



Teachers' strategies in integrating the Technological Pedagogical Content Knowledge (TPACK) model to improve the quality of learning at State Madrasah in Palu city

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Received 1 Jun 2026; Accepted 11 Jul 2026; Published 21 Jul 2026

DOI: <https://doi.org/10.64171/JAES.6.4.80-86>

Abstract

This study is motivated by the need to improve the quality of Islamic Religious Education learning at State Madrasah in Palu City. This study integrated technology to align with pedagogy and content knowledge. The rapid development of technology requires teachers not only to master subject matter but also to integrate technology pedagogically without neglecting Islamic values that characterize the madrasah. Technology-based learning transformation has become a strategic necessity to address 21st-century educational challenges while maintaining the religious identity of Islamic educational institutions. This research aims to analyze teachers' strategies in designing and implementing the TPACK model in learning, identify the challenges and opportunities in its implementation, and explain the implications of applying TPACK for learning quality and students' learning experiences. These objectives are formulated to provide a comprehensive understanding of how technology, pedagogy, and content integrate within the learning context. This study employs a qualitative approach with a case study design. Data were collected through observation, in-depth interviews, and documentation, and then analyzed through data reduction, data display, and reflective conclusion drawing to obtain a comprehensive picture of TPACK implementation in the madrasah. Data validity was strengthened through source and technique triangulation to ensure credibility. The findings reveal that teachers integrate TPACK through systematic lesson planning, the selection of relevant digital media, interactive, technology-based instruction that encourages discussion and collaboration, and comprehensive evaluation that combines digital and non-digital instruments. The integration is further supported by the literacy garden as a contextual learning space. Key challenges include limited technological competence, facilities, time constraints, and the need to maintain Islamic values in digital learning. However, opportunities arise from leadership support, students' enthusiasm, and the madrasah's culture of innovation. TPACK implementation has been shown to enhance student engagement, deepen conceptual understanding, and strengthen ethical and religious character. The implications of this study emphasize the importance of strengthening teachers' professional competence, institutional policy support, and the development of an integrative, religiously grounded learning ecosystem to ensure the sustainable implementation of TPACK in improving the quality of Islamic education.

Keywords: TPACK, Integration, Learning quality, Technology, Content knowledge

Introduction

Teachers are key actors in the learning process and are required to possess comprehensive professional competencies, encompassing mastery of subject matter, learning methods, and the ability to utilize technology effectively (Alfrey, O'Connor, & Jeanes, 2017; Araghieh, Farahani, Ardakani, & Zadeh, 2011) [1, 2]. This challenge is further complicated in religion-based junior high schools, where teachers must balance strengthening Islamic values with the judicious use of modern technology. Madrasah Tsanawiyah, as a formal Islamic educational institution, faces a dual challenge: improving academic quality while maintaining students' religious character. On the one hand, madrasahs are required to keep pace with the digitalization of education; on the other, concerns persist about the negative impact of technology use on students' moral and spiritual values. In response to this complexity, the Technological Pedagogical Content Knowledge (TPACK) model emerged as a conceptual framework that emphasizes the harmonious integration of technological, pedagogical, and content knowledge (Jiménez Sierra, Ortega Iglesias, Cabero-

Almenara, & Palacios-Rodríguez, 2023; Koehler, Mishra, Kereluik, Shin, & Graham, 2014) [13, 14]. This model holds that quality learning can only be achieved if teachers integrate these three aspects contextually and reflectively into their learning practices.

In madrasah environments, the challenges of technology integration are often exacerbated by limited infrastructure, uneven internet access, and a lack of training focused on pedagogical and content integration. These conditions result in low-quality learning that does not utilize technology optimally. Learning that is not fully integrated with TPACK principles tends to be teacher-centered, less interactive, and unable to accommodate students' learning styles fully. As a result, the potential of technology to improve learning quality has not been fully realized. As one of the leading state madrasahs in Palu City, the Madrasah has an institutional responsibility to implement technology-based education policies effectively. However, in practice, technology-based learning innovations tend to be partial and not yet integrated into a systematic pedagogical framework. Technology integration often emerges

as an individual teacher initiative rather than a structured, sustainable collective pedagogical practice. To strengthen a culture of literacy and learning that is adaptive to technological developments, the Madrasah has developed a literacy park as a learning support tool. This literacy park is designed as an alternative learning space that allows students to engage in reading, discussions, exploration of learning resources, and the use of digital-based teaching materials outside the formal classroom. The existence of this literacy park reflects the madrasah's institutional efforts to create a conducive learning environment to strengthen literacy and implement technology-based learning.

