Chapter 15
Integrating Technology into Mathematics Teaching:
A TPACK (Technological, Pedagogical, Content Knowledge)–Based Course Design for College Students

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ABSTRACT

The relationships between content, pedagogy, and technology are important for teaching, yet complex for teachers. The idea of technological, pedagogical, and content knowledge (TPACK) has emerged in the educational technology field as a framework to explain the complexity of technology integration. In contrast to a simple view of technology, TPACK framework emphasizes the connections, interactions, affordances, and constraints of content, pedagogy, and technology. TPACK framework presents a way of thinking about effective technology integration. The preparation of teachers for effective technology integration to instruction appears to be a key component of almost every improvement plan for education and educational reform programs. This chapter provides a course design example for teacher educators about how to give pre-service teachers experience integrating technology with their instructions. The instructor designed this course to enhance mathematics teacher candidates' understanding of TPACK as a result of an intense educational technology course sequence.

INTRODUCTION

Technology is present in every part of every society today. Its pre-eminence has naturally drawn the attention of educational institutions, who are moving to enhance teachers' knowledge of technology integration in the classroom. Teachers have a responsibility to educate society and should know how to teach with technology and about technology. According to Mishra and Koehler (2006) a teacher should know how to teach specific content with the help of technology. The concept is coined as technological, pedagogical, and content knowledge, or TPACK.

A close inspection of the historical development of the interrelationship among technology (T), pedagogy (P) and content (C) knowledge is presented in Figure 1. At the beginning (Phase 1), the focus of teacher education was shifted from the content knowledge of the teacher (Veal & MaKinster, 1999) to pedagogical knowledge that was often thought to be completely independent from content knowledge (Ball, & McDiarmid, 1990).

Following the separated pedagogical knowledge and content knowledge circles, Shulman (1986) proposed the idea of pedagogical content knowledge (PCK) that considers the relationship between pedagogy and content knowledge (phase 2 in Figure 1). Schulman's proposal shifted the focus from topic to the knowledge that actually makes the subject matter comprehensible to learners (Shulman, 1986, 1987; Wilson, Shulman, & Richert, 1987), PCK integrated the two—content knowledge (the knowledge previously considered the primary knowledge for teachers) and pedagogical knowledge (the knowledge about teaching and learning).

According to Shulman (1986), knowledge of the subject is one requisite to being a good teacher, but being a good teaching also requires the support of general pedagogical strategies. Shulman defines "pedagogical content knowledge" as the content knowledge that deals with the teaching process, including "the ways of representing and formu-

lating the subject that make it comprehensible to others" (Shulman, 1986, p. 9). Therefore, under this way of thought, teachers' success was dependent on content and pedagogy simultaneously by embodying "the aspects of content most relevant to its teachability" (p. 9). Redesigning subject matter for effective teaching is the fundamental idea behind the notion of PCK. This requires the teacher to interpret the subject matter, find different ways to teach it, and then make it accessible to the students.

Shulman's notion of PCK has been extended and undergone significant critique by scholars in the years since (e.g., Cochran, King, & DeRuiter, 1993; van Driel, Verloop, & De Vos, 1998). In fact, Shulman's (1986) first description of teacher knowledge included other categories, such as curriculum knowledge and knowledge of educational contexts. According to Shulman (1986), PCK provide guidance for teachers for designing and presenting content knowledge to reach a diverse group of students with a variety of interests and abilities (Shulman, 1986). In Shulman's (1986) words, this intersection contains within it "the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing and formulating the subject that make it comprehensible to others" (p. 9).

Technology and its relationship to pedagogy and content is absent from Shulman's analysis since technologies and issues related to their use in education were not popular at the time that Shulman first made his argument. Traditional classrooms use a variety of technologies; however, until recently, most technologies used in classrooms had come to be seen as mundane and were not even regarded as technologies (Mishra & Koehler, 2006). Thus, the most important change since the 1980s is that technologies have become popular in classroom settings and education primarily because of the availability new digital

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