

Integration of the TPACK Model to Teachers' Pedagogical Competence: An Analysis of Impact and Effectiveness

Walib Abdullah¹, Adi Maladona²

¹Universitas Negeri Surabaya, Surabaya, Indonesia

²Universitas Negeri Surabaya, Surabaya, Indonesia

Corresponding Author: validabdullab321@gmail.com

Submission: 03 December 2025

Revision: 08 December 2025

Accepted: 11 December 2025

Abstract

This study aims to analyze the effectiveness of integrating the *Technological Pedagogical and Content Knowledge* (TPACK) model in improving teachers' pedagogical competence in the digital era. The research employed a mixed-methods approach using an explanatory sequential design. The first phase involved collecting quantitative data through pretests and posttests to measure improvements in pedagogical competence, followed by qualitative exploration through observations and in-depth interviews. The research subjects consisted of 40 secondary school teachers who participated in TPACK integration training. The results revealed a significant improvement in teachers' ability to design and implement technology-based learning, with the average score increasing from 71.25 to 86.80 ($p < 0.001$). Teachers also demonstrated better skills in selecting relevant digital media and applying collaborative learning strategies. These findings confirm that the TPACK model plays a crucial role in strengthening teachers' pedagogical competence and readiness to face the challenges of modern education.

Keywords: TPACK; Pedagogical; Teachers; Digital Learning; Educational Technology

Abstrak

Penelitian ini bertujuan untuk menganalisis efektivitas integrasi model *Technological Pedagogical and Content Knowledge* (TPACK) dalam meningkatkan kompetensi pedagogik guru di era digital. Metode penelitian menggunakan pendekatan campuran (*mixed methods*) dengan desain *explanatory sequential*. Tahap pertama dilakukan pengumpulan data kuantitatif melalui pretest dan posttest untuk mengukur peningkatan kompetensi pedagogik, kemudian dilanjutkan dengan eksplorasi kualitatif melalui observasi dan wawancara mendalam. Subjek penelitian terdiri dari 40 guru sekolah menengah yang mengikuti pelatihan integrasi model TPACK. Hasil penelitian menunjukkan adanya peningkatan signifikan pada kemampuan guru dalam merancang dan melaksanakan pembelajaran berbasis teknologi, dengan skor rata-rata meningkat dari 71,25 menjadi 86,80 ($p < 0,001$). Guru juga lebih mampu memilih media digital yang relevan dan menerapkan strategi pembelajaran kolaboratif. Temuan ini menegaskan bahwa model TPACK berperan penting dalam memperkuat kompetensi pedagogik dan kesiapan guru menghadapi tantangan pendidikan modern.

Kata Kunci: TPACK; Pedagogik; Guru; Pembelajaran Digital; Teknologi Pendidikan

INTRODUCTION

The development of digital technology over the past decade has brought significant changes to learning practices in schools. Technology has not only transformed the way students access information but has also demanded a reconstruction of the teacher's role in the learning process. Teachers are no longer merely transmitters of information; they must now act as facilitators, innovators, and learning designers capable of creating authentic and meaningful learning experiences through the use of technology. To respond to these challenges, teachers are required to master both pedagogical and technological skills simultaneously in order to deliver learning that is interactive, adaptive, collaborative, and aligned with the needs of 21st-century learners.¹ Nevertheless, numerous studies indicate that the implementation of technology-based learning in practice has not yet been fully optimal. Many teachers still face difficulties in selecting, integrating, and applying appropriate technologies that align with pedagogical strategies and the characteristics of the learning content. These challenges arise due to limited technological knowledge, insufficient training, and a lack of hands-on experience in designing digital learning.²

