Research Article

Received: 11 November 2022 / Accepted: 26 December 2022 / Published: 5 January 2023

Technological Pedagogical Content Knowledge for Professional Teacher Development

Surattana Adipat[1]*
Rattanawadee Chotikapanich[2]
Kittisak Laksana[1]
Kanrawee Busayanon[1]
Patumporn Piatanom[1]
Alongkorn Ausawasowan[3]
Islam Elbasouni[4]

[1]Assistant Professor, Ph.D., Faculty of Education, Ramkhamhaeng University, 2086 Soi Ramkhamhaeng 24 Yaek 18, Hua Mak, Bang Kapi District, Bangkok 10240, Thailand
[2]Associate Professor, Faculty of Education, Ramkhamhaeng University, 2086 Soi Ramkhamhaeng 24 Yaek 18, Hua Mak, Bang Kapi District, Bangkok 10240, Thailand
[3]Lecturer, Faculty of Education, Ramkhamhaeng University, 2086 Soi Ramkhamhaeng 24 Yaek 18, Hua Mak, Bang Kapi District, Bangkok 10240, Thailand
[4]Lecturer, University of the Thai Chamber of Commerce, 126/1 Vibhavadee-Rangsit Road, Dindaeng, Bangkok 10400, Thailand

DOI: https://doi.org/10.36941/ajis-2023-0015

Abstract

Technological pedagogical content knowledge (TPACK) is a knowledge that extends beyond the conventional categories of the three "core" areas of education (pedagogy, content, and technology). Not every classroom, subjects, or pedagogical philosophy can benefit from the same technology tools. To improve teaching quality, teachers in any field should participate in professional development programs to learn about and use novel approaches to content distribution, assessment, and documentation. Technology-enhanced education is a challenging, systematized endeavor. When it comes to incorporating technology in the classroom, there is no optimal approach. There is a need for a method that regards teaching as a dialogue between instructors' knowledge and their classroom practices. There are three pillars around which excellent technology-based instruction is built: subject matter, instructional methods, and available technology tools. All the differences in how much and how well schools use technology in the classroom can be traced back to these three interrelated factors. Therefore, teachers must be familiar with the strengths and limitations of various educational resources. This paper aims to provide the basic concept and significance of professional teacher development and analyze TPACK as a key to successful professional teacher development. Finally, it explains how the TPACK is used in many disciplines to improve students' academic excellence and teachers' TPACK in subjects such as science, English, social studies, and mathematics.

Keywords: *technological pedagogical content knowledge, professional teacher development, education, technology, pedagogy*

1. Introduction

Extending beyond being the sum of the three "core" areas of knowledge (pedagogy, content, and technology), technological pedagogical content knowledge (TPACK) is an unique type of expertise. When one comprehends content, pedagogy, and technology, one will have a firm grasp of technological pedagogical content. Knowledge of these three concepts is necessary for successful and exciting technology-based training. TPACK is the foundation of the efficient use of technology in the classroom, necessitating familiarity with the following: the nature of the technological representations of concepts; pedagogical strategies for making effective use of technologies to teach content; factors that make concepts easy or challenging to study, some of the issues that kids have with learning these concepts, and how technology might assist in fixing them; the student's background information and epistemological beliefs; and the technological affordances that make effective use of the technologies possible.

Expert educators use TPACK every time they teach by combining their understanding of instructional technology, pedagogy, and subject matter. There is no universal technical solution that works for every educator, every curriculum, and every philosophy of education since each circumstance that instructors face is a unique blend of the three criteria. The solutions lie, instead, in the flexibility of the educator to work within the complex interplay of content, pedagogy, and technology in every classroom. Solutions or failures may be oversimplified if the complexity of each kind of information or the complexity of the interactions among the components is ignored. Therefore, for teachers to come up with practical solutions, they need to develop expertise in the three key areas (technology, pedagogy, and content), the interplay between them, and the features of their respective contexts. A thorough, flexible, pragmatic, and nuanced understanding of how technology can be used in the classroom is essential while considering TPACK as a body of professional knowledge.

