The 21st century has experienced significant technological and social changes with the increased access to information in new and faster ways as well as the emergence of easy access to multiple technologies. Even prior to school age, according to a report from Common Sense Media (2013), 72% of children ages 0-8 in the US use or have used mobile devices such as touch sensitive tablets or smartphones and as many as 38% of children under the age of 2 use or have used such devices. By the time they enter school, they are used to having access to technological applications such as those they played with in their younger years. They are quick to innovate with the various digital technologies (hereafter referred to as ‘technologies’) that are now available for home and school use. By middle school many students are comfortable with cell phones, taking pictures, and texting to their friends. They are ready to interact with the ever increasing multiple technologies and applications as they are learning. The question is whether their teachers are prepared for engaging these tech-savvy students in the 21st century skills as called for in the Partnership for 21st Century Learning (2015) and the Thoughtful Learning Organization (2016). These organizations identify critical thinking, creative thinking, communicating and collaborating as the 4C’s as today’s essential learning and innovation skills for successful citizenship in a global society. These organizations propose that these skills are important for preparing students to engage in a more complex society. However, with this recognition, an important question arises as to their teachers’ preparation for orchestrating such learning with multiple digital technologies. What knowledge do teachers need for meeting the challenges of the 21st century skills called the 4C’s with the integration of multiple technologies as learning tools?

Many of the new technologies are ones that were not available when today’s teachers were learning at the precollege level and when they were learning how to teach their subject matter. For example, iPads with their multiple applications are currently supplied as a tool for student learning in middle schools. These students are actively taking advantage of the applications on iPads in their homes and are more naturally exploring the different applications, admittedly through a myriad of games. However, with the incorporation of iPads as classroom tools, their teachers are faced with determining how to use the features in this tool for learning. While they have not used this tool in their own precollege training nor have they had instruction for integrating the tool in their teacher preparation program, they now are expected to incorporate the various applications in their instruction. Thus, the addition of iPads as an instructional tool requires that teachers think outside their
traditional views of how the subject matter content is learned and communicated. How can the various applications be incorporated to support student learning of the various subject matter topics?

REFORMING TEACHERS’ TPACK

Reforming teachers’ knowledge for teaching with multiple technologies requires that they have opportunities to learn with the technologies such as iPads in ways that support them in reframing their current knowledge and understandings. These experiences are needed for challenging them to change, revise, and adapt their teaching using these technologies as learning tools. In essence, today’s inservice teachers must continue learning for teaching in the 21st century even after they have completed their preservice teacher education. They do not gain these skills by simply hearing about the importance of incorporating these technologies. They need to be engaged in learning that incorporates new and emerging technologies as learning tools in various subject matter topics. They need to be engaged in higher order thinking skills, using these new and emerging technologies in their topic areas as they are solving more complex problems. And in this process they need to engage in communication and collaboration, sharing their knowledge and helping in the decision making in responding to the problems. Basically, they need to develop and enhance their Technological Pedagogical Content Knowledge (now referred to as TPACK) (Mishra & Koehler, 2006; Niess, 2005, 2008; Thompson & Mishra, 2007). This teacher knowledge ultimately informs their strategic thinking for knowing when, where and how to integrate content-specific knowledge and pedagogical strategies for guiding students’ learning with today’s digital technologies. Koehler and Mishra (2005) described teachers’ knowledge about technology inextricably connected to the contexts of teaching, as a knowledge that must incorporate “what technology can do for them as teachers” (Koehler & Mishra, 2005, p. 132). Thus, as new and more complex technologies emerge and are proposed as educational tools, teachers must keep on learning about teaching with technologies.

Since many teachers have not been prepared in programs where technology was presented as a pedagogical tool, inservice professional development programs have evolved to focus on teacher knowledge development (Chiu & Kuo, 2010; Stobaugh & Tassell, 2011). Online avenues provide potential environments for teachers to access learning experiences as they are concurrently teaching (Moon, Passmore, Reiser, & Michaels, 2014). The challenge for teacher educators is to design effective online instructional inservice programs for engaging teachers in learning not only about multiple technologies but more importantly in learning about teaching their content with these technologies. How should these online experiences be designed to develop and enhance teachers TPACK?

THE RESEARCH PROJECT DESIGNING ONLINE INSERVICE TEACHER EDUCATION

The research project described in this book was supported through multiple Mathematics and Science Partnership (MSP) grants from the US Department of Education, specifically
granted by the state of Oregon. The goal was to design an online Master of Science (MS) program to prepare K-12 teachers for integrating technologies in teaching mathematics and science at the precollege level. The program reflected the graduate requirements for the campus-based, face-to-face MS program, although the delivery involved asynchronous online coursework for participants throughout the world. By the completion of the research, the 45 graduate quarter credit program supported more than 40 participants, taking one three-credit course per term (Fall, Winter, Spring and Summer sessions) over a three-year period.

The initial challenge for the research effort required the identification of an effective framework for the online program, one to engage teachers as an online community of learners in inquiry and reflection that emphasized shared and individual knowledge development. The primary research question examined the orchestration of key online tools and processes for developing teachers’ knowledge. The development of the online TPACK learning trajectory used a social metacognitive constructivist lens. The online learning trajectory supported the design and development of multiple technology-based courses for emphasizing TPACK development through the online MS program.

BOOK CHAPTERS

With the completion of this extended research effort, the task for this book is to describe the insights learned from work about the design and development of an online professional development coursework for inservice teachers for reframing their TPACK knowledge. Six chapters present the insights specifically for teacher educators and other instructional researchers interested in the design of online inservice educational courses and programs.

