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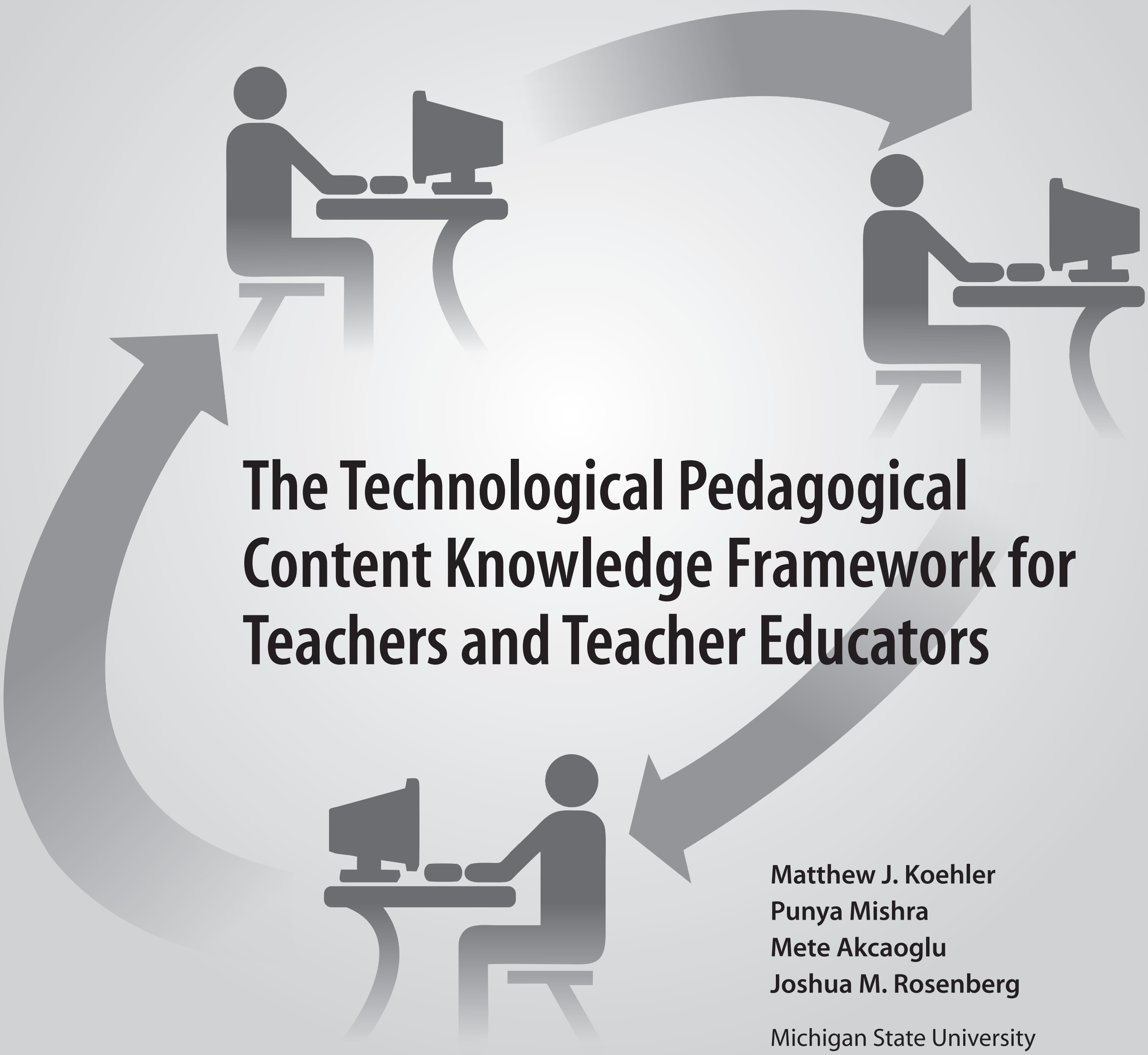

The Technological Pedagogical Content Knowledge Framework for Teachers and Teacher Educators

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Summary

In this paper, we present Technological Pedagogical Content Knowledge (TPACK) as a framework for the integration of technology within teaching. Three main bodies of knowledge – technological knowledge, content knowledge, and pedagogical knowledge – inform the design of this theoretical framework. Accordingly, we describe the characteristics of these three bodies of knowledge, along with the bodies of knowledge that emerge from the interactions between and among them. In this chapter, we argue that knowing how to integrate technology emerges from an understanding both of the three main bodies of knowledge and their interactions. We believe the TPACK framework has significant implications for teachers and teacher educators; specifically, we argue that teachers should be considered "designers" of curricula, and with regards to teacher educators, we identify "learning technology by design" and activity types as two key methods for the development of TPACK.

