

Elementary School Teacher's Competence in Technology Integration and Curriculum Comprehension

Apriyanti Widiansyah^{1*}, Husna Farhana², Dian Anggraeni Maharbid³

^{1,2,3}Fakultas Ilmu Pendidikan, Universitas Bhayangkara Jakarta Raya, Jakarta, Indonesia

*apriyanti.widiansyah@dsn.ubharajaya.ac.id

Abstract. The integration of information and communication technology (ICT) into education has become a crucial component of 21st-century teaching competencies. Elementary school teachers are now expected to develop adaptive skills in utilizing digital tools while demonstrating a comprehensive understanding of the current educational curriculum, particularly the Merdeka Curriculum implemented in Indonesia. This study aims to examine teachers' competencies in adapting to technological advancements and their level of curriculum comprehension within the context of elementary education. Employing a descriptive qualitative design, data were collected through classroom observations, in-depth interviews, and document analysis. The findings reveal that most teachers have demonstrated adequate proficiency in employing digital learning tools, such as online learning platforms, interactive media, and technology-based presentation software. However, variations remain in teachers' capacity to plan, implement, and evaluate technology-integrated instruction. Moreover, teachers' understanding of the Merdeka Curriculum has improved through professional development programs, peer collaboration, and participation in learning communities. These results highlight the necessity of continuous professional training focused on both digital literacy and pedagogical competence to ensure effective, innovative, and contextually relevant learning experiences. Strengthening teachers' technological and curricular expertise is therefore essential to achieving sustainable educational transformation aligned with national and global educational goals.

Keywords: Teacher competence, Technology Integration and Curriculum Comprehension, Elementary School.

INTRODUCTION

The rapid development of digital technology has brought significant changes to the field of education, including at the elementary school level. The integration of technology in learning has become not only a demand of the times but also an essential part of improving the quality of education. Elementary school teachers, as the main agents in implementing learning, play a strategic role in ensuring that the teaching and learning process is effective, interactive, and relevant to the needs of the 21st century. A movement exemplifies the significance of 21st-century learning in education from traditional to contemporary methods. This new strategy focuses on preparing students for the future by providing them with the skills necessary for success in a global market. The 21st-century learning approach refers to teaching and learning methods that focus on developing skills and competencies relevant to the demands and challenges of the 21st-century. (Nurhidayat et al., 2024)

The integration of technology into the teaching and learning process during the COVID-19 epidemic has had a dramatic impact on education. The aforementioned trend is particularly evident when educators take into account the various challenges they have faced as a result of the COVID-19 pandemic. The transition from face-to-face meetings to remote emergency training has been seen, and more recently, a hybrid learning environment has emerged as an alternative approach. The unforeseen alterations have had a substantial effect on individuals' interaction with technology. The integration of this technology into our pedagogical practices holds significant value. Amidst the epidemic, the extensive incorporation of technology plays a crucial role in sustaining employment, education, and interpersonal connections. These modifications persist as integral components of our everyday existence, with certain adaptations expected to endure in our perceptions of technology and education. (S. Dhawan, 2020)

The current global epidemic has brought attention to lessons that remain unlearned about the extensive education technology (ed-tech) landscape and its application in pedagogy. The exploration and utilization of diverse technology tools are imperative in acquiring knowledge and expanding one's learning capabilities. The integration of education within this environment should be prioritized, aiming to make it more pervasive in the daily lives of individuals. Educators must be able to regulate, manipulate, and effectively integrate these instruments within their pedagogical approaches. The possession of prior experience with these technologies is optional for their successful implementation and the cultivation of effective learning environments. As a result of these technologies, as mentioned above, educators are compelled to acquire novel competencies in order to instruct and support their students proficiently. In addition to facilitating the acquisition of knowledge, students must also possess the ability to grasp and effectively utilize the information presented to them in many ways. (S. Henriques, 2021)

Numerous methodologies exist for incorporating technology into educational settings, each possessing the capacity to foster the development of skills and abilities relevant to the demands of the 21st century. Cheung et al. Stated that digital technology enables personalized learning experiences for individuals. Using various instruments in the classroom enhances the effectiveness of customized learning. The advent of digital technologies has facilitated the implementation of instructional methods that leverage the unique attributes of both educators and students. The choices and characteristics of different information and communication technology (ICT) instruments enhance and refine these capabilities. The integration of

technology facilitates the advancement of individual growth, rendering it a prudent choice that merits endorsement. (S. K. S. Cheung, 2021)

Evaluating technology integration is essential to determine its effectiveness in achieving learning objectives. Teachers need to assess students' digital skills, using the information to identify areas where technology integration can be improved. (K. Murkatik, 2020)

However, teachers' ability to integrate technology still varies. Some teachers are able to utilize digital tools and applications to support learning, while others still face challenges in terms of technical skills and pedagogical understanding of technology use. On the other hand, comprehension of the curriculum is also a crucial aspect that determines how well teachers can align the use of technology with learning objectives and student competency achievements.