2. The Significance of Professional Teacher Development

Teachers can improve their efficiency in managing their time and other resources by participating in professional development activities. Ultimately, this helps them save time and energy, thereby allowing them to devote more attention to their students. However, as their careers progress, educators acquire new skills and methods that help them improve their classroom practices (Koh et al., 2018). This is because teachers who participate in professional development programs are better equipped to tailor their lessons and syllabi to the individual requirements of their pupils. However, judging the efficacy of such professional development-aided shifts in teaching practice is challenging since they are usually introduced gradually. Professional development for teachers improves the quality of presentations and course assessments by familiarizing the teachers with alternative delivery methods, reviews, and documentation (Koh et al., 2018).

Furthering their education is another significant benefit of professional development for instructors. It is easy for educators to feel worn out by the day-to-day demands of the profession (Oner, 2020). During professional development programs, they switch roles and spend time as learners instead of educators. This keeps instructors interested because they believe that they are getting the professional development they need to improve their teaching. Teachers who have their sights set on educational leadership roles benefit significantly from engaging in professional development opportunities, and they may gain considerably from seeing and emulating the practices of current school administrators (Oner, 2020). Both teachers and students benefit from professional education development programs, but teachers, in particular, grow in their ability to teach and prepare for leadership roles in the classroom.

However, it is not easy to see technology, education, and content as three interconnected bodies of knowledge. When disruptive technology is introduced into the classroom, instructors are forced to reevaluate their pedagogical practices, students, and the environment and make necessary adjustments (Abedi et al., 2022). This approach flips the script on the common assumption that subject-area curricula serve as the inspiration for educational objectives and technology. There is usually more to it than that, especially when cutting-edge technology is involved. For example, the advent of the Internet and, more specifically, the emergence of online learning necessitated new ways of thinking about fundamental pedagogical concerns, such as the most effective means of sharing information online and fostering dialogue between students and teachers (Abedi et al., 2022). Using technology effectively in the classroom is a challenge. In the TPACK paradigm, each of the following four factors has independent and interdependent effects: content, technology, pedagogy, and classroom setting. In order to effectively integrate technology into the classroom, teachers must strike and maintain a dynamic balance between the many parts. It is important to remember that many things affect the components of finding that sweet spot of harmony.

It could be said that education is an intricate field. However, knowledge of the subject, teaching, and technology form the foundation for a successful educator, and one contributes to the other. To truly appreciate the complexity inherent in teaching, one must have a firm grip on the interdependencies between these three areas of knowledge and how they are applied in today's dynamic and ever-changing classrooms (Abedi et al., 2022). The current work on the TPACK framework aims to expand upon this previous research and scholarly work by expanding the scope of what instructors need to know in order to effectively incorporate technological concepts into their lessons. The TPACK paradigm attempts to facilitate the creation of more effective methods for uncovering and articulating how professional technology knowledge is actualized in practice (Abedi et al., 2022). To help instructors understand the differing degrees to which technology is being incorporated into the classroom, it is helpful to provide a more specific definition of the many types of knowledge required.

Additionally, TPACK offers various opportunities for fostering teachers' professional pedagogy and integration of technology (Abedi et al., 2022). This facilitates a shift away from simplistic methods that see technology as an "add-on" and back toward a more ecological emphasis on the interplay among pedagogy, material, and technological tools in the classroom.

3. TPACK as a Key to Successful Professional Teacher Development

Teachers require a method that recognizes their knowledge and experience as a dynamic pair that must be considered in each classroom context. There is no optimal method for incorporating technology into teaching and learning. Instead, innovative plans for integration should be crafted around specific subject-matter concepts and classroom settings (Du, 2022). Recognizing that integrating technology into the classroom is a challenging, unstructured endeavor, we argue that teachers need to cultivate novel means of understanding and accepting this intricacy in order to fully grasp the range of strategies used for successful technology integration.