Editor's Note

Teacher educators need to visualize ICT integration in a holistic manner, and the authors in this paper present the highly popular framework – TPACK for the readers to consider. It is important to note why adoption of a framework is important to consider ICT integration in teacher education. They argue that good teaching with technology requires shift in exiting practices in both pedagogy and content domains. Teacher educators are therefore urged to think about their own context, and go beyond technology literacy to promote educational practices that innovatively use interaction of technology, pedagogy and content.

Introduction

The Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2008; Mishra & Koehler, 2006) describes the type of teacher knowledge required to teach effectively with technology. Describing what teachers need to know can be difficult because teaching is an inherently complex, multifaceted activity which occurs in varied settings. By its nature, teaching is an ill-structured problem (Leinhardt & Greeno, 1986; Spiro, Coulson, Feltovich, & Anderson, 1988) requiring reasoning about a wide range of interrelated variables such as the background knowledge that students bring into the classroom, teacher and student expectations about the content to be covered, and school and classroom guidelines and rules. The use of technology in the classroom introduces a new set of variables into the teaching context, and adds complexity due to its rapidly-changing nature (Koehler & Mishra, 2008). The TPACK framework identifies a unifying structure that not only respects this complexity, but also provides guidance for appropriate technology integration (Koehler & Mishra, 2008; Mishra & Koehler, 2006).

The TPACK framework describes the kinds of knowledge that teachers need in order to teach with technology, and the complex ways in which these bodies of knowledge interact with one another. This builds on the approach used by Shulman's (1986) pedagogical content knowledge (PCK), describing how and why teacher knowledge of pedagogy and content cannot be considered solely in isolation. Teachers, according to Shulman, need to master the interaction between pedagogy and content in order to implement strategies that help students to fully understand content. The TPACK framework extends Shulman's (1986) notion of PCK by including knowledge of technology.

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Teachers must understand how technology, pedagogy, and content interrelate, and create a form of knowledge that goes beyond the three separate knowledge bases. Teaching with technology requires a flexible framework that explains how rapidly-changing, protean technologies may be effectively integrated with a range of pedagogical approaches and content areas.

Please note that this paper is only a brief summary of the TPACK framework and related ideas. Interested readers may wish to reference more in-depth prior work (e.g., Koehler & Mishra, 2008; Mishra & Koehler, 2006) or by visiting tpack.org.

Overview of TPACK Framework

In the TPACK framework, what teachers need to know is characterized by three broad knowledge bases – technology, pedagogy, and content – and the interactions between and among these knowledge bases. In this approach, technology in teaching is characterized as something well beyond isolated knowledge of specific hardware or software. Rather, technology that is introduced into teaching contexts "causes the representation of new concepts and requires developing a sensitivity to the dynamic, transactional relationship between all three components" (Koehler & Mishra, 2005a, p. 134).

Good teaching with technology, therefore, *cannot* be achieved by simply adding a new piece of technology upon existing structures. Good teaching, with technology, requires a shift in existing pedagogical and content domains.

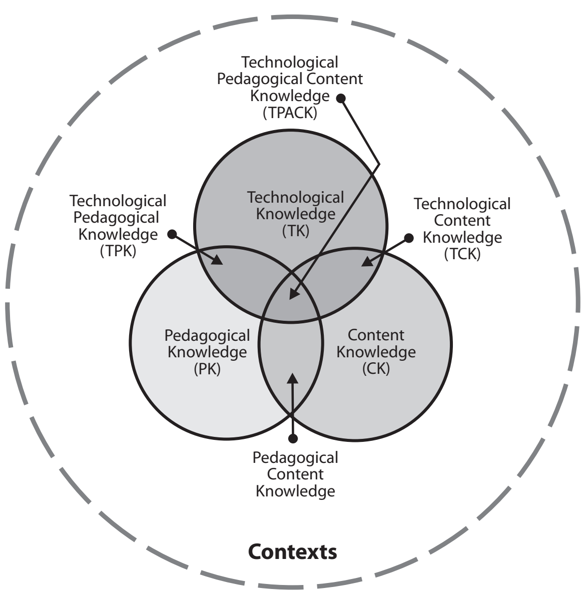

Figure 1. TPACK Framework (Image from http://tpack.org)