The combination of technological competence and curriculum comprehension is a key factor in creating innovative and meaningful learning. Therefore, research on *Elementary School Teachers' Competence in Technology Integration and Curriculum Comprehension* is essential to examine the extent to which teachers can integrate these two aspects in classroom practices, as well as to identify the challenges and professional development needs of teachers in the digital era.

Over the past decade, research on teachers' competence in technology integration and curriculum comprehension has become a central focus in the field of elementary education. Several studies emphasize the importance of teachers' ability to utilize technology to enhance the quality of learning, especially since the implementation of competency-based curricula and digital learning approaches. For instance, the **TPACK (Technological Pedagogical Content Knowledge)** model represents educators' knowledge in managing classrooms and integrating technology into each instructional delivery. Koehler, Mishra, Ackaoglu, and Rosenberg (2013) further explain that Technological Pedagogical Content Knowledge (TPACK) consists of three core domains: **Technological Knowledge (TK)**, **Content Knowledge (CK)**, and **Pedagogical Knowledge (PK)**. These three domains interact to form overlapping areas of knowledge: **Technological Pedagogical Knowledge (TPK)**, **Technological Content Knowledge (TCK)**, and **Pedagogical Content Knowledge (PCK)**. (Riska Septia Wahyuningtyas, 2023)

The integration of technology in education is a demand of the times that cannot be avoided, but its implementation still faces various challenges. (Indriawati, 2020) Many teachers do not

yet have adequate competence in utilizing technology effectively and meaningfully in the learning process. (Guggemos, 2021) Problems such as limited training, low understanding of selecting technology that is appropriate to the characteristics of teaching materials, and inappropriate implementation of digital pedagogy are still often encountered. (Irmita, 2018) In addition, limited infrastructure and access in several areas are also major obstacles to equalizing technology integration. (Voogt, 2017)

This has an impact on the less than optimal teaching and learning process which should be supported by various digital innovations. (Rizqiyah, 2021) TPACK emphasizes the teacher's ability to integrate technology harmoniously with teaching methods and the content being taught. (Westbroek, 2019) By understanding and implementing TPACK, teachers can design more relevant, interactive, and contextual learning strategies. (Palieraki, 2021)

Recent studies indicate that although many teachers hold positive attitudes toward the use of technology, there remains a gap in its optimal classroom implementation, mainly due to the lack of professional training focused on technology-based pedagogical strategies. Moreover, several studies highlight that a deep understanding of the curriculum is a crucial prerequisite for teachers to effectively select and adapt technologies in alignment with learning objectives and students' needs.

The novelty of this research lies in its attempt to deeply connect **technological competence and curriculum comprehension** within the context of elementary school teachers, two aspects that have often been studied separately in previous research. This approach is expected to provide a comprehensive understanding of how these elements interact to enhance learning effectiveness in the digital era.

Although numerous studies have examined teachers' technological competence and their understanding of curriculum implementation, most have tended to analyze these aspects independently. Research that focuses exclusively on technology integration often overlooks how curriculum comprehension influences teachers' ability to apply technology in purposeful and pedagogically sound ways. Conversely, studies emphasizing curriculum understanding rarely investigate how technological competence supports effective curriculum delivery in classroom settings.

This separation has led to a limited understanding of how these two competencies interact to shape instructional practices, particularly in elementary school contexts where digital literacy and pedagogical adaptability are crucial. Furthermore, there remains a lack of empirical

evidence linking teachers' mastery of digital tools with their understanding of curriculum frameworks in an integrated and systematic manner.

Hence, this study provides originality by bridging these two domains technology integration and curriculum comprehension into a cohesive conceptual framework. It aims to uncover how elementary school teachers interrelate technological competence and curriculum understanding to design, implement, and evaluate effective learning experiences in the digital era.

Previous studies have discussed teachers' competence in technology integration and curriculum comprehension; however, most of them have been conducted separately and partially. Research focusing on technology integration generally highlights teachers' ability to utilize digital tools, such as interactive media, educational applications, or e-learning platforms, to enhance student engagement. Meanwhile, studies emphasizing curriculum comprehension tend to explore teachers' ability to design lessons, understand learning outcomes, and align teaching strategies with the curriculum policies in place.

Nevertheless, few studies have directly examined the interrelationship between technological competence and curriculum comprehension, particularly in the context of elementary school teachers. Most prior research has treated these two aspects as independent variables rather than interconnected and mutually reinforcing elements within teaching practice. In addition, previous studies have largely concentrated on secondary or higher education levels, leaving limited exploration of elementary school teachers who play a foundational role in formal education.