Three interrelated aspects, pedagogy, content, and technology, form the basis of effective technological instruction. Variations in the breadth and depth of end tech adoption may be traced back to how these three factors interact in various ways depending on the setting. The heart of the TPACK structure consists of these three pillars of knowledge (Lachner et al., 2021). However, to explain how teachers' content and pedagogy interact to facilitate successful instruction with technology, the TPACK outline develops on Shulman's explanations of pedagogical content knowledge (PCK). Many authors have written on related concepts, although they may have given them other names. Over time and across several publications, the idea of TPACK presented here has evolved. This framework divides instructors' expertise into three distinct areas: curriculum, pedagogy, and technology. The relationships between and among the many types of knowledge exemplified by PCK, Technological Content Knowledge (TCK), and Technological pedagogical Knowledge (TPK), and TPACK are just as crucial to the model's success.

3.1 Content Knowledge

While talking about a teacher, "content knowledge" (CK) refers to how well-versed they are in the topics taught and discussed in the classroom. Content for a history or science for middle school students is not the same as that for an art appreciation class at the university level or a doctoral seminar on the history of astronomy. Instructors' subject-matter expertise is crucial (Lachner et al., 2021). As part of this, teachers should be familiar with not just the concepts, ideas, theories, organizational frameworks, evidence, and proof that make up the body of knowledge but also the standard methods and practices for collecting this information (Lachner et al., 2021). Teachers should be well-versed in the underlying assumptions and central ideas of the subjects they are tasked with instructing since both the body of knowledge and the method of investigation vary substantially for individual subjects. Skills in this category include, but are not limited to, familiarity with scientific facts and hypotheses, the scientific method, and the use of evidence in reasoning. Aesthetic and psychological theories for evaluating art as well as art history, well-known works, artists, and their historical contexts would all belong under this umbrella.

3.2 Pedagogical Knowledge

In education, pedagogical knowledge (PK) refers to teachers' in-depth understanding of the many strategies and techniques used to facilitate student learning. They include things such as the ultimate goals, objectives, and ideals of education. Skills in this area are aligned with pedagogical practices, awareness of one's intended students' characteristics, and ways to check for comprehension (Lachner et al., 2021). How pupils absorb new information, create their understanding of the world, and form healthy mental routines and attitudes toward education are all topics that may be addressed by a teacher with a firm grasp of pedagogy.

3.3 Pedagogical Content Knowledge

Shulman places a premium on PCK that is transformed into new forms for the classroom. This shift happens when teachers evaluate the content, identify numerous ways to express it, and modify and adjust lesson plans based on students' existing knowledge and alternate ways of thinking about the topic (Du, 2022). Similarly, PCK denotes the fundamentals of education, including how students learn, how teachers evaluate their performance, and what information should be reported. To be an effective educator, one needs to be aware of and willing to explore multiple points of view on commonly held misconceptions about and the significance of making connections among a variety of content-based ideas, alternative teaching strategies, students' prior knowledge, and the adaptability that comes from investigating multiple angles on the same opinion or problem.

3.4 Technology Knowledge

The third and final primary knowledge domain in the TPACK system, technology knowledge (TK), is the most dynamic since it is constantly evolving (pedagogy and content). As a result, it is famously hard to define. There is a risk that any attempt to define technological literacy will be out of date by the time this article is released. Nevertheless, there are methods of approaching and using universal technology applicable to technical resources and instruments (Du, 2022). The TPACK framework's understanding of TK is comparable to the concept of fluency in the Use of Information Technologies (FITness) suggested by Committee on Information Technology Literacy. They contend that FITness requires a far broader understanding of information technology to make effective use of it in one's professional and personal life, to know when information technology (IT) will help rather than hurt in accomplishing a goal, and to be able to adjust to new IT as it becomes available. Therefore, FITness requires a more comprehensive and sophisticated grasp of and facility with information technology for data processing, problem-solving, and communication than computer literacy as commonly understood today. Having acquired such TK, one may use IT to do a wide range of jobs and create novel solutions to previously unsolvable problems. This way of thinking about TK does not assume a fixed "final state." Still, it views it as a process that continues throughout one's life via creative, exploratory engagement with technological systems.