The Technological Pedagogical and Content Knowledge (TPACK) model emerges as a conceptual framework that emphasizes the importance of harmoniously integrating technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) as a foundation for teachers to design effective learning in the digital era.³ This paradigm helps teachers understand that the use of technology should not stand alone but must be connected with proper instructional practices and the features of the subject matter. Thus, TPACK needs teachers not just to grasp digital tools or platforms but also to analyze how these technologies might assist conceptual comprehension, improve learning activities, and enhance student engagement. Research demonstrates that teachers who exhibit strong TPACK competences are better equipped to design digital learning that is active, collaborative, and student-centered, hence favorably influencing student motivation and learning outcomes.⁴

Furthermore, several other studies affirm that TPACK plays a crucial role in shaping teacher professionalism in the technological era. Niess emphasizes that TPACK integration must be developed through continuous practical experience rather than solely through theoretical training.⁵ This is reinforced by Angeli and Valanides, who found that TPACK understanding improves significantly when teachers are given opportunities to design and implement technology-

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- 1 L W Anderson and D R Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (New York: Longman, 2001).
 - 2 Judith Harris, Punya Mishra, and Matthew Koehler, "Teachers' Technological Pedagogical Content Knowledge and Learning Activity Types," *Journal of Research on Technology in Education* 41, no. 4 (June 2009): 393–416, <https://doi.org/10.1080/15391523.2009.10782536>.
 - 3 Punya Mishra and Matthew J. Koehler, "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge," *Teachers College Record: The Voice of Scholarship in Education* 108, no. 6 (June 1, 2006): 1017–54, <https://doi.org/10.1111/j.1467-9620.2006.00684.x>.
 - 4 C S Chai, J H L Koh, and C C Tsai, "A Review of Technological Pedagogical Content Knowledge," *Educational Technology & Society* 16, no. 2 (2013): 31–51, <http://www.jstor.org/stable/jeductechsoci.16.2.31>.
 - 5 M.L. Niess, "Preparing Teachers to Teach Science and Mathematics with Technology: Developing a Technology Pedagogical Content Knowledge," *Teaching and Teacher Education* 21, no. 5 (July 2005): 509–23, <https://doi.org/10.1016/j.tate.2005.03.006>.

enhanced learning in authentic contexts.⁶ Moreover, Voogt et al. argue that TPACK is not merely a framework but a new paradigm that encourages teachers to become reflective, adaptive, and innovative designers of digital learning.⁷ In several large-scale studies, such as those conducted by Koh, Chai, and Tsai, it was found that strong TPACK mastery correlates with improved quality in technology-based instructional design.⁸ These findings reinforce that the application of TPACK is not simply an educational trend but a fundamental necessity for teachers to face the challenges of 21st-century learning. However, despite extensive international research, limited empirical evidence is available on how TPACK integration influences teachers' pedagogical competence within the Indonesian educational context. Most prior studies have focused on pre-service teachers or short-term training interventions, leaving a gap in understanding the long-term and practical impact of TPACK implementation among in-service teachers. This gap underscores the need for context-specific research that explores sustainable models of TPACK-based professional development in Indonesia.

Nevertheless, the implementation of TPACK in real educational settings remains suboptimal, as many teachers still struggle to select and integrate appropriate technologies that align with learning objectives, content characteristics, and student needs. These challenges often arise from limited technological proficiency, insufficient hands-on experience in designing digital learning, and inadequate institutional support such as mentoring or targeted professional development.⁹ Consequently, technology is frequently used merely as a presentation tool rather than as an integral element of pedagogical strategy. This condition highlights the need for systematic, contextual, and sustainable efforts to strengthen teachers' pedagogical competence through structured TPACK-based training, professional learning communities, and supportive school policies that foster technological innovation. Therefore, this study becomes highly relevant in examining how the TPACK framework can effectively enhance teachers' pedagogical competence in the digital era, not only by improving their technical ability to operate digital tools but also by transforming the way they design, implement, and evaluate technology-integrated learning.¹⁰ By understanding the interrelationship among technology, pedagogy, and content holistically, teachers are expected to create more interactive and meaningful learning environments aligned with the needs of 21st-century education, thereby contributing to professional growth, innovative practices, and the broader transformation toward a sustainable digital learning ecosystem.

