

Handbook of **Technological Pedagogical Content Knowledge (TPACK)** for Educators

Second Edition

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A decorative graphic in the bottom right corner of the cover. It features a large yellow circle on the left, which overlaps with a light green circle on the right. Below these, there are three overlapping circles: an orange one on the left, a brown one in the middle, and a purple one on the right. A pink circle is positioned at the bottom, overlapping with the orange, brown, and purple circles. A dashed light blue line curves from the left side of the page towards the top right, passing behind the overlapping circles.

Introduction to the Second Edition of the TPACK Handbook

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One of the earliest examples of educational technology appears in the writing of Quintilian (35–100 AD) over 2,000 years ago. Describing a possible innovation in teaching writing, he wrote:

As soon as the child has begun to know the shapes of the various letters, it will be useful to have them cut out on a board, in as beautiful script as possible, so that the pen may be guided along the grooves. Thus mistakes such as occur with wax tablets will be impossible to make for the pen will be confined between the edges of the letters and will always be prevented from going astray.

(cited in Illich, 1993, p. 9)

Even in this example from over 2,000 years ago, we can still identify themes that resonate in contemporary conceptualizations of educational technology. For instance, Quintilian expresses a theory of learning that focuses on the importance of practice and the role of technology in scaffolding learning. There is also an understanding that different technologies (such as wax tablets) may provide different affordances that make that tool more or less suited to the activity. Finally, there is a deep connection between the content to be taught (e.g., writing or penmanship) and the design of the tool (cut-out letters to guide learners). In some sense, the underlying ideas of TPACK—that technology, pedagogy, and content are intricately linked—have always been an important part of thinking about educational technology. Yet, the interplay between content, pedagogy, and technology has often been an implicit part of educational thinking.

Since the introduction of the TPACK framework (Koehler & Mishra, 2009; Mishra & Koehler, 2006), scholarship that explicitly explores these connections has flowered. Though issues of technology integration in teaching had long been in the forefront of much scholarship, the introduction of the TPACK framework has served to integrate many lines of research, while at the same time focusing research on the interplay of content, pedagogy,

and technology. Of course, it can be argued that something like the TPACK framework was in the zeitgeist—as Mishra and Koehler (2006) have noted, there were myriad scholars who had been proposing something similar. So, in some sense, the attention given to the TPACK framework was a product of timing and, perhaps, luck.

Regardless, the impact of the TPACK framework has been considerable. The TPACK community has become a rich, vibrant, and international one, with scholars from around the globe studying theoretical issues and practical applications of the framework (Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013). At the time of writing of this introduction, the Mishra and Koehler (2006) article introducing the framework has been cited over 3,000 times in scholarly publications (according to Google Scholar). At TPACK.org, there are over 6,000 registered users with shared interests that have compiled a bibliography of TPACK-related literature with over 600 articles (and steadily growing). A quick survey of the topics covered in this bibliography illustrates the breadth and depth of research using and conceptualizing the TPACK framework. That is, research spans multiple content areas including mathematics, science, social studies, music, history, physical education, and more. Also, the TPACK framework engages a broad spectrum of researchers and education professionals who are working to understand its theoretical and practical implications.

Many factors played a role in bringing TPACK into the consciousness of the broader educational technology community. This includes the publication of the first *Handbook of Technological Pedagogical Content Knowledge (TPCK) for Educators* in 2008. Under the aegis of the Innovation and Technology Committee of the American Association of Colleges of Teacher Education, the first handbook provided a space for a more detailed articulation of the TPACK framework itself, as in the two introductory chapters by Koehler and Mishra (2008) and Kelly (2008). Drawing from research from experts across the nascent community advancing TPACK scholarship, the first handbook also grounded TPACK in specific subject areas and in teacher education and professional development settings. Additionally, it focused on defining TPACK and integrating it into teacher education and professional development.

Yet, eight years have passed since the publication of the first edition of the *Handbook*. Driven by the growing influence of TPACK on research and practice in both K–12 and higher education, the time is right for a second edition that updates current thinking about theory, research, and practice. It is therefore fitting that we introduce this volume by first taking a moment to reflect back on the history of the TPACK concept, as well as why it has influenced both research and practice in the field of educational technology and teacher education.