3.5 Technological Content Knowledge

The link between technology and subject matter expertise has been indisputable. This newfound ability to represent and manipulate data has allowed for significant advancements in domains disparate as health, archeology, history, and physics. The impact that technologies such as Roentgen's X-ray discoveries and carbon-14 dating have had on the disciplines of medicine and archeology is just one example (Du, 2022). It must also be considered how the introduction of digital computers altered the very foundations of physics and mathematics, elevating the importance of simulation in the quest for knowledge. As technology has progressed, new metaphors have emerged for making sense of the world. Due to technological advancements, previously unimaginable perspectives are now possible, such as seeing the brain as a computer or the heart as a pump. There is depth to the parallels drawn between these symbolic elements. They have often triggered significant paradigm shifts in the respective academic fields.

It is important to design, adapt, and implement appropriate technology tools for varying educational purposes by understanding the influence of technology on maximizing students' knowledge and skills. Unforunately, the variety of content is limited by the technology used. Similarly, confident editorial choices may restrict the available technological options. Due to technological limitations, creating some representations may be difficult, but developing many others may be feasible. Additionally, technical tools may provide additional leeway in traveling between various expressions (Du, 2022). Therefore, TCK is an awareness of how content and technology interact and shape one another. It is not enough for educators to have a thorough grasp of the material they are teaching; they must also be familiar with how certain technologies may alter the material being taught. As such, educators must have a firm grasp on the technologies that are the most appropriate for facilitating subject-matter learning in their respective spheres and how the content sometimes alters the nature of those technologies.

3.6 Technological Pedagogical Knowledge

TPK is an awareness of the potential for pedagogical shifts brought about by the strategic use of technological tools. Understanding the affordances and restrictions of various technology instruments for education is essential, as is familiarity with pedagogical designs and tactics that are disciplinary-appropriate (Arifin et al., 2020). More knowledge about the limits and possibilities of technologies and their disciplinary settings is required to construct TPK. For example, think of the potential uses of whiteboards in educational settings. A whiteboard in a classroom is taken for granted since it is often permanent, accessible to many people, and easy to alter. However, the claim that whiteboards have a single use would be false. A whiteboard in a corporate context may be used quite differently from one used in a creative team's brainstorming session. Many share the whiteboard in this setup (Arifin et al., 2020). This tool is available to all group members and serves as a hub around which meaning is negotiated and constructed. To fully grasp TPK, one must have insight into technology and mutiple ways in which it could be used, depending on the specifics of the situation and the goals being pursued.

Since the vast majority of today's most-used applications are not made with education in mind, TPK takes on further significance. Software packages including Microsoft Office, such as PowerPoint, Word, Entourage, Excel, and MSN Messenger, are often geared at corporate settings. Blogs and podcasts are two examples of web-based media that serve to fulfill the needs of amusement, information sharing, and interpersonal connection (Malik et al., 2019). The best educators can see beyond the apparent applications of technology and repurpose them for unique educational goals. This means that TPK necessitates a proactive, imaginative, and open-minded pursuit of its usage, as a means to better student learning and comprehension.

4. TPACK in Various Disciplines to Improve Students' Academic Excellence

Excellent teachers understand not just their subject matter but also the methods to assist their pupils in internalizing key concepts. Teachers' repertoires of strategies and pedagogical know-how are invaluable resources. Successful teachers may use extensive knowledge and experience to tailor their lessons to each student (Malik et al., 2019). Students' individual goals, classroom resources, required coursework, and parental involvement are some examples. Excellent educators can adapt their teaching strategies and content expertise to meet the needs of their students in every given classroom situation. Preparing outstanding educators requires a primary focus on enhancing the knowledge and abilities of those who join the teaching profession.

Teachers must use education technology alongside their topic and pedagogical expertise in the classroom. Due to education technology's rapidly growing role in the school, there is a pressing need to provide future educators with the necessary technological know-how (Malik et al., 2019). The TPACK framework is recognized widely as the gold standard for effectively evaluating educators' ability to use technology in lesson planning. This paper details educators' skills and expertise in integrating technology successfully into their lessons.

