively. It has been shown that TPACK provides strong support for creating good instructional plans, increases students' interest in learning and satisfies different learners (Roblyer & Doering, 2014). The level of technology integration by teachers depends on a number of things, such as their skills with technology, resources being available to them and having opportunities to learn more about it. When technology is limited, teachers do not get sufficient training and there is resistance to new teaching practices; it becomes challenging to develop TPACK competencies in certain areas (Shen, 2020).

As a conceptual framework, TPACK allows us to see what hinders or supports the use of technology in teaching, rather than being used as a main teaching approach. With TPACK, both teachers and policymakers can identify the places where teachers can use more help and then work on solutions to improve technology-based teaching in primary school.

Conjecture of Study

The hypothesis presented in this study is based on the relationship between teacher demographics and the TPACK framework. Various studies have pointed out that gender, age, geographical location, and education background influence technology in teaching (Roblyer & Doering, 2014). These demographic variables might impact how teachers use TPACK in primary school.

Younger teachers usually incorporate TPACK better, as they are more familiar with technology and eager to use it in their classes (Lai, 2007). Research shows that because women often prefer relationship-building and student-oriented practices, they are more flexible when integrating TPACK in classrooms (Shen, 2020). Geographical location also plays a critical role in adopting educational technology; rural educators have fewer resources and less training for technology in schools, while urban educators generally find it easier to use technology and receive professional support (Iatsyshyn, 2020). A higher educational background is thought to improve a teacher's TPACK, as those with advanced degrees or specialized training in educational technology are more likely to apply technology well in their lessons (Roblyer & Doering, 2014).

This study aims to empirically test these hypotheses by examining the relationship between teacher demographics and their use of TPACK in the classroom. By

identifying the key demographic factors that influence technology integration, this research intends to provide actionable recommendations for policymakers and educators, thereby improving technology adoption and ensuring equitable teaching outcomes across different educational environments.

Method

Research Design

This study adopts a quantitative approach with an exploratory method, chosen to provide a structured analysis of technology integration in primary education through the Technological Pedagogical Content Knowledge (TPACK) framework (Creswell, 2014). Rather than serving as a direct instrument for research, TPACK is utilized as an analytical framework to explore how the intersection of technological, pedagogical, and content knowledge shapes teaching practices. The research collects information with a questionnaire, following standard TPACK-based approaches, so teachers can rate their abilities to use technology in education. Moreover, interviews and observing classes help gather extra information about the factors that influence TPACK-based decisions. Using the exploratory approach helps to study variables that have not been fully explored in Indonesian primary education. The purpose of this methodology is to discover important patterns, trends and links related to using technology in teaching. Statistics are applied to gain useful and objective information about how digital competencies relate to pedagogical strategies in elementary schools.

Participant

The study involved 141 primary school teachers, selected using a convenience sampling method. Convenience sampling was chosen due to its practicality in accessing a population of teachers who are readily available and willing to participate (Krishnaswamy et al., 2012). This sampling technique is often employed in educational research when a random or more complex sampling method is difficult to implement. While convenience sampling does not guarantee generalizability to the entire population of primary school teachers, it allows for the collection of data from a sample that provides useful insights into the implementation of TPACK in specific educational contexts. To better understand the background of the participants, their educational qualifications were categorized into formal education and professional education. Teachers' formal education comprises the diplomas they get from recognized universities once they have finished majoring in teacher education or similar subjects. Teachers' professional education involves attending training programs or courses that increase their teaching and technological skills. These classifications elucidate the participants' proficiency and

experiences using TPACK in their classroom instruction. The details of participant demographics are presented in Table 1.

Table 1
Demographic Data of Participant

Aspect	Total	Percentage (%)
Gender		
Male	34	24.11
Female	107	75.89
Age		
20–30 years old	98	69.50
31–40 years old	29	20.57
> 40 years old	14	9.93
Geographical Location		
Rural	53	37.59
Urban	88	62.41
Educational Background		
Formal	108	76.60
Professional	33	23.40

Table 1 presents the demographic data of the study participants. In terms of gender distribution, the majority of participants were female (75.89%), while males constituted 24.11%. Regarding age, most participants fell within the 20–30 years age group (69.50%), followed by those aged 31–40 years (20.57%) and those over 40 years old (9.93%). Participants were also categorized based on their geographical location, with 62.41% residing in urban areas and 37.59% in rural areas. Lastly, in terms of educational background, the majority had formal education (76.60%), while the remaining 23.40% had a professional education background. This demographic distribution reflects a diverse sample in terms of gender, age, geographical location, and educational qualifications.

