Chapter 19
Preparing Pre-Service STEM Teachers to Teach Using Digital Modeling and Simulation Applications

Mary C. Enderson
Old Dominion University, USA

Ginger S. Watson
University of Virginia, USA

ABSTRACT

This chapter presents a case approach used for modeling and simulation applications in a science, technology, engineering, and mathematics (STEM) teacher preparation program to assist in the development of technological pedagogical content knowledge (TPACK). In this digital age, many pre-service teachers use technological tools daily but do not have knowledge on how to use tools in ways to help develop understanding of STEM concepts. The authors present a framework that promotes learning by teaching to prepare STEM teachers with ways to use modeling and simulation tools in classroom instruction.

INTRODUCTION

Teacher preparation programs have a long history in progressing the work of Lee Shulman (1986, 1987) related to the intersections of content knowledge and pedagogical knowledge – referred to as pedagogical content knowledge (PCK) needed for teaching. This is especially true for the fields of mathematics and science as there is often a great divide between what teachers learn in content courses and what they learn in education courses (Ball, 2000; Ball & Bass, 2000). For many programs, the two shall never meet, which results in pre-service teachers having few opportunities to see the importance of different teaching styles for diverse learners. In several instances, content rises to the top of instruction with little regard for students’ needs to make sense of the content.

DOI: 10.4018/978-1-5225-7001-1.ch019
Preparing Pre-Service STEM Teachers to Teach Using Digital Modeling and Simulation Applications

Technology as a tool for exploring concepts and ideas can help bridge the content and pedagogy so to provide an ideal learning environment for all. The dilemma lies in that technology is in a constant state of change, which presents challenges to teachers fully embracing such tools in classroom instruction. Teachers need learning experiences where they develop technological knowledge (TK) that will connect with content and pedagogical knowledge. “Understanding the impact of technology on the practices and knowledge of a given discipline is critical to developing appropriate technological tools for educational purposes” (Koehler & Mishra, 2009, p. 65). This technological knowledge is a component of TPACK, Technological Pedagogical Content Knowledge, which is critical for today’s teachers to acquire. TPACK not only identifies one’s possession of content, pedagogical, and technological knowledge, but also the insight to know how these areas interact with and support each other. The authors believe digital tools that support modeling and simulations (M&S) in the disciplines of science, technology, engineering, and mathematics, or STEM, will help develop stronger TPACK in future teachers. These digital tools are a critical part of everyday life, but more importantly play a major role in applications used in the fields of science, technology, engineering, and mathematics. Preparation programs need to give due attention to promoting such tools in their programs so to advance the technological knowledge of content specific teachers.

This chapter presents the efforts of one undergraduate STEM teacher preparation program to make attempts at developing TPACK in secondary pre-service teachers. Specifically, cases involving the use of M&S applications are integrated into STEM education courses where science, technology education, and mathematics pre-service teachers explore content as learners and then transition into presenting content as teachers. There is little research on pre-service teacher development of TPACK (Jang & Chen, 2010; Niess, 2005) and even less on the integration of M&S tools to help in this process. This chapter addresses how technological cases are framed and accomplished, along with the successes and challenges one secondary program has confronted in preparing teachers for today’s STEM classrooms.

BACKGROUND

The professional community is well aware that technology integration is even more far removed than the content and pedagogy union. Niess (2005) brought this point to attention when she addressed ways pre-service teachers learn about technology. She indicated that it was not unusual for future teachers to “learn about teaching and learning with technology in a more generic manner unconnected with the development of their knowledge of the subject matter” (p. 510). This practice is congruent with an educational technology course that has a mix of teacher candidates from various disciplines in it. Pre-service teachers are often required to complete course assignments that have some connection or tie to their content area or field where their evaluation is more focused on the tool rather than how the tool supports study of the concept. While this may be valuable for teacher candidates on an introductory level, stand-alone technology courses often miss the mark of how to incorporate technological tools for exploring or learning content (Moursund & Bielefeldt, 1999; Niess, 2005). Experiences where real content concepts, principles, rules, and problem solving (Gagné, 1985) can be explored, tested, or observed are critical to teachers fully embracing the power of technology in classroom instruction (Gorder, 2008; Lee, Linn, Varma, & Liu, 2010; Li & Ma, 2010). Modeling and simulation tools allow such environments to be a part of the learning process which promote dynamic experiences rather than static presentation of concepts (De Freitas, 2006; Motola, Devine, Chung, Sullivan, & Issenberg, 2013; Solvie & Kloek, 2007).
22 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the product's webpage: www.igi-global.com/chapter/preparing-pre-service-stem-teachers-to-teach-using-digital-modeling-and-simulation-applications/215513?camid=4v1


Related Content

Effective Educational Leadership in the Digital Age: An Examination of Professional Qualities and Best Practices
Kwesi Armah Tandoh and Josephine Effibah Ebe-Arthur (2018). Handbook of Research on Digital Content, Mobile Learning, and Technology Integration Models in Teacher Education (pp. 244-265). www.igi-global.com/chapter/effective-educational-leadership-in-the-digital-age/186253?camid=4v1a

About Masters in Distance Education Experts for E-Learning Systems

“I Found Myself Retweeting”: Using Twitter Chats to Build Professional Learning Networks

Faces or Fingers: Building Community With Synchronous Chat