Pedagogically, literacy parks have strategic potential as implementation spaces for Technological Pedagogical Content Knowledge (TPACK)-based learning (Ching Sing, Joyce Hwee Ling, & Chin-Chung, 2013; Harris & Hofer, 2011) [7, 11]. This learning environment can be utilized by teachers to integrate learning content with a variety of pedagogical strategies and the support of technology as a learning medium and resource. However, based on initial observations, the use of literacy parks in madrasas has not been fully integrated into the systematic planning, implementation, and evaluation of TPACK-based learning, so their potential as part of the learning ecosystem has not been fully realized. The fundamental problem identified is the unequal conceptual understanding of the essence of TPACK integration among teachers.

Some teachers still interpret the use of technology as merely fulfilling administrative learning requirements or as a variation of teaching methods, without prior analysis of how learning objectives, material characteristics, pedagogical strategies, and relevant technology choices are integrated. As a result, technology is present in learning as an additional element, rather than an integral part of the learning design. The use of technology does not conflict with Islamic values, as long as it is directed towards meaningful educational goals. On the contrary, technology should be positioned as a means to strengthen the quality of learning, deepen students' understanding, and foster awareness of the importance of knowledge. Therefore, research on teacher strategies in integrating TPACK in madrasas is becoming increasingly relevant and meaningful. This research is expected to bridge normative Islamic values with modern pedagogical practices in an effort to improve the quality of learning in madrasas. Therefore, qualitative research is needed that focuses on teacher strategies in integrating TPACK to improve the quality of learning in madrasas so that technology integration is not only technical but also pedagogical, contextual, and Islamically valuable.

Literature review

Teachers strategy

In this study, teacher strategies are defined as a series of conscious, planned, and reflective actions undertaken by teachers in the design, implementation, and evaluation of learning (James *et al.*, 2024; Liao, Liu, Wang, & Qin, 2024) [12, 16]. These strategies encompass how teachers select learning

approaches, manage the classroom, utilize media and technology, and adapt learning to student characteristics and the madrasah context. Teacher strategies are understood as dynamic and contextual pedagogical processes, not simply technical procedures. The study focuses on how teachers make pedagogical decisions in integrating technology, pedagogy, and learning content. According to Joyce and colleagues, the choice of learning model must be tailored to learning objectives, student characteristics, and the material being taught (Kostaki & Linardakis, 2025; Nguyen, Nguyen, Nguyen, & Huynh, 2024) [15, 18]. Effective teachers are those who can vary instructional models to create an active, meaningful, and appropriate learning environment for students. Differentiated learning strategies are also important for teachers to implement. Each student has different abilities, learning speeds, and learning styles. Therefore, teachers need to adjust their teaching methods and the material presented to suit each individual's needs. In this strategy, teachers vary how they deliver material, such as assigning work of varying difficulty, using different media or methods to explain the same topic, and paying special attention to students who need more assistance. With a differentiated approach, all students, regardless of their background and abilities, can learn effectively and feel valued in the learning process.

Authentic assessment strategies are a crucial element in measuring learning success. Authentic assessment focuses not only on final exams but also on learning processes and outcomes relevant to the real world. Teachers can use various assessment instruments, such as portfolios, presentations, projects, or practical assignments, that allow students to demonstrate their understanding and skills more comprehensively. These assessments help teachers evaluate not only students' knowledge but also their ability to apply that knowledge in real-life contexts. Therefore, teacher strategies that incorporate authentic assessment will provide a more holistic picture of student development and support the achievement of overall learning objectives.

Technological Pedagogical Content Knowledge (TPACK)

Technological Pedagogical Content Knowledge (TPACK) in this study is defined as a teacher knowledge framework that integrates three main components, namely content knowledge, pedagogical knowledge, and technological knowledge, in an integrated manner in learning practices (Oved & Alt, 2025) [28]. Definition of the Technological Pedagogical Content Knowledge (TPACK) Model: Understanding TPACK as a framework that combines three main components: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK). An explanation of how these three components must interact with each other to create effective teaching. TPACK is a conceptual framework developed by Punya Mishra and Matthew J. Koehler in 2006. This theory builds on Shulman's idea of Pedagogical Content Knowledge (PCK) by integrating technological elements into the combination of content and pedagogical knowledge (Wang, Samsudin, & Hidayat, 2026) [32]. TPACK emphasizes that effective teachers in technology-based learning must have

unified and balanced knowledge of the three components, namely Content Knowledge (CK), which includes teacher knowledge of the subject matter being taught. Next, there's pedagogical knowledge (PK), which encompasses knowledge of teaching methods and strategies, including how to facilitate student learning. Finally, there is Technological Knowledge (TK), which encompasses knowledge of various digital technologies, tools, and resources that can be used to support the teaching and learning process.