4.1 TPACK in Science and Mathematics Education

Both as a separate topic and a tool for teaching other subjects, governments, and schools throughout the globe are incorporating technological knowledge into formal education. Schools and governments have been making technological literacy a compulsory subject to produce citizens who are comfortable using computers and other high-tech digital tools in their daily lives. The use of specialized tools in the educational process is gaining popularity as a strategy to boost learning outcomes and student retention (Arifin et al., 2020). Computer simulations, for example, may be used in the classroom to help students learn about scientific concepts that would be impossible or too hazardous to examine using traditional experimental methods, such as subatomic particles, galaxies, or black holes. Simulations allow students to see and analyze events that are not immediately observable, such as meiosis and mitosis in biology. The importance of technology in facilitating learner-centered pedagogies, in which students investigate and grasp scientific and mathematical ideas via technology, emphasizes the problem-solving processes rather than the calculations themselves (Arifin et al., 2020). Similarly, technological advancements such as graphing and some computer-based mathematics learning systems help improve young children's conceptual and procedural understanding of mathematics. Students benefit from increased chances for collaborative learning and information sharing when technology is used in the classroom, and this is especially true for STEM subjects.

Using technology in the classroom has improved teachers' instructional techniques in science and mathematics. The scientific or mathematics material to be taught, the technology to be used, and the pedagogical approaches must be considered while instructors determine whether and how to include technology in their lessons (Arifin et al., 2020). Teachers of these subjects should also consider how their subject matter connects to students' everyday lives, the tools they use in the classroom, and the methodology that may best foster student growth. The primary emphasis of this chapter is on answering the issue of what teachers need to know and how they should acquire it to effectively incorporate technology into their science and mathematics instruction.

Teachers must be well-versed in the science and mathematics they teach and how technological tools might shift students' perspectives on these disciplines. Educators must become familiar with a wide range of technologies in schools. Conversely, they must understand how the integration of diverse technology may affect teaching subjects such as science and mathematics (Arifin et al., 2020). Educators' increasing technology use in the teaching space necessitates a model that can track the evolution of science and mathematics education. The TPACK of teachers is a model for describing the skills and understanding educators need in order to utilize technology wisely in the classroom. It is also a guide for creating professional development arrangements to cultivate technology integration knowledge and abilities among pre-service and in-service educators.

Science education has a reputation for being difficult because it requires students to master material that many see as difficult or impossible to grasp. Rather than focusing on developing a knowledge of scientific ideas and systems, it has become usual practice for students to memorize algorithms to pass science exams (Cheng & Xie, 2018). On the other hand, learning goals in science subjects place a premium on the growth of more multifaceted mental abilities, such as the capacity to reason, solve problems, and apply higher-order thinking. Their active participation in science education should spark students' ability to think critically and creatively. To do this, scientific educators must make informed decisions about which pedagogical factors are most important for teaching a particular study area.

Similarly, educators in scientific disciplines must use tools that facilitate deep learning and retention of material. Teaching and learning science place a premium on the use of technology (Cheng & Xie, 2018). When used correctly, technology can drastically improve classroom dynamics. Therefore, rather than just replacing the current teaching style, the idea of employing technology in the science classroom should be founded on the notion of problem-solving. Technological tools are essential to supplement the material covered in scientific classes and address instruction and student retention issues.

The choices made by science professors significantly impact their students' development as scientists and as people. Some of these choices are related to adjusting the curriculum, while others may affect how technology is used in the classroom. Teachers' TPACK is the primary factor in determining the nature and implementation of instructional techniques and tactics (Cheng & Xie, 2018). When instructors have a firm grasp on all aspects of TPACK, they are more equipped to use knowledge in the teaching space. Several studies have shown that instructors tend to separate technological knowledge from subject matter expertise. This misconception has hindered efforts to develop new approaches to education that make better use of technology to improve education. Teachers receive training in pedagogy and technology; nevertheless, many fail to integrate these skills with their subject matter expertise. Through the lens of the TPACK framework, educators may assess their own body of professional knowledge. Increasing TPACK is one way to help teachers better meet students' needs in the classroom. Teachers' chances of effectively integrating technology into the school may be improved by working to increase their TPACK (Cheng & Xie, 2018).