The Challenges of Researching Educational Technology

Much of the educational technology research literature is conceptually fragmented and relies heavily on case studies (Ronau & Rakes, 2012). This is understandable given the rapid pace at which technology evolves, where every new tool provides new opportunities for use within education. It is not surprising that most frameworks that are used usually are appropriated from outside of the education and teacher education literature, such as

from psychological or sociological theories of learning. As a result, the literature contains many studies spanning multiple frameworks and methodologies, making it unclear how they fit within each other, and there is significant definitional variation of how constructs and concepts are used and understood with little synthesis across studies and little programmatic research. Writing of this in another context, Potter (2008) describes this as the “honeybee” approach to research, describing it as follows:

where scholars are busy bees whose attention is attracted by so many interesting topics (flowers in bloom). They flit from one topic to another as they make their way across the field of flowers. The positive aspect of this “honeybee” nature of the research is that many topics get explored. Also, the travels of the bees have an effect of cross-pollinating topics with ideas and methods from other topics. However, there is a limitation to this honeybee approach. While flowers benefit from the cross-pollination and can grow on their own, research topics need scholars to stay in one place and build a system of explanation on each topic to the extent that scholars spend time trying out lots of different topics, the field stays thin—that is, there are few places where scholars conduct programmatic research that builds depth.

(Potter, 2008, p. 13)

Thus, the fragmented nature of the field of educational technology research, its ever expanding literature, and the lack of programmatic work all lead to the need for some approaches and frameworks that are “home-grown” (for want of a better word). Such home-grown constructs would include conceptualizations and demarcations of the domain that are emergent from the demands of the domain itself. It is not surprising that the two frameworks that have had significant impact in the recent past in the domain of teacher education and teacher professional development have been Shulman’s construct of Pedagogical Content Knowledge and the TPACK framework (which, essentially, is an extension of Shulman’s seminal work). Both frameworks emerge from *within* the discipline of teacher education and are not imported from a different domain such as psychology, sociology, or cognitive science. This is not to say that psychological, sociological, or cognitive principles and ideas do not have a role to play in developing our understanding of teacher knowledge, but rather that they are subsumed or integrated *within* a framework that respects the contours of the domain of practice that constitute teacher education, teacher professional development, and technology integration.

The Value of Frameworks

At some level, any framework provides two key functions (Maxwell, 2012). First, it acts as a *coat closet*—it provides a high-level “big picture” view for making sense of what you see. Particular pieces of data, or specific research studies, which otherwise may seem unconnected or irrelevant to one another can now be related to each other. The ability to find connections between studies is particularly important in the field of educational technology, where new technologies often lead to studies that appear to be new and specific to

the affordances of particular tools and technologies. Second, a framework can act as a *spotlight*, illuminating what you see, drawing attention to particular events of phenomena, and shedding light on relationships that may otherwise have gone unnoticed or misunderstood.

In other words, the TPACK framework provides a visual or written product that “explains, either graphically or in narrative form, the main things to be studied—the key factors, concepts, or variables—and the presumed relationships among them” (Miles & Huberman, 1994, p. 18). A framework such as the TPACK framework provides a model or a map of why the world is the way it is (Strauss, 1995). It is a simplification of the world, but a simplification aimed at clarifying and explaining some aspect of how it works. It does so by telling an enlightening story or providing an explanation about some phenomenon, one that gives you new insights and broadens your understanding of that phenomenon.

In a similar vein, Mishra and Koehler (2006) identified and described three key functions that they hoped the TPACK framework would perform—*descriptive*, *inference* generation, and *application*. In short, theory allows us to *describe* a phenomenon based on theoretical constructs—it lets us see the world through a particular lens. The TPACK framework provides the structure needed to describe technology integration as the interplay between technology, pedagogy, and content. Frameworks also guide *inference* making, based on what we observe or the data we collect. Like a spotlight, the TPACK framework draws attention to particular events of phenomena and sheds light on relationships that leads to inferences. And finally, the TPACK framework can scaffold how findings can be *applied* to other contexts.

It is important to note, however, that all theories and frameworks are abstractions that focus attention on the big picture. Their weakness, however, is that in order to grasp that bigger picture, they often elide details. By being top-down constructs, frameworks can sometimes be mistaken for reality, rather than abstracted representation of reality. Thus, as empirical scholars, we need to understand the dual need—to develop theoretical constructs that allow for us to generalize across cases and yet be deeply grounded in the reality of the world. Elbow (1973, 2006) suggests that one way of keeping ourselves honest, as a discipline, is to play both the “believing game” and the “doubting game.” In the case of the former, we accept the theory as it is and seek to apply it across contexts, using it to deepen our understanding of the phenomena under investigation. In the latter, we seek to challenge the theory, looking for its flaws and weaknesses, pushing and probing its hidden fault lines so as to keep it honest, as it were.