The Technological Pedagogical Content Knowledge (TPACK) model is a framework that integrates three essential components in education: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK). TPACK guides educators in understanding how these three components must interact to create effective, efficient, and relevant learning experiences for students.¹⁶ In this context, TPACK not only emphasizes the importance of each component separately but also highlights the importance of a harmonious relationship between the three for optimal learning practices. Content Knowledge (CK) refers to the knowledge possessed by teachers regarding the material or topic being taught. This includes a deep understanding of facts, concepts, theories, principles, and ideas in a particular discipline. For example, a mathematics teacher must have strong knowledge of mathematical concepts such as algebra, geometry, or calculus. Without a good understanding of this content, a teacher will not be able to convey the material clearly or deeply to students. Pedagogical Knowledge (PK) focuses on knowledge of teaching methods and strategies. This includes understanding how to manage a classroom, designing effective learning experiences, and assessing and evaluating student learning. PK involves various skills, such as using different learning approaches, understanding student needs, and applying techniques to increase student participation in the learning process. Teachers with strong pedagogical knowledge can adapt teaching methods to students' learning styles and the learning objectives to be achieved. TPACK is analyzed through how teachers choose technology that is relevant to the learning material, adapt it to pedagogical strategies, and link it to learning objectives. In this study, TPACK is not measured quantitatively, but rather understood through teacher practices and reflections on learning as revealed in observations and interviews.

Integration of TPACK in teaching

TPACK integration in learning refers to the process of utilizing technology that is pedagogically designed and adapted to the characteristics of the learning material (Chiu, 2026; Dang, Alani, Nayani, & Erturk, 2026) ^[8, 10]. In this study, TPACK integration is examined through the stages of learning planning, classroom implementation, and learning evaluation, reflecting the integration of technology, pedagogy, and content. TPACK integration is analyzed by examining the extent to which technology is used as an integral part of the learning process rather than merely as a complement. The focus of observation is on the integration of learning objectives, methods, technological media, and evaluations used by

teachers in daily learning practices. Improved learning quality in this study is defined as positive changes that occur in the learning process after teachers implement the Technological Pedagogical Content Knowledge (TPACK) model integration strategy. Operationally, this improvement is characterized by increasingly effective learning processes that actively involve students, the use of a variety of technology-based learning methods and media, clarity in teacher delivery, and the establishment of dynamic educational interactions between teachers and students. In addition, teachers' ability to integrate technology, pedagogy, and content is a key indicator of improved learning quality.

Improved learning quality is also evident in the results achieved by students after the learning process (Liu, Zhang, & Yang, 2026) ^[17]. This includes increased conceptual understanding of the material taught, improved learning outcomes reflected in evaluation scores, and growing student motivation and interest in learning. Furthermore, students' critical and creative thinking skills are also crucial in measuring learning quality. All of these indicators are assessed through observation, interviews, and documentation, providing a comprehensive picture of the effectiveness of teachers' strategies for integrating the TPACK model to improve learning quality in madrasas. Improved learning quality is also operationalized through the continuity of innovative and adaptive learning practices to technological developments and student needs. This is evident in teachers' consistent design of TPACK-integrated learning plans, reflective implementation of learning, and evaluations oriented toward continuous improvement. Thus, learning quality is not only measured in the moment but also assessed through its sustainability and long-term impact on improving student competency and teacher professionalism in managing learning that is relevant to current demands.

Methodology

This study uses qualitative methods. In qualitative research, theory serves only as a guide for data gathering and analysis (Nurdin & Pettalongi, 2022; Nurdin, Stockdale, & Scheepers, 2016) ^[19, 22]. The data was collected through direct observation, in-depth interviews, and written document analysis at the research site (Rusli, Hasyim, & Nurdin, 2021; Rusli & Nurdin, 2022) ^[29, 30]. The research was conducted in a government madrasah in Palu city, Indonesia. The researcher chose the school because it is a reputable government school that implements effective educational technology in Islamic education. The results of this study can later serve as a reference and guideline for integrating local language into the teaching of the Islamic religion and for making schools a model for other educational institutions. Data were collected through direct observation, focus group discussion, in-depth interviews, and written document analysis. The interviews involved the school principal, five teachers, and ten students. The interviews were recorded and transcribed. The transcripts were consulted with participants to obtain their consent (Nurdin, Scheepers, & Stockdale, 2022; Nurdin, Stockdale, & Scheepers, 2014) ^[22, 21]. The data analysis used a deductive approach, which can be

interpreted as a research procedure that produces deductive data from interviews and field notes. Data analysis was conducted using thematic analysis from Strauss and Corbin (1998) [31]. The analysis started with open, axial, and selective coding. The final result of the data analysis is the set of themes identified.