Chapter 1 introduces the Technological Pedagogical Content Knowledge (TPACK) as teachers’ knowledge for designing, implementing, and evaluating curriculum and instruction with technology. TPACK portrays the complex interaction among content knowledge, pedagogical knowledge and technological knowledge that steers teachers in the strategic thinking of when, where, and how to guide students’ learning with technologies. The chapter connects inservice teachers’ TPACK knowledge construct with the Cochran-Smith and Lytle (1999) construct that they called knowledge-of-practice. The knowledge-of-practice notion considers the knowledge that inservice teachers gain through engagement in a community in which they learn from practice through “systematic inquiry about teaching, learners and learning, subject matter and curriculum, and schools and schooling” (Cochran-Smith & Lytle, 1999, p. 274), thus pointing to the importance that their practice is when they learn from inquiry within communities where they are also actively engaged in reflecting on all that they are encountering as they teach. The chapter provides the knowledge direction for online inservice teacher education for guiding teachers in reframing their knowledge for teaching with technologies.

Chapter 2 details the three year, design-based research effort that resulted in the online TPACK learning trajectory that teacher educators might use in redesigning inservice teacher coursework that prepares them with the pedagogical challenges in orchestrating and managing knowledge-building communities in their classroom instruction. The researchers relied on a social metacognitive constructivist instructional lens for identifying
the online trajectory, specifically describing key tools and instructional processes important in online education for guiding the content towards an enhanced TPACK understanding. The learning trajectory frames the design used in the online MS program courses to focus on integrating technology in K-12 teaching.

Chapter 3 presents insights from a multiple case, descriptive study that detailed the key tools (community of learners and reflection) and processes (shared/individual knowledge development and inquiry) in the online learning trajectory supported the reframing of technological pedagogical content knowledge (TPACK). Three themes add insights for the design of online learning trajectories that incorporate these tools and processes: the tools and processes are needed for constructing knowledge, for transitioning participant’s thinking as a student to that of a teacher, and for recognizing their value as pedagogical strategies for learning with technologies. This chapter presents a specific course that contains details for using the online TPACK learning trajectory for framing the online design. The emphasis on communicating and collaborating while inquiring into teaching with multiple technologies such as Google Docs and Google Slides demonstrates how an online knowledge-building community is established.

Chapter 4 describes insights from a research-based application of an online inservice teacher education course, describing how scaffolding content, pedagogy, and technologies in a problem-based learning approach reframes teachers’ TPACK for integrating digital image and video technologies with 21st century inquiry thinking skills: critical thinking, creative thinking, communicating and collaborating. The result is an explanatory framework for how the scaffolding of the content, pedagogy, and technologies within the online TPACK learning trajectory situated in a social metacognitive constructivist instructional approach guides teachers in rethinking, relearning and reframing their TPACK knowledge for engaging students in 21st century inquiry thinking with digital image and video technologies. This chapter is another specific course with details for designing online knowledge-building communities and using the tools and processes of the learning trajectory to support teacher participants in reframing their TPACK.

Chapter 5 presents how inservice teacher preparation balances theory with practice for supporting teachers in applying theoretical knowledge to practice through an online blended course framed with the online TPACK learning trajectory. The course blends practical experiences of the Scoop Notebook (Borko, Strecher, & Kuffner, 2005) with asynchronous community of learners’ examinations of instructional strategies. The results describe teachers in action research using Scoop artifacts as objects to think with for transforming their TPACK that integrates technologies in teaching their content, ultimately transforming their TPACK-of-practice. This chapter reveals specific recommendations for the design of a blended course design that integrates online coursework with teachers’ practice of the ideas in their classroom instruction.

Chapter 6 concludes the research work on the design and development of the online TPACK learning trajectory by extending the thinking on the future of online inservice teacher education. The chapter outlines basic recommendations for the design of online inservice teacher education courses. Limitations and future research extend the understanding of TPACK through online teacher education professional development where teachers relearn, rethink and reframe learning and teaching with technologies. Multiple factors frame the
thinking about future designs for online programs aimed at transforming inservice and perhaps extending to preservice teachers’ TPACK development.

**CONCLUSION**

The major goal of this six-year research project was to understand and describe how online education can be designed to guide teachers’ TPACK professional development. The online TPACK learning trajectory guided the design of multiple courses using different technologies to guide the teacher participants’ experiences. Since the beginning of the research in 2008, the influence of technology in education has escalated with the incorporation of more diverse technologies promoted for education.

The design of the courses emphasizes the establishment of a knowledge-building community learning environment. The challenge is to engage the teacher participants in communication, collaboration and inquiry. The specific technologies for each course were selected to engage the teachers in at least one of these actions. The specific problems were focused toward mathematics and science.

However, the key insights for this research were on the general framework for online teacher education. The emphasis is on communication, collaboration and inquiry. The technologies certainly can be varied to match the technologies for other content areas. The challenge for teacher educators is to consider a system pedagogical approach, specifically selecting appropriate technologies for the content area of interest such that the technology is useful in communication, collaboration or inquiry so that future renditions of each of the courses might actually make changes in the technologies that are scaffolded in the TPACK content. The social metacognitive constructivist lens for the trajectory resulted in the identification of tools and processes that were identified as important in scaffolding the content through a knowledge-building community learning environment.

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**REFERENCES**