The research on TPACK over the past decade has seen both examples of these “games.” There are scholars who have played the “doubting game” by questioning the framework and underlying theory about the nature, organization, independence, and interdependence of the underlying constructs and the important role of context. This has clearly led to the flowering of a strong line of theoretical work. Others have gone the other route, playing the “believing game,” taking the framework as it stands and trying to apply the framework. This application can be seen both in research, as scholars seek to better measure TPACK and its effectiveness, and in practical application, as practitioners seek to guide the development of TPACK in pre- and in-service teachers.

The rest of the handbook can be seen as an expansion of a broader set of ideas. On one hand we have the theoreticians who are playing the doubting game, which forms some of the first section of this handbook. On the other hand are the researchers and practitioners who accept the framework as is and seek to conduct research or study its impact on practice. Thus, the next two sections of the handbook focus on Research and Practice.

Organization of This Handbook

The handbook is organized into three sections. In the first, theory—how TPACK is conceptualized across the authors' scholarship, as well as the work of others—is explored. Next, in the section on research, the authors describe studies of TPACK, focusing specifically on methodological and analytic approaches. Finally, on application, we investigate the challenges of applying TPACK theory and research to practice.

Section I: Theory

Section I provides an updated understanding of Technological Pedagogical Content Knowledge (TPACK). Authors provide a review of TPACK development as a construct, encourage purposeful advances in the development of teachers, and explore it conceptually through the lens of a 21st-century educator.

Angeli, Valanides, and Christodoulou provide a chronological review of TPACK as a valid construct and framework. While educational researchers have been and are working toward the same goal of integrating technological skills into classrooms, these authors offer that we must, as an international community, narrow the definition and determine one specific framework for future work. Of particular significance, according to the authors, is the issue of whether TPACK can be seen as being transformative or integrative in nature. Voogt, Fisser, Tondeur, and van Braak seek to develop a “theory of practice” to guide the development of teachers' TPACK. Drawing on the philosophy of technology, the theory of situated cognition, and a theory of teaching as design, the authors focus on the active and constructive role of the teacher, arguing for the need for approaches that are intentional and reflective, design-based, and collaborative. Smart, Finger, and Sim reframe Schulman's famed Nancy, the exceptional teacher of the latter 20th century, and introduce Carmelina, the exceptional teacher of the 21st century. By exploring the reasoning of both teachers, they investigate how pedagogical reasoning has changed since Shulman introduced the term. They explore the fit of a new term, “technological pedagogical reasoning,” for describing teaching in the 21st century.

Section II: Research

The second section of this handbook focuses on research, providing both reviews of the literature and an array of studies aimed at furthering the understanding of TPACK in practice. Archambault offers a comprehensive review of qualitative measures and approaches that have been developed and used to study the development of TPACK in both pre-service

and in-service populations. Chai et al., in contrast, offer a review of studies that employ quantitative measures of TPACK. Both Archambault and Chai and colleagues note that the complex nature of TPACK, the essential subjectivity that lies at the heart of the social sciences, demands the need for more research around content areas, teacher's thinking, and design processes.

The next set of chapters provides a sampling of current research around the TPACK framework. First is a case study by Schmidt-Crawford, Tai, Wang, and Jin, in which they observe exceptional educators and their use of TPACK. The next three articles focus on developing TPACK. Janssen and Lazonder report on a two-part study conducted to determine how teachers develop TPACK through providing specific support for them in the lesson-planning process. Niess describes the results of a study on the design and implementation of a learning trajectory focused on TPACK in an online course. Findings indicate that teachers develop TPACK most effectively when skills are taught and integrated in classes and opportunities for application are provided. Benton-Borghi ends the second section with a study combining TPACK with Universal Design for Learning (UDL). Combining these two approaches develops the teachers' skills in the integration of technology for all students in courses with and without diversity and disability.

Section III: Implications for Practice

The greatest value of the TPACK framework has been in its application to practice both in higher education and K–12 contexts. This is the focus of the third section. The chapters in this section are tightly tied to the context within which learning happens. This can be seen by a focus on a specific period (pre-service or in-service) or specific domains (science, mathematics, language arts, and foreign languages).