6 Charoula Angeli and Nicos Valanides, "Epistemological and Methodological Issues for the Conceptualization, Development, and Assessment of ICT-TPCK: Advances in Technological Pedagogical Content Knowledge (TPCK)," *Computers & Education* 52, no. 1 (January 2009): 154–68, <https://doi.org/10.1016/j.compedu.2008.07.006>.

7 J Voogt et al., "Technological Pedagogical Content Knowledge – A Review of the Literature," *Journal of Computer Assisted Learning* 29, no. 2 (April 16, 2013): 109–21, <https://doi.org/10.1111/j.1365-2729.2012.00487.x>.

8 J.H.L. Koh, C.S. Chai, and C.C. Tsai, "Examining the Technological Pedagogical Content Knowledge of Singapore Pre-service Teachers with a Large-scale Survey," *Journal of Computer Assisted Learning* 26, no. 6 (December 7, 2010): 563–73, <https://doi.org/10.1111/j.1365-2729.2010.00372.x>.

9 Harris, Mishra, and Koehler, "Teachers' Technological Pedagogical Content Knowledge and Learning Activity Types."

10 Jo Tondeur et al., "A Multilevel Analysis of What Matters in the Training of Pre-Service Teacher's ICT Competencies," *Computers & Education* 122 (July 2018): 32–42, <https://doi.org/10.1016/j.compedu.2018.03.002>.

Method

This study employed a mixed-methods approach using a sequential explanatory design, which combines quantitative and qualitative methods in two consecutive phases. The quantitative phase was conducted first to measure the improvement in teachers' pedagogical competence after the integration of the Technological Pedagogical and Content Knowledge (TPACK) model.¹¹ It involved pretests and posttests to determine the extent of change in competence before and after the intervention. The participants consisted of 40 secondary school teachers from various subject areas who voluntarily joined the TPACK integration training program. In the subsequent qualitative phase, data were gathered from a smaller group of 6 to 10 teachers selected purposively to ensure diverse teaching backgrounds and experiences. This qualitative exploration aimed to provide deeper insights into how teachers applied the TPACK model in their classroom practice and to understand their perceptions of its effectiveness. didapatkan

The data collection employed various devices to guarantee thorough coverage of both pedagogical and technological dimensions. We got quantitative data from pedagogical competence tests and TPACK Likert-scale questionnaires that were based on the seven main parts of the TPACK framework: technological knowledge, pedagogical knowledge, content knowledge, and their intersections. Prior to utilization, the instruments were subjected to validation by specialists in educational technology and pedagogy to evaluate construct validity and content relevance. To make sure that the measurement items were consistent with each other, Cronbach's Alpha was used to test reliability. Descriptive statistics were used to find mean differences in the quantitative data, and a paired-sample t-test was used to find the significance level of the change in instructors' pedagogical competence after the training intervention.

Meanwhile, qualitative data were collected through classroom observations and in-depth interviews with selected teachers. Observations focused on identifying how teachers integrated technological tools into lesson design, classroom management, and assessment activities. The interviews further explored teachers' experiences, challenges, and reflections during the implementation of TPACK-based teaching. Qualitative data were analyzed following the Miles and Huberman framework,¹² which includes data reduction, data display, and conclusion drawing. The findings from both phases were then integrated through triangulation to ensure validity and to provide a holistic understanding of how TPACK integration influences teachers' pedagogical competence. The overall procedure comprised several key steps: instrument development and validation, pretest administration, TPACK training implementation, classroom observation, posttest administration, and interview sessions. This structured methodological approach allowed the study to generate both measurable outcomes and contextual insights regarding the effectiveness of TPACK in fostering teachers' professional growth and readiness for technology-enhanced learning.¹³

11 John W Creswell and Cheryl N Poth, *Qualitative Inquiry and Research Design: Choosing among Five Approaches* (Sage publications, 2016).

12 Matthew B Miles and A Michael Huberman, *Qualitative Data Analysis: An Expanded Sourcebook*, 2nd ed. (Sage Publications, 1994), https://books.google.co.id/books?id=U4IU_-wJ5QEC&source=gbs_navlinks_s.