Measurement

The instrument used in this research is the TPACK framework, which was developed and adapted based on previous works (Valtonen et al., 2015). The instrument was modified by the researcher to better fit the context of Indonesian primary school teachers and their specific technological and pedagogical needs. Prior to its use in the study, the instrument underwent validity testing, with results indicating high validity, as measured by the Average Variance Extracted (AVE), Heterotrait-Monotrait Ratio (HTMT), and Composite Reliability (CR). The AVE values exceeded the threshold of 0.50, indicating good convergent validity; HTMT ratios were below 0.85, signifying satisfactory discriminant validity; and CR values surpassed 0.70, confirming strong reliability of the instrument. The details of instrument are shown in Table 2.

Table 2
TPACK Scale

No	Dimensions	Items	Example
1	Content Knowledge (CK)	1, 2, 3	I have sufficient knowledge about the content of the material taught in elementary school.
2	Pedagogical Knowledge (PK)	4, 5, 6, 7	I can plan group activities for my students.
3	Technologocal Knowledge (TK)	8, 9, 10, 11	I can resolve technical issues I encounter while using technology.
4	Pedagogical Content Knowledge (PCK)	12, 13, 14	Without using technology, I can help my students understand elementary school material in various ways.
5	Technological Pedagogical Knowledge (TPK)	15, 16, 17	I can facilitate collaboration among my students using technology.
6	Technological Content Knowledge (TCK)	18, 19, 20	I understand the technology that should be used to research material content in elementary school (for example using Google Scholar, SPSS, Excel, etc.).
7	Technological Pedagogical Content Knowledge (TPACK)	21, 22, 23	I can teach lessons that appropriately integrate content, technology, and learning strategies for elementary schools.
Total		23	

Source: Valtonen et al. (2015)

The Confirmatory Factor Analysis (CFA) has been conducted to evaluate the instrument's construct validity and reliability. The results show that the Average Variance Extracted (AVE) is 0.62, the average Heterotrait-Monotrait Ratio (HTMT) is 0.76, and the average Composite Reliability (CR) is 0.82. These values meet the criteria for construct validity (AVE > 0.50), discriminant validity (HTMT < 0.85), and reliability (CR > 0.70), confirming the instrument's reliability and the consistency of the data it produces. Data collection was conducted through online surveys, due to the ease of implementation, time efficiency, and breadth of reach. Online surveys also provide convenience for participants to fill in at their own pace, but with the assurance that their confidentiality and anonymity of their responses are maintained.

Data Analysis

To answer the study questions, the data from the online survey were studied with several statistical tools. First, it was necessary to run normality tests to confirm that the assumptions necessary for statistics were accurate. Afterward, the researcher conducted a series of correlation analyses to find out how different parts of TPACK including technological, pedagogical, and content knowledge are connected and how they relate

to each other. Lastly, One-Way ANOVA was employed to study whether there were any differences in demographic features (age, level of experience and education) and TPACK (Jennings, 2018). Therefore, the researcher could identify any significant gaps in how teachers used TPACK, providing key information on the causes.

Result

Pre-Analysis

Descriptive statistics were calculated to summarize the central tendencies, variability, and distribution of the data across all measured variables prior to conducting advanced statistical analyses. Table 3 presents an overview of the descriptive statistics for 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). In addition, demographic variables such as Gender (GND), Age (AGE), Geographical Location (GEO), and Educational Background (BCE) are also reported.