This paper assumes that teachers were given various resources to help them work together more efficiently and gain insight from their collaborative efforts in lesson planning, classroom execution, and self-reflection. Guidelines for working together effectively, a subject matter expert, sample courses, and digital resources, including films, animations, and images, were all available as sources of help (Cheng & Xie, 2018). Teachers face technical and pedagogical obstacles while integrating technology into their lessons. The scaffolding of a facilitator or an expert is needed to tackle these difficulties. It is not simple for educators to update their practice to include technological advancements, necessitating a more comprehensive range of strategies. Teachers are better able to learn when they are given activities with built-in scaffolding and provided an opportunity to work in groups with subject matter experts and peers. Additionally, educators may save time by using online learning tools like animations, simulations, and videos to create tech-enhanced classes.

Teachers' understanding of how to use technology in their science and mathematics classes may greatly improve by seeing exemplary sessions. Teachers may benefit from illustrative lectures by better experiencing the purpose of their training, gaining access to relevant context information, and receiving encouragement as they put their newfound knowledge into practice in their classrooms

(Cheng & Xie, 2018). Good lessons may give instructors real insights to utilize in the classroom to gain practical experience or can serve as a model for teachers to follow while developing their lesson plans. Above all, it is difficult for educators to work in design teams due to difficulties in reaching consensus and organizing one's time effectively. Teachers need rules to provide them with a sense of direction while working in design teams, allowing them to use their time better and produce higher-quality designs. Thus, instructors were supplied with the cooperation guidelines to aid them in their debate and decision-making in the design teams. Teaching staff interactions in design team meetings may benefit from collaboration guidelines.

4.2 TPACK in English Education

Since the turn of the 21st century, network information technology worldwide has made rapid strides. Education and modern network information technology have worked closely together to help in the improvement of education and teaching at Chinese institutions. One of the most valued qualities of a current college English translation professor is the ability to impart knowledge thoughtfully (Redmond & Lock, 2019). Institutions and educational programs must also work to identify and develop exceptional potential. Teaching English as a foreign language at higher education institutions may be advanced through the creation of smart teaching classrooms, enhancing instructors' intelligent teaching abilities, and concentrating on teachers' professional technical skills. However, it may also guarantee that the English translation team entering the 21st century is one of the most creative and competent in its field.

Intelligent education has always been the end goal of worldwide education expansion and the direction of modern university reform.

Now that the "Internet Plus" era has arrived, people can better understand well-thought-out lectures. "Smarter teaching" refers to pedagogy that does more than impart knowledge; instead, it aims to develop students' skills and minds (Redmond & Lock, 2019). Intelligent technologies such as AI and big data have changed the educational paradigm. Incorporating smart teaching strategies, fostering innovative learning, and motivating students to study intelligently are all components of intelligent teaching. Both the theory of constructivist learning and the idea of the creation of wisdom provide theoretical support for the practice of wisdom teaching, a modern approach to retooling English translation classes in higher education (Redmond & Lock, 2019). The proficiency of first-year English lecturers is increasingly crucial in conveying information in academic English. College English instructors may better serve their students, contribute to the advancement of knowledge, and keep up with the technological demands of the modern world by honing their analytical skills.

Through cutting-edge technologies such as the web, big data, and cloud computing, people's careers and ways of life have undergone radical transformations. However, the change also highlights the limitations of schools as places of learning. In October 2020, the Chinese government released a new education plan that will set new requirements for the professionalization of IT teachers. American scholar Shulman created the PCK framework, from which the TPACK framework draws inspiration (Redmond & Lock, 2019). There has been a lot of recent attention paid to the TPACK knowledge framework due to its importance to the growth of educators. None of the seven fundamental facets of the TPACK knowledge architecture can be understood without reference to the others. The TPACK knowledge architecture is built on interaction, complexity, and dynamic balancing tenets. Research on teachers' degrees of TPACK is extensive. Therefore, studies assessing teachers' TPACK in various STEM fields, including physics, mathematics, and computer science, have been undertaken at both the primary and secondary school levels. There is a greater focus on TPACK among scientific faculty than humanities faculty.