13 Muhammad Yusuf Pratama et al., "Islamic Religious Education in Indonesia: Roles, Implementation, and Methods in Shaping Islamic Character in the Modern Era," *Indonesian Journal of Islamic Educational Review* 2, no. 3 (October 13, 2025): 282–92, <https://doi.org/10.58230/ijier.v2i3.422>.

RESULTS AND DISCUSSION

Effectiveness Test Results and Analysis of Teachers' Pedagogical Competence Improvement Based on the TPACK Model

Based on the paired sample t-test conducted on 40 teachers, the following findings were obtained:

Table 1. The Paired Sample t-test

Variable	Pretest Mean	Posttest Mean	Difference	Significance
Pedagogical Competence	71,25	86,80	+15,55	p < 0.001

Source: Author

Descriptive analysis shows the average scores for each TPACK component as follows:

Table 2. Descriptive analysis

Component	Mean score (1–5)	Category
Technological Knowledge (TK)	3.85	Good
Pedagogical Knowledge (PK)	4.21	Very Good
Content Knowledge (CK)	4.37	Very Good
Technological Pedagogical Knowledge (TPK)	3.76	Good
Technological Content Knowledge (TCK)	3.68	Good
Pedagogical Content Knowledge (PCK)	4.10	Good
TPACK Utuh	3.82	Good

Source: Author

The findings of this study show that the integration of the TPACK model has a significant impact on improving teachers' pedagogical competence in the digital era. Based on quantitative analysis of 40 teachers, there was a substantial increase in pedagogical competence scores between the pretest and posttest, with the average rising from 71.25 to 86.80 and a significance level of $p < 0.001$. These results indicate that TPACK training effectively enhances teachers' ability to design and implement more effective learning processes. In addition, the questionnaire results revealed that teachers' mastery of the TPACK components was in the good to very good category, with content knowledge (CK) and pedagogical knowledge (PK) being the strongest aspects. However, technological knowledge (TK) and its integrations (TPK, TCK, TPACK) remained in the good category and had not reached an optimal level, suggesting the need for additional support.

Post-training classroom observations showed that most teachers were able to select and use appropriate technologies that aligned with learning objectives. A total of 85% of teachers successfully integrated technology appropriately, while 70% utilized technology-based pedagogical strategies such as flipped classrooms and digital collaborative learning. Roughly 60% of teachers also began developing lesson plans (RPP) using the TPACK approach, although some difficulties persisted, particularly regarding the synchronization of technological, pedagogical, and content knowledge. In-depth interviews supported these observations; teachers acknowledged that

TPACK integration made learning more engaging and increased student participation. However, they also reported challenges such as limited facilities, insufficient planning time, and a lack of ongoing support.

Overall, triangulation of quantitative data, observations, and interviews confirmed that the TPACK model effectively enhances teachers' pedagogical competence, especially in the areas of selecting learning technologies and implementing innovative pedagogical strategies. Nonetheless, the level of success varied among teachers, making continuous training, facility support, and technical guidance crucial for achieving more optimal and sustainable TPACK integration.

The findings further demonstrate that TPACK integration significantly improves teachers' pedagogical competence, as indicated by the increase in pretest-to-posttest scores. This improvement suggests that teachers gained a more comprehensive understanding of blending technology, pedagogy, and content in the learning process. These results align with the TPACK framework introduced by Mishra and Koehler, which emphasizes that strong professional competence among teachers must include integrated content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK).¹⁴

With regard to technological knowledge, questionnaire results showed increased use of educational technology among teachers, though still categorized as "good." This indicates a continuing need for sustained support in effectively utilizing technology. This condition aligns with Chai, Koh, and Tsai, who explained that many teachers still require additional learning experiences to meaningfully integrate technology with pedagogical strategies and instructional content.¹⁵ Therefore, technological knowledge development requires not only theoretical understanding but also continuous hands-on practice.