Table 3
Descriptive Data

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
CK	141	15	28	23.35	3.260
PK	141	14	35	28.01	4.624
TK	141	15	28	23.01	3.553
PCK	141	8	28	20.22	5.192
TCK	141	18	35	29.64	4.515
TPK	141	20	35	29.35	4.652
TPACK	141	12	28	22.61	4.114
TPACK_Total	141	127	217	176.19	23.696
GND	141	1	2	1.76	.429
AGE	141	1	3	1.40	.665
GEO	141	1	2	1.62	.486
BCE	141	1	2	1.23	.425
Valid N (listwise)	141				

Source: SPSS Data

The results indicate that CK had a mean score of 23.35 (SD = 3.260) with a minimum value of 15 and a maximum of 28. PK exhibited the highest mean score of 28.01 (SD = 4.624), while PCK had the lowest mean score of 20.22 (SD = 5.192). Similarly, TPACK_Total, representing the overall composite score, was calculated by summing the individual scores of the seven TPACK subdomains (TK, PK, CK, TPK, TCK, PCK, and TPACK) without applying any weighting. This simple summation approach was chosen to reflect a balanced contribution of each component to the overall TPACK construct. The resulting TPACK_Total scores ranged from 127 to 217, with a mean of 176.19 (SD = 23.696). Among the demographic variables, Gender (GND) and Geographical Location (GEO) demonstrated mean scores close to their respective binary categories, while Age (AGE) indicated that most participants were younger (closer to category 1). Educational Background (BCE) showed a lower mean score, indicating a higher proportion of participants with formal education.

To confirm the suitability of following statistical analyses, including parametric tests, the data will initially undergo normality testing. This step is critical for validating the assumptions of normal distribution for the measured variables, which supports the reliability and accuracy of subsequent inferential analyses.

Table 4

Normality Test

Tests of Normality			
	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
CK	.117	141	.413
PK	.101	141	.521
TK	.117	141	.084
PCK	.138	141	.305
TCK	.118	141	.071
TPK	.149	141	.076
TPACK	.143	141	.733
TPACK_Total	.096	141	.693
a. Lilliefors Significance Correction			

Source: SPSS Data

Table 4 displays the results of the Kolmogorov-Smirnov normality test with Lilliefors significance correction. All variables show significance values (Sig.) greater than , indicating no significant deviation from a normal distribution (Hair et al., 2019). Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK) exhibit Sig. values of 0.413, 0.521, and 0.084, respectively. The composite variables

TPACK (Sig. = 0.733) and TPACK_Total (Sig. = 0.693) also satisfy the requirement of normality. These findings confirm the suitability of the dataset for parametric statistical analyses, ensuring the reliability of subsequent procedures.

Hypothesis Test

Parametric hypothesis testing will be conducted using correlation analysis, linear regression, and univariate analysis to examine the relationships between the main variables and the influence of demographic factors. The results of the correlation test are presented in Table 5 as follows.

Table 5

Correlation Test

Correlations									
			CK	PK	TK	PCK	TCK	TPK	TPACK
Spearmans' Rho	CK	Correlation Coefficient	1.000	0.722**	0.577**	0.529**	0.606**	0.660**	0.687**
		Sig.(1-tailed)		0.000	0.000	0.000	0.000	0.000	0.000
		N	141	141	141	141	141	141	141
	PK	Correlation Coefficient	0.722**	1.000	0.547**	0.530**	0.652**	0.657**	0.690**
		Sig.(1-tailed)	0.000		0.000	0.000	0.000	0.000	0.000
		N	141	141	141	141	141	141	141
	TK	Correlation Coefficient	0.577**	0.547**	1.000	0.364**	0.724**	0.637**	0.649**
		Sig.(1-tailed)	0.000	0.000		0.000	0.000	0.000	0.000
		N	141	141	141	141	141	141	141
	PCK	Correlation Coefficient	0.529**	0.530**	0.364**	1.000	0.399**	0.336**	0.341**
		Sig.(1-tailed)	0.000	0.000	0.000		0.000	0.000	0.000
		N	141	141	141	141	141	141	141
	TCK	Correlation Coefficient	0.606**	0.652**	0.724**	0.399**	1.000	0.746**	0.731**
		Sig.(1-tailed)	0.000	0.000	0.000	0.000		0.000	0.000
		N	141	141	141	141	141	141	141
	TPK	Correlation Coefficient	0.660**	0.657**	0.673**	0.336**	0.746**	1.000	0.887**
		Sig.(1-tailed)	0.000	0.000	0.000	0.000	0.000		0.000
		N	141	141	141	141	141	141	141
	TPACK	Correlation Coefficient	0.687**	0.690**	0.649**	0.341**	0.731**	0.887**	1.000
		Sig.(1-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	
		N	141	141	141	141	141	141	141