The first two chapters provide us with the broad contours of the literature on the development of TPACK among pre-service and in-service teachers. Mouza synthesizes prior research on the ways in which pre-service teachers' TPACK has been measured in the contexts in which they teach and describes the strategies teacher educators and researchers have explored to develop their TPACK. Harris provides an overview of the ways in which in-service teachers' TPACK has developed, specifically focusing on 12 distinct pathways from the literature.

Herring, Meacham, and Mourlam focus on TPACK development among higher education faculty and the importance of leadership structures across universities to support faculty using technology in a comprehensive and learner-centered way. Hofer, Lee, Slykhuis, and Ptaszynski describe their work on a TPACK-based faculty development initiative enacted and implemented through the Microsoft Technology Enriched Instruction Program.

The next two chapters demonstrate extensions of the TPACK framework and the development of TPACK in new domains. Chandra investigates how the school leadership affects the context of technology integration through a year-long case study of a high school principal, while Forssell explores how designers of learning tools and technologies can utilize TPACK in their work.

The last four chapters focus on specific domains for the application and development of TPACK, from music to math, science to language arts. Polly and Orrill focus on designing professional development among elementary school mathematics teachers, while Baran, Canbazoglu-Bilici, and Uygun explore continuous in-service professional development for science teachers. In contrast, Mroziak and Bowman investigate the development of music TPACK in higher education to demonstrate how technology is integrated into musical practice. Wang discusses the creation of digital stories by pre-service teachers as a way to develop the TPACK of teachers who teach English as a foreign language.

Conclusion

The growth and richness of TPACK research over the past decade makes it difficult if not impossible to capture it completely in this handbook. What we have attempted is to combine broader reviews of the literature and field with specific studies and research papers. This way, we believe, we could at least offer a sampling of the work that is currently underway.

The diversity of approaches in this handbook means that different readers may use the handbook in different ways. Those who are new to TPACK may focus on the first section (on theory). Researchers designing studies or looking to compare their work to related scholarship may consult the second section (on research). Finally, those looking to directly apply TPACK to their work as professional development providers, administrators, or teacher educators may find the third section (applications to practice) most helpful. We hope that, as a whole, this handbook provides the reader with a broad overview of TPACK with specific insights into the theory, research, and application of the framework across multiple contexts.

References

- Elbow, P. (1973). *Writing without teachers*. New York: Oxford University Press.
- Elbow, P. (2006). The believing game and how to make conflicting opinions more fruitful. In C. Weber (Ed.), *Bringing light into the darkness: A guide to teaching peace, empathy, and understanding* (pp. 16–25). Portsmouth, NH: Heinemann.
- Illich, I. (1993). *A vineyard of the text: A commentary to Hugh's Didascalicon*. Chicago, IL: University of Chicago Press.
- Kelly, M.A. (2008). Bridging digital and cultural divides: TPCK for equity of access to technology. In AACTE Committee on Innovation and Technology (Eds.), *Handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 30–60). New York: Routledge.
- Koehler, M.J., & Mishra, P. (2008). Introducing TPCK. In AACTE Committee on Innovation and Technology (Eds.), *Handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 3–29). New York: Routledge.
- Koehler, M.J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education (CITE)*, 9(1), 60–70.
- Maxwell, J.A. (2012). *Qualitative research design: An interactive approach*. Thousand Oaks, CA: SAGE Publications.
- Miles, M.B., & Huberman, A.M. (1994). *Qualitative data analysis*. Thousand Oaks, CA: SAGE Publications.

- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108, 1017–1054. doi:10.1111/j.1467-9620.2006.00684.x
- Potter, W. J. (2008). *Arguing for a general framework for mass media scholarship*. Thousand Oaks, CA: SAGE Publications.
- Ronau, R. N., & Rakes, C. R. (2012). Making the grade: Reporting educational technology and teacher knowledge research. In R. N. Ronau, C. R. Rakes, & M. L. Niess (Eds.), *Educational technology, teacher knowledge, and classroom impact: A research handbook on frameworks and approaches* (pp. 323–332). Hershey, PA: Information Science Reference.
- Strauss, A. (1995). *Qualitative analysis for social scientists*. Cambridge, UK: Cambridge University Press.
- Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013). Technological pedagogical content knowledge—A review of the literature. *Journal of Computer Assisted Learning*, 29, 109–121.