Observation data revealed that most teachers were able to apply TPACK-based learning strategies such as the use of LMS platforms, interactive videos, project-based learning, and digital discussions. However, some teachers used technology merely as a supplement rather than as an integral part of structured learning strategies. This challenge reflects findings by Harris, Mishra, and Koehler, who argued that successful technology integration depends heavily on a teacher's ability to design learning activities that blend technology, pedagogy, and content simultaneously.¹⁶

From interview results, teachers expressed increased confidence in teaching after understanding the TPACK framework because it made learning more engaging, interactive, and relevant to students' needs. However, teachers also mentioned challenges such as limited ICT facilities, lack of ongoing training, and insufficient time for preparing technology-based lessons. These constraints illustrate that successful TPACK implementation depends not only on teachers' individual competence but also on school-level support, availability of digital infrastructure, and policies that encourage learning innovation.¹⁷

14 Mishra and Koehler, "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge."

15 Chai, Koh, and Tsai, "A Review of Technological Pedagogical Content Knowledge."

16 Harris, Mishra, and Koehler, "Teachers' Technological Pedagogical Content Knowledge and Learning Activity Types."

17 Harris, Mishra, and Koehler.

Overall, the findings strengthen the view that TPACK is an effective framework for improving teachers' pedagogical competence in the digital era. However, its implementation has not yet been optimal across all teachers. Continuous professional development, technical assistance, and the provision of learning resources are essential to ensure that technology becomes an integral part of the teaching process. Thus, TPACK integration not only boosts teachers' confidence but also enriches instructional strategies and enhances learning experiences for students.

Integration of the TPACK Model with Modern Education

The development of modern education cannot be separated from the advancement of technology that has transformed how teachers and students interact. Technology is now an integral part of teaching and learning activities, not merely as a supporting tool but as a key medium for creating meaningful learning experiences.¹⁸ The TPACK model (Technological Pedagogical and Content Knowledge) emerges as an approach that emphasizes the balance between technological, pedagogical, and content mastery. In modern education, TPACK helps teachers understand how technology can be effectively integrated to make learning more interactive, relevant, and aligned with the needs of 21st-century learners. This integration enables teachers to adapt to the changing characteristics of digital and collaborative students.

The integration of the TPACK model in modern education reflects a paradigm shift from conventional learning to innovation-based learning. Teachers are no longer the sole source of knowledge but facilitators who guide students to construct understanding independently. Through TPACK, teachers learn to align teaching methods with both the technology and the subject matter used. For instance, when explaining scientific concepts, teachers can use digital simulations to illustrate complex phenomena that are difficult to explain verbally. In this way, technology supports comprehension rather than serving as an accessory. This approach makes TPACK integration not only a technical strategy but also a pedagogical one that nurtures creativity and student engagement.

Research data indicate that teachers who participated in TPACK training showed a significant improvement in their ability to design technology-based learning. The average pedagogical competence score increased from 71.25 in the pretest to 86.80 in the posttest, with a significance level of $p < 0.001$. This shows that TPACK integration effectively strengthens teachers' ability to connect content, teaching strategies, and technology use. Moreover, observation results revealed that about 85% of teachers were able to choose technology that matched learning objectives, while 70% applied digital strategies such as flipped classrooms and collaborative online learning. These numbers demonstrate that TPACK integration is not just theoretical but has a tangible impact on classroom practice.