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The TPACK framework also emphasizes the role of the context within teaching and learning occurs. Ignoring context leads to "generic solutions to the problem of

Teaching is a context-bound activity, and teachers with developed TPACK use technology to design learning experiences tailored for specific pedagogies, crafted for specific content, as instantiated in specific learning contexts.

teaching" (Mishra & Koehler, 2006, p. 1032). Teaching is a context-bound activity, and teachers with developed TPACK use technology to design learning experiences tailored for specific pedagogies, crafted for specific content, as instantiated in specific learning contexts. In the sections below we describe each of the components of the TPACK framework and, most importantly, their interactions with each other.

Technological Knowledge (TK)

TK includes an understanding of how to use computer software and hardware, presentation tools such as document presenters and projects, and other technologies used in educational contexts. Most importantly, TK covers the ability to adapt to and learn new technologies. It is important to note that TK exists in a state of flux, due to the rapid rate of change in technology (Mishra, Koehler & Kereluik, 2009) and due to the protean nature of technology (Koehler & Mishra, 2008). For instance, modern computer hardware and software become quickly obsolete, and computers can be used for a variety of pedagogical tasks, such as research, communication, and media consumption and creation.

Content Knowledge (CK)

CK refers to the knowledge or specific nature of a discipline or subject matter. CK varies greatly between different educational contexts (e.g. the differences between the content of primary school math and graduate school math), and teachers are expected to master the content they teach. Content knowledge is also important because it determines the discipline-specific modes of thinking unique to each field.

Pedagogical Knowledge (PK)

PK describes the "general purpose" knowledge unique to teaching. It is the set of skills that teachers must develop in order to manage and organize teaching and learning activities for intended learning outcomes. This knowledge involves, but is not limited to, an understanding of classroom management activities, the role of student motivation, lesson planning, and assessment of learning.

PK may also describe knowledge of different teaching methods, such as knowing how to organize activities in a way conducive to students' constructive building of knowledge.

Pedagogical Content Knowledge (PCK)

PCK reflects Shulman's (1986) assertion that effective teaching requires more than separate understanding of content and pedagogy. PCK also acknowledges the fact that different content lends itself to different methods of teaching. For example, the teaching of speaking skills for a foreign language teacher requires student-centered activities where students engage in meaningful and authentic communicative tasks. Contrast this to a graduate-level art appreciation seminar where a teacher-centered lecture may be an appropriate way for the professor to describe and model ways of engaging with art. In this sense, PCK means going beyond being a content expert or just knowing general pedagogic guidelines, to understanding the unique interplay between content and pedagogy.

Technological Content Knowledge (TCK)

TCK describes knowledge of the reciprocal relationship between technology and content. Technology impacts what we know, and introduces new affordances as to how we can represent certain content in new ways that was not possible before. For example, today, students can learn about the relationship between geometric shapes and angles by touching and playing with these concepts on the screens of handheld, portable devices. Similarly, visual programming software now allows even primary school students to pick up programming by designing and creating digital games. In addition, technology enables the discovery of new content and representations of content; such as the relationship between the advent of Carbon-14 dating for archeology and the manner in which Google Trends can be used to predict the spread of the flu virus (Qualman, 2013).

Technological Pedagogical Knowledge (TPK)

TPK identifies the reciprocal relationship between technology and pedagogy. This knowledge makes it possible to understand what technology can do for certain pedagogic goals, and for teachers to select the most appropriate tool based on its appropriateness for the specific pedagogical approach. Technology can also afford new methods and venues for teaching, and ease the way certain classroom activities are implemented. For example, collaborative writing can take place with Google Docs or Google Hangouts instead of face-to-face meetings, extending collaborative activities over distances. Also, the advent of online learning and more recently, massively open online courses (MOOCs) require teachers to develop new pedagogical approaches that are appropriate for the tools at hand.

Technological Pedagogical Content Knowledge (TPACK)

TPACK describes the synthesized knowledge of each of the bodies of knowledge described above, with a focus upon how technology can be uniquely crafted to meet pedagogical needs to teach certain content in specific contexts. Alone, each of the constituent bodies of knowledge, that comprise TPACK, represents a necessary and important aspect of teaching. *But effective teaching is much more than each of the pieces (TK, PK & CK).* For the teacher with TPACK, knowledge of technology, pedagogy, and content is synthesized and put to use for the design of learning experiences for students.