Results and Discussion

Utilization of learning technology from a TPACK perspective

Based on our research, the most relevant learning approach for implementing Technological Pedagogical Content Knowledge (TPACK) is Student-Centered Learning (SCL). This approach puts students as the primary subjects in the learning process, while the teacher acts as a facilitator who guides and directs the learning process. This approach was chosen based on research findings indicating that classroom learning processes still tend to be teacher-centered, resulting in underdeveloped student interaction and activity. Furthermore, the use of technology in learning is still not optimally integrated and is used more as a tool for delivering material than as a means of exploring learning. From a TPACK perspective, the Student-Centered Learning approach is highly relevant because it integrates three main components: technology (Technological Knowledge), pedagogy (Pedagogical Knowledge), and content (Content Knowledge). Pedagogically, this approach encourages active learning methods such as discussion, collaboration, and problem-solving, enabling students to construct knowledge independently. From a technological perspective, students can utilize various digital media as learning resources, not just as tools for receiving information. Meanwhile, from a content perspective, learning materials can be understood more deeply because students are directly involved in exploring and constructing knowledge.

Theoretically, the Student-Centered Learning approach aligns with constructivist theory, which states that students construct knowledge through learning experiences. This is also supported by the TPACK concept, which emphasizes the importance of integrating technology, pedagogy, and content in creating meaningful learning. Thus, this approach not only increases student engagement but also supports the use of technology more effectively and contextually. In its implementation, this approach can be realized through various strategies, such as group discussion-based learning, digital media for independent learning, and project-based assignments that encourage students to search for, process, and present information. In addition, learning environments such as literacy parks can be integrated into the learning process to support students' exploration activities.

The Student-Centered Learning approach is the most appropriate for supporting the implementation of TPACK because it fosters active, interactive, and meaningful learning and encourages optimal technology integration in the learning process. The results of the study also show that the selection and utilization of technology in learning have not been fully integrated optimally within the Technological Pedagogical Content Knowledge (TPACK) framework. The technology

used by teachers generally still serves as a tool for delivering material, not as an integral part of the learning design that connects pedagogical and content aspects simultaneously. From a TPACK perspective, the use of technology should not stand alone, but rather be integrated with pedagogical strategies and the characteristics of the learning materials. Dahri *et al.* (2024) [9] explain that technology in learning will be effective if used contextually, namely in accordance with the learning objectives, methods used, and students' characteristics. Technology is not just a tool, but a means to strengthen the process of knowledge construction.

The research results show that the technologies most frequently used by teachers include presentation media such as PowerPoint and instructional videos, as well as communication applications like WhatsApp. In addition, some teachers have begun using digital platforms such as Google Classroom and digital evaluation tools such as Google Forms and Quizizz. The use of these technologies has had a positive impact on student interest and motivation to learn, particularly through the presentation of more visual and interactive materials. However, the use of these technologies remains partial. Teachers have not fully linked the choice of technology to the characteristics of the material and the learning strategies used. This aligns with research findings showing that technology is often positioned as a complement to learning, rather than an integral part of the learning design. The use of presentation media such as PowerPoint should serve not only as a tool for conveying information but also as a means of facilitating interaction and conceptual understanding. Similarly, instructional videos can help students visualize abstract material, thereby helping them understand concepts more concretely.

Meanwhile, digital platforms such as Google Classroom and WhatsApp can support collaborative learning and communication between teachers and students. Therefore, a more systematic strategy is needed for the selection and use of technology, taking into account the appropriateness of the relationship among technology, pedagogy, and content. Teachers need to develop the ability to integrate technology creatively and innovatively, so that learning is not only informative, but also interactive and meaningful.

Teacher strategies in implementing models (TPACK) in learning

Teachers' interpretations of integrating technology, pedagogy, and content within the Technological Pedagogical Content Knowledge (TPACK) framework vary in level of understanding, depending on their individual experiences and professional contexts. Some teachers interpret this integration as an effort to integrate technology in harmony with learning strategies and the substance of teaching materials to improve the effectiveness and quality of the learning process. However, there are still teachers who partially integrate TPACK, viewing technology only as a tool for delivering material, without a strong connection to the pedagogical approach and content characteristics. This difference in interpretation has direct implications for classroom learning practices, because a complete understanding of TPACK encourages teachers to

design contextual, innovative learning that is oriented towards students' needs and characteristics. Field documentation of learning in madrasas shows that teachers' interpretations of integrating technology, pedagogy, and content exhibit diverse, contextual patterns. In several observed classes, teachers appear to interpret TPACK integration as an effort to integrate subject matter with appropriate learning methods and to support it with relevant technology.