In practice, TPACK integration helps teachers recognize that each technology carries its own pedagogical value. The selection of digital media cannot be arbitrary; it must align with the content characteristics and students' learning styles. For example, teachers may use interactive

18 Barry Fishman and Chris Dede, "Teaching and Technology: New Tools for New Times," in *Handbook of Research on Teaching*, vol. 5 (American Educational Research Association, 2016), 1269–1334, https://doi.org/10.3102/978-0-935302-48-6_21.

reading applications for literacy lessons or digital lab simulations for science experiments.¹⁹ Such awareness is only possible when teachers can integrate the three main components of TPACK (technological, pedagogical, and content knowledge) in a balanced way. As a result, technology use becomes a natural and inseparable part of the learning process, embedded within the goals of modern education.²⁰

The integration of the TPACK model also reinforces the role of teachers as creative and contextual learning designers. In modern education, teachers are expected to transform learning materials into engaging learning activities supported by technology. For example, using online learning platforms such as Google Classroom or a Learning Management System (LMS) allows teachers to create interactive virtual classrooms that students can access anytime.²¹ Teachers may also combine instructional videos, digital quizzes, and online discussions to encourage collaboration. This integration expands the learning space beyond physical classrooms into flexible digital environments, allowing learning to adapt to students' needs and the ongoing evolution of technology.

In addition to fostering creativity, TPACK integration promotes more student-centered learning. By employing appropriate technologies, students have greater opportunities to participate actively and develop critical thinking skills. For instance, teachers can use collaborative platforms such as Padlet or Jamboard to let students express ideas visually.²² This approach makes learning more democratic since every student can contribute, not only those who are verbally active in class. Such integration also helps students build confidence, communication skills, and digital literacy. By combining technological and pedagogical elements, TPACK helps create a learning environment that is inclusive, participatory, and relevant to modern life.

The application of TPACK integration in modern education has also transformed teachers' work patterns. Many teachers who have undergone TPACK training began developing lesson plans (RPP) that align each learning stage with the digital media used. For instance, science teachers design lessons using virtual experiments to replace difficult hands-on lab work, while language teachers incorporate educational videos and online forums to improve communication skills. This approach makes learning both efficient and interactive. Field data show that many teachers have adopted TPACK-based lesson planning, although some still face challenges such as limited time and technological facilities at school.²³

19 Saif Saeed Alneyadi, "Virtual Lab Implementation in Science Literacy: Emirati Science Teachers' Perspectives," *EURASIA Journal of Mathematics, Science and Technology Education* 15, no. 12 (July 10, 2019): em1786, <https://doi.org/10.29333/ejmste/109285>.

20 Dr. Lohans Kumar Kalyani, "The Role of Technology in Education: Enhancing Learning Outcomes and 21st Century Skills," *International Journal of Scientific Research in Modern Science and Technology* 3, no. 4 (April 11, 2024): 05–10, <https://doi.org/10.59828/ijrmst.v3i4.199>.

21 Sambit Dash, "Google Classroom as a Learning Management System to Teach Biochemistry in A Medical School," *Biochemistry and Molecular Biology Education* 47, no. 4 (July 2019): 404–7, <https://doi.org/10.1002/bmb.21246>.

22 Keunhyun Park, Anna Farb, and Benjamin George, "Effectiveness of Visual Communication and Collaboration Tools for Online GIS Teaching: Ssing Padlet and Conceptboard," *Journal of Geography in Higher Education* 47, no. 3 (May 2023): 399–410, <https://doi.org/10.1080/03098265.2022.2065669>.

23 Jérémy Castéra et al., "Self-Reported TPACK of Teacher Educators Across Six Countries in Asia and Europe," *Education and Information Technologies* 25, no. 4 (July 2020): 3003–19, <https://doi.org/10.1007/s10639-020-10106-6>.

Overall, the integration of the TPACK model with modern education illustrates how technology, pedagogy, and content knowledge strengthen one another to build adaptive learning systems. Teachers who understand this model are able to optimize technology not merely as media but as part of a broader learning strategy that enhances instructional quality. Learning becomes more contextual, collaborative, and aligned with the needs of modern society. Through TPACK integration, education evolves into a dynamic social process where teachers and students co-construct knowledge through meaningful and responsible use of technology.