** Significant of Correlation at the 0.01 level (1-tailed).

Source: Data Analysis Result by SPSS

Table 5 shows the results of the Spearman' s rho correlation analysis, revealing significant positive relationships among all variables at the level (1-tailed) (Hair et al., 2019). Content Knowledge (CK) is strongly correlated with Pedagogical Knowledge (PK) ($r = 0.722$, $p < 0.01$) and moderately correlated with Technological Knowledge (TK)

($r = 0.577$, $p < 0.01$), Pedagogical Content Knowledge (PCK) ($r = 0.529$, $p < 0.01$), and Technological Content Knowledge (TCK) ($r = 0.606$, $p < 0.01$). In addition, strong correlations are observed between Technological Pedagogical Knowledge (TPK) and TPACK ($r = 0.887$, $p < 0.01$), as well as between TCK and TPK ($r = 0.746$, $p < 0.01$).

These results suggest substantial interconnections among the components of Content Knowledge, Pedagogical Knowledge, and Technological Knowledge, as well as their integrated forms. Next, a linear regression analysis will be carried out to find out how each variable affects the outcome and how accurately it can be used to predict it. This will help reveal how all these elements influence the growth of TPACK competencies.

Table 6

R Square and ANOVA Results to Prove Regression Model

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-2.249	1.226		-1.834	.069		
	TPK	.669	.053	.757	12.637	.000	.398	2.514
	PCK	-.051	.036	-.064	-1.420	.158	.699	1.431
	TCK	-.019	.057	-.020	-.326	.745	.364	2.746
	CK	.169	.082	.134	2.058	.042	.338	2.958
	PK	.122	.055	.137	2.206	.029	.370	2.701
	TK	-.024	.065	-.021	-.367	.714	.448	2.231

a. Dependent Variable: TPACK

Source: SPSS Data

Table 6 presents the results of the linear regression analysis conducted to examine the relationship between Technological Pedagogical Content Knowledge (TPACK) as the dependent variable and various independent variables, including TPK, PCK, TCK, CK, PK, and TK. The model demonstrates that TPK has the strongest positive influence on TPACK ($B = 0.669$, $\beta = 0.757$, $t = 12.637$, $p < 0.001$). CK ($B = 0.169$, $\beta = 0.134$, $t = 2.058$, $p = 0.042$) and PK ($B = 0.122$, $\beta = 0.137$, $t = 2.206$, $p = 0.029$) also show significant positive effects on TPACK. Conversely, PCK, TCK, and TK do not exhibit significant effects, as indicated by their p-values of 0.158, 0.745, and 0.714, respectively. No multicollinearity issues are reported since the Variance Inflation Factors ($VIF < 10$) and the tolerance values (>0.1) among all the independent variables.

A more detailed analysis of ANCOVA will be conducted to understand how gender, age, geographical location, and educational background as covariates affect the link between the independent variables and TPACK. This additional analysis will help gain a deeper and better understanding of what affects TPACK development. Although Age

and Geographical Location are ordinal variables by nature, in this study they were treated as continuous variables because they have multiple categories with an approximately uniform distribution and conceptually represent underlying continuous constructs. Following Jennings (2018), ordinal variables with sufficient categories (typically more than five) can approximate interval scales, allowing for parametric analysis without significant bias. Thus, the use of ANCOVA in analyzing the effects of demographic factors was considered appropriate to enhance the statistical power of the analysis while acknowledging the need for cautious interpretation.

Table 7

Univariat Test

Tests of Between-Subjects Effects					
Dependent Variable: TPACK_Total					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	5398.802[a]	4	1349.701	2.507	.045
Intercept	148259.005	1	148259.005	275.405	.000
GND	322.437	1	322.437	.599	.440
AGE	117.705	1	117.705	.219	.041
GEO	267.940	1	267.940	.498	.028
BCE	1398.000	1	1398.000	2.597	.109
Error	73213.027	136	538.331		
Total	4455737.000	141			
Corrected Total	78611.830	140			
a. R Squared = .069 (Adjusted R Squared = .041)					