In certain learning practices, teachers utilize technology as part of a pedagogical strategy to help students understand material concepts. For example, the use of visual media and digital learning resources not only serves to convey information but also to elicit questions, clarify abstract concepts, and encourage active student participation. Observations also indicate that, in some classes, teachers' understanding of TPACK integration is often partial. Technology is used primarily as a tool to assist with material presentation, while the pedagogical approach remains dominated by the lecture method. Under these conditions, technology has not yet fully served as a means to change learning interaction patterns or to significantly increase student engagement. The integration of technology and content does not appear to be fully integrated into the learning design, but rather serves as an addition to the teaching process.

Classroom learning demonstrates that teachers' interpretations of how to integrate technology, pedagogy, and content span a spectrum. Teachers who can harmoniously integrate these three elements tend to produce more interactive and contextual learning. Teachers who continue to interpret technology separately from pedagogical strategies and content demonstrate a need to strengthen their conceptual understanding of TPACK. These findings confirm that teachers' interpretations of TPACK integration are a key foundation for determining the quality of classroom learning planning and implementation. The principal emphasized the importance of balancing technology, pedagogy, and Islamic values in learning. In an interview, he stated the following:

"The integration of technology, pedagogy, and content is integral. Technology supports the way we teach and the material we deliver. Most importantly, technology must be used to achieve learning objectives and remain aligned with the Islamic values that characterize madrasahs. In general, teachers understand that technology is important in learning. Some can connect technology to the methods and materials they teach, but others still use technology only as a supplementary tool. For us, technology is a tool. If the material is difficult to understand through verbal explanation alone, we use digital media to help students grasp it more easily. However, we always adapt it to the classroom conditions and student abilities"

The interview results indicate that the interpretation of TPACK remains pragmatic and situational. Teachers understand the importance of integrating technology, pedagogy, and content, but have not yet fully viewed the three as a unified whole that must be systematically designed from the planning stage. Technology is more often understood as a flexible tool whose use is adapted to learning conditions. Students also stated that

using technology helps them understand the subject matter, especially material considered difficult or abstract. Student opinions also indicate that technology integration is perceived in terms of learning benefits, particularly in terms of understanding and interest in the material. Students tend to judge the effectiveness of technology based on its relevance to the material and the teacher's teaching style. This finding aligns with the TPACK principle, which emphasizes that the effectiveness of technology is highly dependent on its suitability to pedagogy and content.

Variations in teachers' understanding of and readiness to implement Technological Pedagogical Content Knowledge (TPACK) remain a real phenomenon in school learning practices. These differences are influenced by educational background, teaching experience, the intensity of educational technology training, and school institutional support. Some teachers have demonstrated a good understanding of how to integrate technology with pedagogical strategies and content in a harmonious manner, thus creating interactive and meaningful learning. However, there are still teachers who tend to understand technology separately from pedagogical and content aspects, resulting in suboptimal utilization and limited use of aids. This condition indicates that teachers' readiness to implement TPACK is not only related to technical skills but also to pedagogical awareness and reflective ability in designing learning relevant to students' needs in the digital era.

Conclusion

Teachers at Palu City Islamic schools have implemented an integrative strategy in designing and implementing TPACK-based learning by combining mastery of teaching materials (content knowledge), varied pedagogical approaches (pedagogical knowledge), and the use of learning technology (technological knowledge). This strategy is implemented through the development of learning tools that incorporate contextual technology integration and the use of digital media, such as interactive presentations, learning videos, and online learning platforms, to support the learning process. Teachers also adapt the choice of technology to the characteristics of the material and students' needs, so that technology does not stand alone but serves to reinforce the pedagogical process and conceptual understanding. In its implementation, teachers face several challenges, including limited technological facilities and infrastructure, differences in digital competency levels among teachers, and time constraints in designing optimal TPACK-based learning. Furthermore, student adaptation to the use of technology in learning is also a challenge. Opportunities that support the successful implementation of TPACK include support from the Islamic school, policies that encourage the use of technology in learning, relatively adequate internet access, and teacher motivation to improve professional competence through training and independent learning. These opportunities are important capital in developing innovative and sustainable learning.

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