The Impact of TPACK Integration on Modern Society and Education

The TPACK approach has changed the way teachers educate and the way education interacts with modern culture in important ways. Schools are becoming a part of digital culture instead of being apart from it. This is because technology is becoming a bigger aspect of everyday life. Teachers who use the TPACK framework bring together traditional teaching methods with digital ways of life. This integration produces a new social ecology where students, teachers, and parents may all connect through digital learning platforms. The classroom becomes a place that looks like the real world: people work together, things move quickly, and information is important. TPACK helps education fit better with how people learn, talk to each other, and solve problems in their daily lives.

Data from various studies show that the implementation of TPACK has had measurable effects on educational quality and teacher performance. Quantitatively, there was a significant increase in pedagogical competence scores, rising from an average of 71.25 before training to 86.80 afterward, with a significance level of $p < 0.001$. Moreover, observation data revealed that 85% of teachers successfully integrated technology into lessons, and 70% implemented digital-based learning strategies such as flipped classrooms and online collaboration. These data points confirm that TPACK integration directly improves how teachers design and conduct lessons.²⁴ The improvement in teaching practice further contributes to the modernization of educational systems and enhances institutional readiness for continuous innovation.

The TPACK paradigm encourages a move toward active, student-centered learning in terms of how it affects education. When teachers know how to use technology, teach, and know the subject matter well, students are no longer just passive receivers of information; they are active builders of knowledge. They take part by using internet discussions, interactive media, and project-based tasks. These kinds of activities help kids learn how to think critically, be creative, and use technology well, all of which are important skills for success in the 21st century. Schools that use TPACK frameworks also make their learning spaces more flexible and hybrid by combining in-person and online techniques.²⁵ This improvement not only makes the classroom more modern, but it also makes learning opportunities available to everyone. As technology becomes a part of

24 Joyce Hwee Ling Koh, "TPACK Design Scaffolds for Supporting Teacher Pedagogical Change," *Educational Technology Research and Development* 67, no. 3 (June 2019): 577–95, <https://doi.org/10.1007/s11423-018-9627-5>.

25 Md. Tauseef Qamar et al., "Incorporating Face-to-Face and Online Learning Features to Propose Blended Learning Framework for Post-COVID Classrooms in India," *Asian Association of Open Universities Journal* 19, no. 1 (August 2024): 70–87, <https://doi.org/10.1108/AAOUJ-08-2023-0097>.

lesson planning, learning becomes more open to everyone and can be changed to fit diverse needs and learning styles.

Another educational impact lies in the professional growth of teachers. Through TPACK integration, teachers develop technological confidence, reflective thinking, and pedagogical innovation. They learn to select tools that best support their instructional goals rather than using technology superficially. Teachers who master TPACK report higher motivation, improved collaboration with peers, and greater responsiveness to students' needs. Professional learning communities built around TPACK also strengthen networks among educators, allowing them to share teaching resources and strategies.²⁶ This process enhances professional identity and promotes lifelong learning. In a broader sense, the adoption of TPACK elevates teaching from a routine occupation into a dynamic, research-informed profession capable of responding to continuous educational change.

From a societal perspective, the integration of TPACK contributes to building a digitally literate community. When schools embrace digital learning models, they indirectly cultivate families and communities that are more aware of technology's educational potential. Parents engage more actively through online platforms, while students develop responsible digital habits that extend beyond school walls. This phenomenon fosters social adaptation to the digital age, creating communities that value learning, innovation, and collaboration. The classroom becomes a microcosm of modern society, teaching not only academic content but also social and digital ethics. Thus, TPACK-based education prepares students to participate meaningfully in a connected, information-rich world.²⁷

The broader social impact of TPACK integration can also be seen in the reduction of educational inequality through technology. Digital platforms enable remote access to quality learning resources, especially for students in underprivileged or rural areas. Teachers equipped with TPACK can design content that reaches students regardless of geographic or socioeconomic barriers.²⁸ This accessibility strengthens the ideal of inclusive education by providing equal learning opportunities. However, challenges remain, such as unequal internet access and limited digital infrastructure. These issues highlight that the success of TPACK integration depends not only on individual teacher competence but also on collective societal commitment to digital equity and technological inclusion.