The TPACK framework also functions as a theoretical and a conceptual lens for researchers and educators to measure pre-service and in-service teachers' readiness to teach effectively with technology.

The TPACK framework is a testament to the complexity of teaching. The framework proposes that tackling all of the variables at once creates effective teaching with technology. The TPACK framework also functions as a theoretical and a conceptual lens for researchers and educators to measure pre-service and in-service teachers' readiness to teach effectively with technology. For this purpose, researchers have developed a range of instruments, quantitative and qualitative, to measure TPACK (Koehler, Shin & Mishra, 2011; Schmidt, et al., 2009).

Implications for Teachers

Because every teaching context is unique and there are varied interactions between technology, pedagogy, and content, there is not a universal or "one-size fits all" solution to the problem of teaching. Due to the intertwined relationships among technology, pedagogy and content, teachers face a great number of decisions. These decisions shift with permutations of technology, pedagogy, subject-matter and classroom context. The diversity of possible responses implies that a teacher should be an active agent and to become *designers* of their own curriculum (Koehler & Mishra, 2005a).

The complex and ill-structured nature of teaching with technology leads to the idea of "teachers as designers" who are constantly engaged in the active, iterative, and feedback-driven process of problem-finding *and* creative problem-solving (Koehler & Mishra, 2005b). As Kafai (1996) suggests, in the design process,

… the designer begins by finding a problem, then discovers parts of the solution, tries to make sense out of it, considers how to reframe the situation, and continues with problem solving. This process seems to stop when an artifact has been created, but, actually, it never ends because existing design solutions are used and reused in new design situations. (Kafai, 1996, p. 73).

According to Brown and Campione (1996), curricula are comprised of pieces that act in cohesion, instead of a collection of teaching practices in isolation. Often, the failures in creating successful curricula, which incorporate technology organically, stem from ignoring this idea of cohesion, and "trying to pull together disparate sets of items" (Mishra & Koehler, 2006, p. 1034). Therefore, the creator of such an intricate design piece can only be teachers who know, understand and craft the interrelated pieces into a meaningful whole. This is the essence of TPACK.

The constant process of negotiating among existing limitations causes designs go through iterative cycles of change and refinement to create optimal learning experiences. This process is akin to bricolage (Turkle & Papert, 1992), which emphasizes creativity and flexibility. Similarly, teachers often make creative decisions based on the teaching context, technologies available, how these tools can enhance the existing pedagogies – which are determined based on the unique affordances and limitations of the content at hand. During the process of designing their own curricula, the decisions that go into making up the curriculum become the primary responsibility of teachers, who understand the particularities of specific teaching contexts. For this reason, the design process helps teachers to become a part of the curriculum (Dewey, 1934).

The image of "teachers as designers" has also very important implications in informing teacher educators. Design, or learning by design, requires learners to actively experience the process, and they provide rich contexts for learning (Harel & Papert, 1990, 1991; Kafai, 1996; Perkins, 1986). In the next section, we describe approaches to teacher education in technology, and highlight the importance of learning by design.

Implications for Teacher Educators

Dozens of methods have been proposed for the development of TPACK, and they vary in their effectiveness. Among various approaches, an emphasis upon *how* teachers integrate technology in their practice is more important than the emphasis upon *what* teachers integrate in their practice (Mishra & Koehler, 2006).

Among various approaches, an emphasis upon how teachers integrate technology in their practice is more important than the emphasis upon what teachers integrate in their practice.

For example, approaches that develop technological knowledge (TK) in isolation, where technology literacy is the goal, fail to assist teachers in the development of the educational uses of those tools. Similarly, approaches that develop only pedagogy or content – or even pedagogical content knowledge-do not capture the scope and unique flavor of knowledge needed to effectively teach with technology.

Other methods of developing TPACK have avoided these problems by focusing on different approaches to developing the connected, contextualized knowledge described in the TPACK framework. In the following sections, we describe two unique approaches: *learning technology by design* and by *activity types*. For other proposed methods of developing TPACK, interested readers can read Angeli and Valanides (2009); Brush and Saye (2009); and Niess, van Zee, and Gillow-Wiles (2010).