The uniqueness of this study lies in its integrative approach, which connects technological competence and curriculum comprehension within a comprehensive analytical framework. This study does not merely assess teachers' mastery of technology or their understanding of the curriculum but also investigates how these two competencies interact to enhance the effectiveness of classroom learning. Therefore, this research is expected to provide both theoretical and practical contributions to the development of elementary teachers' professionalism in the digital era and serve as a foundation for designing more comprehensive and contextual teacher training programs.

To address the identified research gaps, this study adopts a descriptive and analytical approach aimed at understanding the interconnection between elementary school teachers' technological competence and their comprehension of the curriculum. The approach involves

examining how teachers plan, implement, and evaluate learning activities that integrate digital tools in alignment with curriculum objectives.

This study uses a descriptive qualitative research method and collects various literature related to TPACK in teacher technology integration. The technique used in this article is to use literature study, namely by examining and understanding document references that are relevant to the impact of TPACK on teacher technology integration. The type of research used is library research, namely research that uses library data to be studied more deeply and reviewed in order to obtain objective results.

METHODOLOGY

This study employs a qualitative descriptive method. Descriptive research is conducted to depict and illustrate the condition of the research object in its present state based on empirical facts. This method aims to reveal problems, conditions, or events as they are, with its primary focus on describing factual information. The findings of the study are expected to provide an objective portrayal of the actual condition of the subjects being examined. Throughout the research process, the researcher continually poses questions such as “why,” “for what reason,” and “how it occurs”. (Moleong. Lexy J., 2008)

The qualitative research method, often referred to as the naturalistic research method, is used to examine objects in their natural conditions. In this approach, the researcher serves as the key instrument. Data collection techniques are carried out through interviews, and the data analysis is inductive in nature. The findings of qualitative research place greater emphasis on interpreting phenomena rather than producing generalizations. (Sugiyono, 2015)

Qualitative research is a type of study that generates findings that cannot be obtained through statistical procedures or other forms of quantification. This research aims to develop a general understanding of social realities from the participants' perspectives. Such understanding is not predetermined but is derived through an analysis of the social realities that constitute the focus of the study, ultimately leading to a general conclusion about the phenomena. Furthermore, qualitative research also allows for the development of theories based on emerging findings from the field.

This study employs the interactive model of analysis proposed by Saldana, the activities in qualitative data analysis are carried out interactively and continuously until data saturation is reached. The analysis process includes data condensation, data display, and conclusion drawing and verification. The purpose of this qualitative descriptive study is to provide a

systematic, factual, and accurate description of a particular phenomenon, namely elementary school teachers' competencies in technology integration and curriculum understanding. (Miles, 2014)

To complement the qualitative findings, semi-structured interviews and classroom observations were conducted to gain a deeper understanding of teachers' practical experiences in technology-based instruction and curriculum implementation. The data were analyzed using thematic analysis, which enabled the identification of key themes related to teachers' perceptions, the strategies they employed, and the challenges they faced in integrating digital tools into curriculum-based learning.

RESULTS AND DISCUSSION

A. Overview of Literature Review Findings

The reviewed literature encompasses international and national journal articles, research reports, and academic books that focus on teachers' competencies in technology integration and curriculum understanding within the context of primary education. In general, the findings indicate that teachers' competence in integrating technology cannot be separated from their ability to comprehend the prevailing curriculum. Technology integration in learning becomes meaningful only when its use is aligned with the intended learning outcomes and the pedagogical principles mandated by the curriculum.

A substantial body of literature identifies a pronounced misalignment between the expectations articulated in technology driven curriculum policies and teachers' demonstrated capacity to enact these expectations within authentic classroom contexts. (O. , & M. M. Handini, 2022) This misalignment is shaped by a constellation of interrelated factors, including the robustness of teacher professional development initiatives, the adequacy of technological infrastructure, the depth of teachers' digital literacy, their accumulated instructional experience, and the prevailing norms and practices embedded within school culture. Consequently, teacher competence should be conceptualized not as a purely technical attribute but as a multidimensional construct that synthesizes pedagogical expertise, disciplinary knowledge, technological fluency, and comprehensive curriculum literacy.

a. Technology Competence of Primary School Teachers

1. Teachers' Digital Technical Skills

Technical skills are widely recognized as a critical foundation for effective technology integration in education. (Allen, 2017) In the context of primary education, these skills encompass the operation of computers, tablets, projectors, Learning Management Systems (LMS), online assessment platforms, and presentation software. While indispensable, technical proficiency alone is insufficient to guarantee meaningful learning outcomes.

Empirical evidence indicates that teachers who prioritize technical competence in isolation often engage in superficial technology use for instance, presenting videos without pedagogical alignment or employing applications repetitively without promoting critical student engagement. (B., C. A. , & M. J. Twining, 2024) These findings highlight the necessity of a comprehensive understanding of the pedagogical affordances of technology to enhance instructional effectiveness.