4.3 TPACK for Social Studies Education

In education for teachers, TPACK has rapidly become a ubiquitous framework. It expands on the ideas of pedagogical subject knowledge and the role of the teacher as the "gatekeeper" of the curriculum by providing a shared vocabulary for discussing technology integration into education (De Rossi & Trevisan, 2018). This model aims to improve the TPACK framework by making it easier to compare the educational goals of social studies instructors with their technological decisions (Valtonen et al., 2019). Students in programs preparing to teach social studies may benefit from following the giving-prompting-making paradigm while deciding how best to use technology in their lessons. Social studies slideware, drill-and-practice software, and proprietary digital video are just a few widely accepted technologies that have reinforced rather than questioned the established curriculum.

The topic of technology in the classroom is so important that some of the most prestigious academic publications in the field of social studies devote an entire issue each year to it (MacPhail et al., 2019). Members of the social studies education community collaborate closely via groups such as the Society for Information Technology and Teacher Education's social studies education committee. There has been a rise in the curiosity to try out technology-mediated learning, but the rate at which it is being incorporated into social studies classrooms has been slow (MacPhail et al., 2019). The discipline of social studies has been called into question over whether or not it is suitable for technology use in education due to the delayed adoption rate of both social studies teacher educators and K-12 classroom instructors. It is not usual for a social scientist to utilize or be interested in technology.

Moreover, teachers face significant challenges while attempting to adopt and implement new technological practices in the classroom. Some educators struggle with finding effective ways to use technology in the classroom. As a result, it is not always the case that the benefits shown in laboratory settings are also achieved in more realistic educational contexts, even though the ICT applications have proved beneficial in isolation. It has been argued that educational technology often fails to mesh with established pedagogical norms and may even diminish a teacher's sense of professional agency (MacPhail et al., 2019). Consequently, when educators use technology in the classroom, they often "domesticate" the program to fit in with standard instruction methods rather than using the tool's affordances.

Additionally, suitable pedagogical models should be included in kindergarten technology usage for young children. Such approaches presuppose a high degree of congruence between technology usage in the classroom and standard pedagogical procedures. Improving teachers' access to and competence with technology is crucial if we successfully incorporate it into classroom practice.

5. Conclusion

In conclusion, the best educators can see beyond the apparent applications of technology and repurpose it in novel ways for educational ends. TPK programs need to encourage students to look forward, think creatively, and be open-minded about how technology can be used to improve their education. Schools are increasingly incorporating technology into their curricula as a means of bettering the educational experience for students. One clear advantage of computer simulations in science education is that they allow students to research phenomena that would be impractical or unsafe to study in the lab. It is not enough for educators to have expertise in the areas they teach; they must also understand how different technological tools might impact those subjects. Teachers need a broader set of tools in their toolbox when they adapt their pedagogy to include digital media. Teachers may benefit from the real-world examples provided by suitable lessons, which can be implemented directly into their classrooms or used as a basis for developing new classes. Teachers need rules to give them a sense of direction while working in design teams to make the most efficient use of their time.

This paper offers a pedagogical model comprised of three parts: urging, providing, and creating to explain the connection between education and technology. Generally speaking, social studies courses do not make much use of technology. Future social studies instructors may better utilize the framework to incorporate technology into their lessons. The integration rate of technology-mediated teaching in social studies education has remained low despite the growing interest in this area of research. In addition to potentially undermining a teacher's confidence in their abilities, research suggests that technological innovations in the classroom frequently fail to mesh with the established norms of the profession. Improving teachers' access to and competence with technology is crucial if they successfully incorporate it into classroom practice.

