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Change in COVID-19 Pandemic: Investigating Early Childhood Education Teachers' Technological Pedagogical Content Knowledge (TPACK) Competencies

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ABSTRACT

This study delved into the realm of early childhood education, specifically focusing on the Technological Pedagogical Content Knowledge (TPACK) of teachers in Riau Province, Indonesia. Quantitative data were gathered from a sample of 124 early childhood educators catering to children aged 3 to 5 in school-based settings. The research utilized an instrument adapted from Kabakci Yurdakul's TPACK-Deep survey, tailored to suit the unique educational landscape of early childhood education in Indonesia. Data analysis primarily involved descriptive techniques. The findings underscored the imperative for teachers to enhance their TPACK competencies to effectively tackle emerging challenges and elevate the quality of education, aligning with the evolving demands of children's educational needs. However, a notable gap emerged as many educators struggled to integrate technology into their teaching practices, often due to insufficient access to necessary technological resources. This highlights the pressing need for educators to continuously hone their expertise in technology, pedagogy, and content knowledge to optimize learning experiences for young learners.

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1. INTRODUCTION

The rapid advancement of technology is revolutionizing various aspects of human life. In today's digital era, technology permeates both personal and professional domains, significantly impacting how individuals interact with the world (Graham, 2011). A key area witnessing profound transformations due to technological progress is education, where educators are increasingly required to adeptly integrate technology into their teaching methodologies. Recent years have seen significant strides in early childhood education, accompanied by a heightened emphasis on educators' professional capabilities and the establishment of new pedagogical standards (Novianti & Febrialismanto, 2020).

However, the onset of the COVID-19 pandemic presented unprecedented challenges to educational systems worldwide, necessitating a swift shift from traditional face-to-face learning to online platforms. To effectively navigate this new educational landscape, schools must leverage both synchronous and asynchronous learning approaches, optimizing digital formats for remote teaching. For early childhood educators, this entails selecting, designing, and implementing developmentally appropriate and technology-enhanced activities to foster optimal learning and development in children (Altun, 2019).

Integrating education and technology has become essential for fostering and modernizing the professional growth of educators in the modern environment, raising generations of digitally literate adults, and raising intelligent kids (Darling-Hammond, 2015). As the world changes digitally, a shift to greater societal reliance on technology has directed early childhood education teachers to emphasize the use of technology in children's learning and play activities (Arnott et al., 2018; Fleer, 2018). Unfortunately, the lack of teacher knowledge, skills, abilities, and competencies connected to technology usage in the teaching process becomes the main barrier to technology integration.

Teachers should have appropriate pedagogy and knowledge to deliver course content effectively and provide quality learning. This framework, known as PCK or pedagogical content knowledge, which Shulman PCK brought, is crucial for early childhood teachers. It is about the content and determines the teacher's performance (Shulman, 1986a). As technology advanced, we realized that PCK was insufficient to teach effectively. Research indicates that prior teaching experience improves learning outcomes and processes (Darling-Hammond, 2011; Olfos et al., 2014). Technology should be added to teaching and learning in the classroom, meaning a teacher should have technological competencies. The side now uses traditional classroom equipment such as whiteboards and markers with a projector, computer, and interactive board to create effective, efficient, and high-quality education (Cekerol & Ozen, 2020).

TPACK, short for Technological Pedagogical Content Knowledge, represents the fusion of content and pedagogical knowledge (formerly known as PCK) with technological proficiency. This concept was pioneered by Koehler and Mishra in 2009. TPACK serves as a structured framework empowering educators to address challenges related to integrating Information and Communication Technology (ICT) into classroom instruction (Chai, Koh, & Tsai, 2010). It emphasizes the crucial role of embedding technology knowledge within pedagogical and content contexts. TPACK diverges from techno-centric approaches that prioritize standalone technology skills, highlighting the nuanced and interconnected nature of teachers' knowledge base (Baran, Chuang, & Thompson, 2011).

In online learning activities, TPACK becomes one of the determinants of teacher success in teaching. Little is known about preschool teachers' ideas and pedagogical practices regarding employing technology. Therefore, it is critical to comprehend how teachers use technology to teach and how their knowledge base might inform their pedagogical approach. According to Kewalramani Havu-Nuutinen, teachers accept the ideas of technology as a pedagogical affordance and are keen on planning a better learning experience for children (2019). When incorporating technology and digital media into early childhood education, educators should consider integrating it into the curriculum rather than isolating it from instructional activities (Donohue & Schomburg, 2017). Even though technology can offer excellent teaching experiences, research consistently demonstrates that teachers lack confidence and integrate it slowly and cautiously during online learning (Havu-Nuutinen, Sporea, & Sporea, 2017).