Naming their approach *Activity types* to reflect the kinds of domain-driven learning activities that teachers and students do everyday in their classrooms, Harris & Hoefer (2011) build knowledge about technology onto teachers' existing understanding. In this approach, teachers first formulate goals for student learning (Mishra & Koehler, 2009). Then, they choose activity types appropriate for the specified goals. Finally, they select specific technologies based upon their choice of activity types. Research indicates that activity types help teachers to make careful, strategic decisions around the integration of technology in their teaching (Harris & Hofer, 2011).

The *learning technology by design* approach emerged as a method for the development of TPACK through faculty and graduate students working together to develop online classes in a design-based seminar (Mishra & Koehler, 2005a). Through the act of *designing*, students and faculty constructed both online classes (which were later taught by the faculty) as well as an awareness of technology's role in reaching instructional goals for specific content. In this approach, students are not recipients of instruction, but undertake a "cognitive apprenticeship" with instructors (Mishra & Koehler, 2006). This design-based process is an authentic context for learning about educational technology that recognizes that design-based activities take on meaning and occur iteratively over time.

Principles of the learning technology by design approach (Mishra & Koehler, 2006) have been used to support design teams that have created educational movies, re-design existing websites, and developed curriculum used in K-12 schools. In the learning technology by design process, students design an educational technology artifact (e.g., an online course, movie, and redesigned website) that develops in-step with the student's progress through coursework or professional development. To accomplish this, students are organized into groups, and the initial discomfort students feel due to working in groups to solve ill-structured instructional problems is, over time, replaced with a sense of accomplishment and deeper engagement with course readings and discussions (Koehler & Mishra, 2005b). Throughout, the instructor employs the role of facilitator, available for immediate and ad hoc assistance to students as they progress toward the completion of their artifact.

The development of TPACK should begin with relatively familiar technologies - with which teachers may have already developed TPACK - and to gradually progress to those that are more advanced.

All technology has affordances and strengths (Mishra & Koehler, 2006), regardless of the method teacher educators select to develop teachers' TPACK. Therefore, the development of TPACK should begin with relatively familiar technologies – with which teachers may have already developed TPACK – and to gradually progress to those that are more advanced (Koehler & Mishra, 2008; Koehler et al., 2011). In the case of pre-service teachers, whose knowledge development is limited not only with regards to TPACK, but also its constituent knowledge bases, such as PCK (Brush & Saye, 2009), it is important for teacher educators to first introduce relatively familiar technologies. Additionally and in order to facilitate the development of TPACK among pre-service teachers, teacher educators should also identify and provide ample design opportunities to encounter authentic problems of practice slowly and in a spiral-like manner (Koehler & Mishra, 2008). The changing conditions and multiple contexts present challenges to the task of developing educators with TPACK; nevertheless, a deep understanding of TPACK imparts the general, flexible knowledge needed to teach effectively with technology.

Conclusion

New technologies are driving necessary and inevitable change throughout the educational landscape. Effective technology use, however, is difficult, because technology introduces a new set of variables to the already complicated task of lesson planning and teaching. The TPACK framework describes how effective teaching with technology is possible by pointing out the free and open interplay between technology, pedagogy, and content. Applying TPACK to the task of teaching with technology requires a context-bound understanding of technology, where technologies may be chosen and repurposed to fit the very specific pedagogical and content-related needs of diverse educational contexts (Kereluik, Mishra, & Koehler, 2010; Mishra & Koehler, 2009).

Technology education... should become an integral part of teacher education, moving beyond teaching technology literacy in isolation.

In confronting the ways in which technology, content, and pedagogy interact in classrooms contexts, we see an active role for teachers as designers of their own curriculum. Like all design tasks, teachers are faced with an open-ended and ill-structured problem in the process of crafting their curricula. This requires teacher educators to adopt, identify and select methods to develop technology integration knowledge by starting from already-existing bodies of teacher knowledge in a gradual manner (Koehler & Mishra, 2008); or in the case of pre-service teachers, to thoughtfully and slowly reveal authentic problems of practice (Brush & Saye, 2009). Technology education, therefore, should become an integral part of teacher education, moving beyond teaching technology literacy in isolation.

Complexity is an everyday part of teaching, and the ubiquitous nature of digital technologies only adds to the complexity that teachers face. The TPACK framework, however, provides teachers with a tool to manage complexity. By recognizing the unique interplay between and among the core bodies of knowledge that comprise TPACK within unique contexts, TPACK provides teachers and teacher educators with a framework that guides them to achieve meaningful and authentic integration of technology into the classroom.

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