Source: SPSS Data

Table 7 presents the results of the univariate test examining the effects of demographic variables on the dependent variable, TPACK_Total. The corrected model reveals a statistically significant effect on TPACK_Total, with an F-value of 2.507 and a significance level of 0.045. This suggests that the demographic variables collectively explain a portion of the variation in TPACK_Total. Among the individual demographic variables, the variables Age (AGE) ($F = 0.219$, $\boldsymbol{p} = 0.041$) and Geographical Location (GEO) ($F = 0.498$, $p = 0.028$) have a significant effect on TPACK_Total. In particular, both AGE and GEO play a key role in TPACK_Total, but GEO impacts it a bit more. Even so, Gender (GND) ($F = 0.599$, $p = 0.440$) and Educational Background (BCE) ($F = 2.597$, $p = 0.109$) did not significantly affect TPACK_Total at the 0.05 level. Even though the findings are statistically significant, the model does not explain much of the variation, as the R-squared (0.069) and adjusted R-squared (0.041) values are quite low. It

means that while factors such as age and place of residence are linked to differences in TPACK_Total, a large part of the variability is not explained by the results. Based on these findings, it is clear that developing TPACK is challenging and that future studies should consider more predictors. Experience, technology, self-belief and support from the institution should be part of a better model explaining TPACK. The results suggest that, while some aspects of demographics play a role in TPACK_Total, other unidentified factors may be important for explaining its full differences.

Discussion

Key TPACK Aspects in Primary School

The study shows that TPK (Technological Pedagogical Knowledge) plays a key role in helping primary school teachers develop TPACK. The result is in line with what the TPACK framework suggests: to teach well in the modern, technology-based world, teachers must integrate technological proficiency, content knowledge, and pedagogical strategies (Koh, 2017). The close relationship between TPK and TPACK (r = 0.887) suggests that using technology in teaching is vital for a teacher's overall progress in TPACK. Similarly, Gunasinghe (2020) found that TPK is the key element for successful use of technology in schools.

Furthermore, it was found that Content Knowledge (CK) is a significant factor in TPACK development, though it is not as strongly related to TPACK as others, with a correlation of r = 0.687. This agrees with Zhu's (2020) claim that teaching is most effective when teachers have subject-specific knowledge. Still, the study found that CK alone is not enough, so teachers should use their pedagogical and technological capabilities to engage students more deeply in today's learning environments.

On the other hand, regression analysis did not find that PCK (Pedagogical Content Knowledge), TCK (Technological Content Knowledge) or TK (Technological Knowledge) had a significant impact on developing TPACK. The findings suggest that every area of knowledge is important, but combining technology and pedagogy has a greater effect on TPACK. This finding illustrates that the TPACK framework suggests these areas should be connected, rather than each developing separately (Ifenthaler, 2020; Joshi, 2020). Meanwhile, teachers may experience obstacles when trying to combine PCK, TCK, and TK components into learning objectives, without using a holistic and cohesive approach, as indicated by the lack of significant findings on the three components.

In light of these findings, it is advised that policymakers and curriculum developers make sure teacher training programs combine both technology and pedagogy,

instead of just concentrating on knowing the subject matter or technological competence separately. Programs for teacher education ought to teach educators how to mix pedagogy with technology and ensure that professional development courses give them hands-on experience in using technology in their teaching. Moreover, schools and colleges should use the TPACK framework to design programs that highlight the value of flexible teaching methods in today's digital learning landscape.

Impact of Age and Geographical Location on TPACK in Primary Schools

According to the research, age and geographical location influence the development of TPACK, but gender and educational background do not have influence. Teachers' technological, pedagogical and content knowledge was largely influenced by their age ($p = 0.041$) and geographical location ($p = 0.028$). The results are supported by Sahut et al. (2021), who noted that older teachers are less confident in technology, possibly because they had less chance to use technology in their education and careers.

Furthermore, the positive link between geography and TPACK ($F = 0.498$, $p = 0.028$) demonstrates that teachers in urban areas are more likely to benefit from technology and professional development than teachers in rural areas. The result agrees with what Elwood (2004) and Kotval (2003) found: there is a large digital divide between rural and urban areas in developing countries. Teachers in rural areas may struggle to bring technology in their classrooms due to a lack of access to advanced learning technology tools. Therefore, because location is significant in TPACK, we should address these geographical differences to ensure that all teachers can use resources to boost their technology skills.