References

Abedi, E., Prestridge, S., & Geelan, D. (2022). Beginning teachers' reflections on pre-service technology training and sense of preparedness. *Society for Information Technology & Teacher Education International Conference* (pp. 302–311). Association for the Advancement of Computing in Education (AACE).

Arifin, Z., Nurtanto, M., Priatna, A., Kholifah, N., & Fawaid, M. (2020). Technology andragogy work content knowledge model as a new framework in vocational education: Revised technology pedagogy content knowledge model. *Online Submission, 9*(2), 786–791.

Carpenter, J. P., Rosenberg, J. M., Dousay, T. A., Romero-Hall, E., Trust, T., Kessler, A., Phillips, M., Morrison, S. A., Fischer, C., & Krutka, D. (2020). What should teacher educators know about technology? Perspectives and self-assessments. *Teaching and Teacher Education*, *95*, 103124.

Cheng, S. L., & Xie, K. (2018). The relations among teacher value beliefs, personal characteristics, and TPACK in intervention and non-intervention settings. *Teaching and Teacher Education*, *74*, 98–113.

De Rossi, M., & Trevisan, O. (2018). Technological pedagogical content knowledge in the literature: How TPCK is defined and implemented in initial teacher education. *Italian Journal of Educational Technology, 26*(1), 7–23.

Du, M. (2022). Application of digital technology-based TPACK in English translation. *Mobile Information Systems, 2022*(3), 1–9.

Koh, J. H. L. (2020). Three approaches support faculty technological pedagogical content knowledge (TPACK) creation through instructional consultation. *British Journal of Educational Technology, 51*(6), 2529–2543.

Koh, J. H. L., Chai, C. S., & Natarajan, U. (2018). Developing Indonesian teachers' technological pedagogical content knowledge for 21st-century learning (TPACK-21CL) through a multi-prong approach. *Journal of International Education and Business, 3*(1), 11–33.

Kohli, R. (2019). Lessons for teacher education: The role of critical professional development in the teacher of color retention. *Journal of Teacher Education, 70*(1), 39-50.

Lachner, A., Fabian, A., Franke, U., Preiß, J., Jacob, L., Führer, C., Küchler, U., Paravicini, W., Randler, C., & Thomas, P. (2021). Fostering pre-service teachers' technological pedagogical content knowledge (TPACK): A quasi-experimental field study. *Computers & Education, 174*, 104304.

MacPhail, A., Ulvik, M., Guberman, A., Czerniawski, G., Oolbekkink-Marchand, H., & Bain, Y. (2019). The professional development of higher education-based teacher educators: Needs and realities. Prof. Dev. Educ. 45, 848–861.

Malik, S., Rohendi, D., & Widiaty, I. (2019, February). Technological pedagogical content knowledge (TPACK) with information and communication technology (ICT) integration: A literature review. *5th UPI International Conference on Technical and Vocational Education and Training (ICTVET 2018)* (pp. 498–503). Atlantis Press.

Oner, D. (2020). A virtual internship for developing technological pedagogical content knowledge. *Australasian Journal of Educational Technology, 36*(2), 27–42.

Philipsen, B., Tondeur, J., Pareja Roblin, N., Vanslambrouck, S., & Zhu, C. (2019). Improving teacher professional development for online and blended learning: A systematic meta-aggregative review. *Educational Technology Research and Development, 67*(5), 1145–1174.

Redmond, P., & Lock, J. (2019). Secondary pre-service teachers' perceptions of technological pedagogical content knowledge (TPACK): What do they think? *Australasian Journal of Educational Technology, 35*(3), 45–54.

Valtonen, T., Sointu, E., Kukkonen, J., Mäkitalo, K., Hoang, N., Häkkinen, P., Järvelä, S., Näykki, P., Virtanen, A., Pöntinen, S., Kostiainen, E., & Tondeur, J. (2019). Examining pre-service teachers' technological pedagogical content knowledge as evolving knowledge domains: A longitudinal approach. *Journal of Computer Assisted Learning, 35*(4), 491–502.