Regardless of technology's convenience in teaching and learning, there is still a lack of knowledge about early childhood teachers' beliefs and pedagogical practices in using technology. These factors can affect their willingness to engage children in online learning. As such, it is critical to comprehend teachers' pedagogical practices, knowledge base, and competencies when teaching with technology. This research used a TPACK-deep scale, which Kabakci Yurdakul developed to measure preservice teachers' TPACK competencies (Kabakci Yurdakul et al., 2012).

The TPACK concept, introduced by Mishra and Koehler in 2006, expanded upon Shulman's theoretical framework from 1986. Shulman's framework aimed to understand the essential competencies teachers need to effectively integrate technology into education, building upon the

Pedagogical Content Knowledge (PCK) conceptual framework. Mishra and Koehler further developed this concept by identifying three key pillars: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) (Mishra & Koehler, 2006). These pillars were interconnected, showcasing that their combined interaction resulted in more than just the sum of their parts. This dynamic interaction led to the emergence of four additional knowledge types: technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK) (Graham, 2011; Koehler & Mishra, 2009). The models proposed by the TPACK framework focus on the effective integration of technology, emphasizing teacher pedagogical competencies throughout the teaching process.

Kabakci Yurdakul et al. (2012) pioneered the development of the Technological Pedagogical Content Knowledge scale (TPACK-Deep), designed specifically to assess preservice teachers' TPACK competencies in-depth. This innovative scale offers a nuanced approach, enabling researchers and educators to delve into the intricate nuances of teachers' technological, pedagogical, and content knowledge integration. By utilizing the TPACK-Deep scale, educators can engage in thoughtful questioning and strategic planning to enhance teacher training programs focused on technology integration. This facilitates the identification and development of teachers' TPACK levels, contributing to more effective and targeted support in preparing educators for the complexities of modern educational environments.

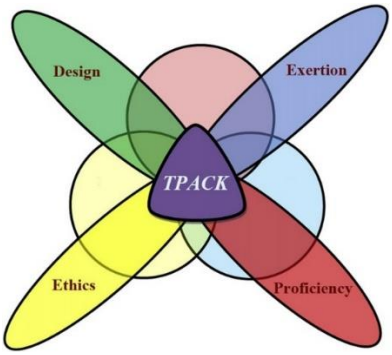

Figure 1. The Framework and Factors of TPACK-deep Scale.

The instrument utilized in this study comprised 33 items rated on a 5-point Likert-type scale, organized into four distinct factors. The first factor, design, assessed teachers' abilities in designing instruction by integrating their technological and pedagogical knowledge with the content being taught. The second factor, exertion, evaluated teachers' proficiency in utilizing technology to facilitate teaching activities, as well as their capabilities in assessing and evaluating the effectiveness of these activities. The third factor, ethics, focused on teachers' ethical competencies concerning the teaching profession and technology-related ethical considerations such as privacy, accuracy, intellectual property, and accessibility. Lastly, the competency factor gauged educators' leadership skills in integrating technology seamlessly into pedagogy and content knowledge, demonstrating their mastery in teaching methodologies and problem-solving abilities related to teaching practices, subject matter, and technology implementation.

2. METHODS

This research is descriptive quantitative research with a survey method. A quantitative descriptive study describes a particular social phenomenon or event of a problem (Creswell, 2014). Quantitative descriptive analysis is used to analyze data by describing it according to actual conditions in the field. The data was collected using Google Forms to determine the TPACK of early childhood education teachers covering online learning during the pandemic. The population and samples in this study were

as many as 124 early childhood education teachers in Riau Province, with sampling techniques being simple random sampling. Without considering the population's stratification, populations are randomly sampled, and respondents are chosen (Sugiyono, 2017). Data analysis techniques use percentage formulas. The percentage formula can be seen as follows:

$$\boldsymbol{P = \frac{F}{N} x\ 100\%}$$

Descriptive research aims to characterize a variable rather than test a specific hypothesis (Suharsimi, 2013). Numbers are used in quantitative analysis for various purposes, including data gathering, interpretation, and result presentation. Thus, it can be said that the purpose of quantitative descriptive research in this study is to observe, evaluate, and numerically characterize the object under investigation as it is and then make inferences about it based on the phenomena observed throughout the study. The presentation of calculation data in the form of tables and histograms. While for the interpretation of the correlation coefficient with the value of *r* (Barwell, 2004), as described in Table 1.