In modern education, TPACK also has an effect on social values and cultural behavior. When teachers use digital technologies in the classroom, it encourages openness, collaboration,

26 Yin Hong Cheah, Ching Sing Chai, and Yancy Toh, "Traversing the Context of Professional Learning Communities: Development and Implementation of Technological Pedagogical Content Knowledge of a Primary Science Teacher," *Research in Science & Technological Education* 37, no. 2 (April 2019): 147–67, <https://doi.org/10.1080/02635143.2018.1504765>.

27 Carolina Bustamante, "TPACK-Based Professional Development on Web 2.0 for Spanish Teachers: A Case Study," *Computer Assisted Language Learning* 33, no. 4 (May 2020): 327–52, <https://doi.org/10.1080/09588221.2018.1564333>.

28 Mao Li, "Exploring the Digital Divide in Primary Education: A Comparative Study of Urban and Rural Mathematics Teachers' TPACK and Attitudes Towards Technology Integration in Post-Pandemic China," *Education and Information Technologies* 30, no. 2 (February 2025): 1913–45, <https://doi.org/10.1007/s10639-024-12890-x>.

and adaptation, which are all virtues that are in line with the spirit of modern society.²⁹ When students work together online, they learn to accept other points of view and how to communicate ethically. Teachers set an example for how to use technology responsibly by showing how to think critically and follow digital ethics.³⁰ Over time, these kinds of actions create a culture of technical responsibility that goes beyond the school. The principles of digital citizenship, hitherto confined to academic discourse, integrate into the social fabric, influencing individual interactions with information and each other within the digital public sphere.

The influence of TPACK integration on contemporary culture and education illustrates that technology is not an external entity but an intrinsic component of human advancement. As instructors, students, and schools get used to this integration, the lines between learning and everyday life get less clear. Education becomes into a social activity that is linked to communication networks, media platforms, and group creativity. TPACK is a link between technology and human values. It makes sure that digital change in education supports, not replaces, the core of meaningful learning and social connection. The incorporation of TPACK changes how people learn, how knowledge is communicated, and how society changes in the modern world.

CONCLUSION

This study demonstrates that the integration of the Technological Pedagogical and Content Knowledge (TPACK) model significantly enhances teachers' pedagogical competence in the digital era. The quantitative results reveal a substantial increase in pedagogical competence scores, from 71.25 to 86.80 ($p < 0.001$), indicating that TPACK-based training effectively strengthens teachers' ability to design, implement, and evaluate technology-integrated learning. Observations and interviews further confirm that most teachers successfully applied technology-aligned strategies such as flipped classrooms, collaborative learning, and interactive digital media. The study contributes to the field of modern education by providing empirical evidence that TPACK not only develops teachers' technological proficiency but also transforms their instructional mindset toward creative, student-centered, and innovation-driven learning. This integration bridges the gap between pedagogy and digital literacy, preparing teachers to become facilitators in a rapidly evolving educational ecosystem.

Although this study confirms the effectiveness of TPACK integration in improving teachers' pedagogical competence, it remains limited by its focus on short-term training outcomes within a single institutional context. Future research should explore longitudinal studies on the sustainability of TPACK-based pedagogical transformation, examining how teachers' digital competence, instructional creativity, and technology adoption evolve over time. Such research can provide deeper insights into how continuous professional development and institutional policies contribute to maintaining the long-term impact of TPACK implementation across diverse educational settings.

29 Salma Sultan Ali and Nathan A. Hawk, "Examining Cultural Background as Context and In-Service Teachers' Perception of TPACK: A Mixed-Method Study," *Education and Information Technologies* 29, no. 3 (February 24, 2024): 3547–70, <https://doi.org/10.1007/s10639-023-11939-7>.

30 Haoxu Geng, "Redefining the Role of Teachers in Developing Critical Thinking Within the Digital Era," in *Proceedings of the 2021 International Conference on Modern Educational Technology and Social Sciences (ICMETSS 2021)*, 2021, <https://doi.org/10.2991/assehr.k.210824.005>.

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