2. Teachers' Technological-Pedagogical Skills

Research on digital pedagogy emphasizes that teachers' ability to integrate technology with instructional strategies is a key component of meaningful integration. Pedagogical technological competence encompasses the following aspects The selection of technologies that align with instructional goals and the characteristics of the learning content is a fundamental step in the process of technology integration. In addition, the design of learning activities should be directed toward fostering interaction, collaboration, and student creativity through various digital platforms. Technology is also utilized to support differentiated instruction, including adjusting the level of difficulty of learning materials to meet individual student needs. Furthermore, the use of technology in formative assessment such as digital quizzes and automated feedback plays an essential role in continuously monitoring students' learning progress.

The study conducted by (Anderson, 2017) indicates that teachers with a deep understanding of digital pedagogy are able to significantly enhance student engagement and motivation. This capability extends beyond merely operating applications; it involves leveraging technology to facilitate the development of Higher Order Thinking Skills (HOTS).

3. TPACK Framework as a Competency Indicator

The Technological Pedagogical and Content Knowledge (TPACK) framework developed by (Mishra, 2006) serves as a primary reference for assessing and enhancing teachers'

competencies in technology integration. This framework represents the intersection of three core domains of knowledge, namely: 1) Content Knowledge (CK): knowledge of the subject matter. 2) Pedagogical Knowledge (PK): knowledge of instructional strategies. 3) Technological Knowledge (TK): the ability to use digital technologies.

The TPACK framework emphasizes that successful technology integration depends on teachers' ability to synthesize these three domains. For example, in elementary mathematics instruction, teachers are not merely expected to present digital math games, but to understand how such activities support foundational number concepts and logical reasoning. The literature concludes that teachers with strong TPACK competencies are better equipped to facilitate meaningful and well-structured learning experiences.

4. Curriculum Understanding as the Foundation for Technology Integration

a. Understanding the Structure, Principles, and Objectives of the Curriculum

Curriculum understanding encompasses not only familiarity with the Learning Outcomes (CP), but also the ability to interpret the curriculum's underlying philosophy, learning principles, and the competency standards students are expected to achieve. Teachers who possess a strong understanding of the curriculum are able to plan instruction systematically and integrate technology as a tool rather than an end in itself.

(P., G. G., & M. A. Twining, 2024) found that teachers who understand the structure of the curriculum are better able to align technological tools with instructional needs. For example, they may select digital literacy applications to enhance reading comprehension skills or employ science simulations to strengthen students' understanding of force and motion concepts.

b. Aligning Technology with Learning Indicators

The literature indicates that one of the major challenges faced by teachers is the inability to align technological tools with specific learning indicators. As a result, the use of technology often lacks clear curricular direction. Research shows that technology should be used to: 1) Support students in achieving basic competencies, 2) Strengthen literacy and numeracy skills, 3) Facilitate differentiated instruction, 4) Enhance critical thinking and communication skills. When curriculum understanding is weak, technology integration tends to become a repetitive activity devoid of meaningful pedagogical purpose.

5. Synergistic Relationship Between Technological Competence and Curriculum Understanding

The literature emphasizes that effective technology integration can only occur when teachers possess both technological competence and a solid understanding of the curriculum. The relationship between these two components is synergistic and inseparable. Teachers with high technological skills but limited curriculum understanding tend to: 1) Use applications that are not instructionally relevant, 2) Overlook learning outcomes, 3) Spend instructional time on digital activities with minimal academic value.

Conversely, teachers with strong curriculum understanding but low digital literacy often: 1) Struggle to maximize the potential of technology, 2) Rely on conventional instructional methods, 3) Experience difficulty meeting the demands of 21st-century learning. (S., & M. M. Handini, 2022) found that technological improvements are effective only when accompanied by training that also addresses curriculum analysis and instructional design.

This literature review reinforces the position of TPACK as a relevant theoretical framework in developing teacher competencies. In addition, the studies highlight the importance of understanding the curriculum as the primary foundation before implementing technology integration.

CONCLUSION

The literature review demonstrates that effective technology integration in education requires a balanced combination of technological competence and a strong understanding of curriculum principles. The TPACK framework emerges as a relevant and comprehensive theoretical model for guiding teachers in synthesizing content knowledge, pedagogical knowledge, and technological knowledge. Studies further emphasize that curriculum understanding particularly regarding learning objectives, instructional principles, and competency standards is foundational to ensuring that technology is used purposefully rather than superficially. Teachers who lack curriculum mastery tend to employ digital tools without clear instructional alignment, while those with limited digital literacy struggle to meet the demands of contemporary learning environments. Overall, the findings affirm that professional development should simultaneously enhance teachers' technological skills and strengthen their curriculum literacy to achieve meaningful and pedagogically grounded technology integration.

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