Table 1. Interpretation of Value Coefficients *r*

Correlation Coeffisient	Category
0.81 - 1.00	Very high
0.61 - 0.80	High
0.41 – 0.60	Medium
0.21 – 0.40	Low
0.00 – 0.21	Very low

3. FINDINGS AND DISCUSSION

Since the COVID-19 epidemic broke out in several nations, it has caused disruptions in several industries, including education. The current pandemic in Indonesia has a significant effect on the education industry. Colleges and universities are temporarily shuttered to stop the virus from spreading widely. The government has decided to switch from the traditional educational system to home-based internet media learning. Even after the pandemic, some schools chose a hybrid learning system so that teacher's technological skills were still needed.

The unstructured interview was conducted with ECE teachers. The data were collected using Google Forms questionnaires. There were thirty-three statements the teacher should choose by selecting a scale of 1 to 5. Figure 2 is the form for collecting data on ECE teachers' TPACK during the COVID-19 Pandemic.

Table 2. Online Learning Facilities Available in Schools

No	Online Learning Facilities Available in Schools	Total	Percentage
1	Internet Network	37	29,8%
2	Laptop/Gadget	63	50,8%
3	TPACK Trainings	4	3,2%
4	Original Software	1	0,8%
5	Guidebook	1	0,8%

Online learning facilities are the primary need for online learning to run well. The use of online-based learning facilities can offer pedagogical benefits. Online learning knows no time zones, locations, or distance for students (Tatli, 2009). 50.8% of respondents stated that schools provide laptops or

gadgets that can be used for learning purposes, while only 29.8% of respondents stated that there is an internet network that teachers can use in schools. The internet network becomes the primary need; online learning cannot be implemented without this. Instead, the teacher will use a private internet network.

Only a meager 3.2% of teachers have engaged in training activities specifically targeting TPACK. This figure is strikingly minuscule when juxtaposed with the broader pool of respondents. Furthermore, it underscores the prevailing trend where teachers are often left to navigate the complexities of integrating technology into learning independently, emphasizing the critical need for more robust and widespread professional development initiatives in this domain.

Table 3. Data Calculation of Indicator

No	Indicator	Actual Score	Ideal Score	Percentage	Category
1	Design	373,4	620	60,22	Medium
2	Exertion	375,8	620	60,62	Medium
3	Ethics	370,4	620	59,74	Medium
4	Proficiency	250,4	620	40,39	Low
	Total	1.370	620	55,24	MEDIUM
373,4 + 375,8 + 370,4 + 250,4 = 1.370 : 4 = 342,5 : 620 x 100 = 55,24% (MEDIUM)					

Their experiences influence teachers' approach and behaviour toward technology use in educational environments related to technology-education adoption's benefits (Baran et al., 2011). Encouraging teachers to integrate effectively with technology is crucial, and they need to understand how to apply instructional practices in which technological, content, and pedagogical knowledge are being put together. We see TPACK as a practical conceptual framework to explain how teachers integrate technology into their teaching practices. The first component of TPACK-Deep is the design element, which demonstrates the ability of instructors to use technology and pedagogy related to the subject matter in their lesson designs to enhance the learning experience.

Teacher competency in design factor is 60,22% with the category medium. They still need to increase their understanding and proficiency to evaluate the many technologies that will be employed in the classroom and select the most suitable one for the learning needs of the students. Teachers' lack of knowledge, skills, or competencies correlated to technology use in teaching are the main barriers to technology integration (Chen, Looi, & Chen, 2009). Teachers lacked support in technology connected to the pedagogical environment and technology related to classroom management, in addition to lacking knowledge and abilities in technology (Hew & Brush, 2007).