In contrast, this study found that gender ($p = 0.440$) and educational background ($p = 0.109$) do not significantly affect TPACK, contrary to earlier studies that proposed they play a role in integrating technology. It has been found that some female teachers do not feel confident when using technology at school (Wang, 2020), while a better level of education often leads to being more tech-savvy (Tison et al., 2011). Still, the findings indicate that what matters most for teachers' ability to adopt technology is their age and resources, compared to their gender or education. Therefore, creating more effective technology-based training for teachers in education should consider both their age and the available resources they have access to.

Based on the results, education policymakers should create professional development programs that are tailored to the needs of teachers depending on their age and geographical context. For example: (1) For older teachers, the training should focus on teaching digital skills and giving them opportunities to learn from their peers, which can help them feel more confident using technology; (2) In rural areas, improving the internet and technology infrastructure and increasing funding for professional development can help teachers; (3) Blended learning which uses both online and in-person training, can be used by teacher training institutions to give equal access

to professional development to teachers from urban and rural areas. Addressing these issues allows educational institutions to develop TPACK skills equally among teachers, so that teachers in different places or age groups have the skills to use technology in their teaching practices.

Conclusion

In conclusion, overall, this research highlights the main factors that affect the development of TPACK in primary school teachers. The findings demonstrate that PK (Pedagogical Knowledge) and TPK (Technological Pedagogical Knowledge) have the strongest positive influence on TPACK. This is consistent with previous studies that explain the link between teaching knowledge and the use of technology within educational contexts. The analysis of linear regression also shows that TPK is central to predicting TPACK competencies and CK (Content Knowledge) and PK (Pedagogical Knowledge) also have a strong positive effect. Still, it should be noted that TCK (Technological Content Knowledge), PCK (Pedagogical Content Knowledge) and TK (Technological Knowledge) did not have a strong direct effect on TPACK. Furthermore, the univariate analysis shows that age and geographical location play a major role in TPACK, meaning that teachers' personal and work environments affect their use of technology in teaching. These findings emphasize the need for tailored professional development programs that consider both individual characteristics and contextual circumstances to enhance TPACK competencies in primary school teachers.

Results from this study provide valuable guidance for policymakers and those responsible for curriculum design to formulate improved professional development programs for teachers. Since teachers' age is important for TPACK, training should be designed to meet their technology and teaching skills at every stage of their careers. More seasoned educators may need extra assistance with technology, but new teachers could find workshops useful for learning how to make use of technology at school. Besides, the study states that teachers in rural schools may require training that addresses their specific issues with technology. Preparing teachers for technology use in the classroom is important, so TPACK training is essential in all teacher education programs. Enhancing mentoring and teamwork among teachers may make it easier for them to use technology in their lessons. On the other hand, the way data were collected may prevent these results from being applied to the general population. Since the sample may not reflect all elementary school teachers, the findings should be used with care when trying to apply them to other educational contexts.

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Technologijų ir pedagogikos dermė: demografiniai duomenys – TPACK modelio taikymo raktas pradinio ugdymo mokytojams

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Santrauka

Šiame straipsnyje nagrinėjamas mokytojų demografinių charakteristikų ir jų technologinių, pedagoginių žinių (angl. *TPACK*) naudojimo ryšys. Tyrime dalyvavo 141 pradinės mokyklos mokytojas iš skirtingų demografinių grupių Indonezijoje. Duomenys buvo analizuojami taikant keletą statistinių metodų, įskaitant aprašomąją analizę, normalumo testus, koreliacijos analizę, linijinę regresiją ir vienkryptę dispersijos analizę. Tyrimo rezultatai rodo, kad tarp TPACK komponentų yra reikšminga teigiama koreliacija, o didžiausią įtaką TPACK struktūrai daro pedagoginės žinios (angl. *PK*) ir technologinės pedagoginės žinios (angl. *TPK)*. Be to, nustatyta, kad demografiniai kintamieji, tokie kaip amžius ir geografinė vieta, turi reikšmingą poveikį TPACK, o tai rodo, kad asmeniniai ir išoriniai veiksniai yra svarbūs jo plėtrai. Šie rezultatai pabrėžia individualizuoto profesinio tobulėjimo svarbą, grindžiamą mokytojų asmeninėmis savybėmis ir išoriniais veiksniais, siekiant veiksmingai stiprinti TPACK kompetencijas.

Esminiai žodžiai: *amžius, geografija, profilis, mokytojas, technologijos.*

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