After months of online teaching, teachers have shown progress in developing online learning materials, preparing for various learning activities, making learning videos that children can use not only when learning online, and designing assessments used in teaching processes. Most of the preparation resulted from self-learning because only 3,2% of teachers participated in training related to online learning, online curriculum design, or online learning content-making exercises. Kukulska-Hulme et al. (2015) state that teachers must consider integrating technology into the curriculum rather than treating it as a stand-alone activity if they wish to incorporate technology and digital media into early childhood classroom practices. Teachers are aware of technology and digital media integration in early childhood classrooms. However, they are less satisfied with their preparation for technology integration into classrooms. Research results indicate that teachers require more training and information about technology integration in practice and how to engage children in activities using technology and digital media (Alelaimat, Ihmeideh, & Alkhawaldeh, 2020).

The second factor in TPACK is exertion. It refers to teachers' competencies to execute technology for teaching, measurement, and evaluation for an effective teaching process. Teachers' competencies in this second factor are 60,62% with the category medium. Exertions include the teacher's ability to use technology to update knowledge and skills regarding the content area and implement effective classroom management in the teaching and learning process. (Parette, Quesenberry, & Blum, 2010) assert that the integration of technology in early childhood education should consider the appropriateness of technology use and prioritize the use of this medium in a developmentally appropriate way. Havu-Nuutinen et al. state that although technology has many good effects on education, research shows that teachers lack confidence and moderately integrate technology into play-based practices (2017).

Using technology to update the knowledge and skills regarding teaching and measuring children's development is another indication of exertion. The accessibility of ICT devices and technical support are the external factors affecting technology integration in education. Teachers' internal factors, such as competencies, attitudes, and beliefs, are essential in developing and designing appropriate technology-enriched classroom learning experiences (Anderson & Maninger, 2007). Teachers more enthusiastic about technology are more likely to include it in their lessons (Marangunić & Granić, 2015). Technology integration into the learning environment should be described in terms of a few key components. It suggests that technology should be integrated into educational activities and suitable for children's developmental stages. Also, devices are pivotal in helping teachers implement technology successfully (McManis & Gunnewig, 2012).

The third TPACK factor is ethics, which refers to teachers' attitudes while integrating technology into the learning process. We take copyright concerns seriously regarding digital sources and choose trustworthy online resources (59,74% in the Medium category). With technology's advances, we generally agree that young children can benefit intellectually and socially from developmentally appropriate software. Additionally, kids should be able to actively engage with computers and any accompanying software to explore and pick up new ideas (Chuang & Ho, 2015). Teachers should become models for computers and software so children will learn to use them appropriately and obey ethical norms. Teachers should have digital literacy skills so they can manage to help children understand how to use digital devices and software responsibly (Park & Hargis, 2018).

Proficiency is the scale's final component. This component, 40,39% with category Low, measures instructors' capacity to combine content, pedagogy, and technology by becoming authorities in their field and resolving subject-specific issues. Teachers struggle with effectively using technology in their courses (Voogt & McKenney, 2017). It is still difficult for them to use technology, ideally in learning. The limitations of knowledge, skills, access to digital devices and facilities, and perceived training have not been obtained evenly by teachers, making most of them learn independently or in a group of teachers and rely only on resources they can use for children's learning activities. Children's Learning environments differ from those of other age groups (Guernsey, 2014). It is essential to investigate what developmentally appropriate technology integration entails and how to support educators in comprehending and implementing it successfully.

4. CONCLUSION

Kabakci Yurdakul's development of the TPACK depth scales stands as a pivotal tool for evaluating teachers' TPACK competencies. In the modern educational landscape, where technology plays an increasingly central role, TPACK is indispensable for educators looking to effectively leverage technology in their classrooms. It empowers teachers to not only select and utilize hardware and

software tools but also to identify relevant resources and integrate them seamlessly into the teaching-learning process. In the realm of early childhood education, the integration of technology must be thoughtfully curated, ensuring alignment with play-based activities and developmental appropriateness for young learners. While there is a clear imperative for educators to enhance their technological competencies to navigate challenges and elevate educational quality, it is noteworthy that many teachers still struggle to effectively apply technology skills in their teaching practices.

Moving forward, future research could delve deeper into understanding the barriers hindering teachers' adoption of technology in education. This could involve exploring the effectiveness of various training methodologies, the impact of collaborative networking among educators, and the importance of providing adequate online resources and devices to facilitate seamless integration of technology into educational practices. Such insights are particularly critical in the context of pandemics or similar scenarios where online education emerges as the primary mode of instructional delivery, highlighting the urgent need to equip educators with the necessary tools and competencies to thrive in digital learning environments.

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