Chapter 42
Technology-Supported Inquiry in STEM Teacher Education: From Old Challenges to New Possibilities

Marina Milner-Bolotin
University of British Columbia, Canada

ABSTRACT

The chapter describes the implementation of collaborative educational technologies in STEM teacher education to support teacher-candidates in acquiring inquiry-based teaching skills and positive attitudes about inquiry learning. The focus is on five different collaborative technology-enhanced pedagogies: (1) Peer Instruction, (2) collaborative design of conceptual questions with PeerWise, (3) data-driven STEM inquiry via using live data collection and analysis, (4) computer modeling-enhanced inquiry, and (5) collaborative reflection on peer teaching. Teacher-candidates experienced these pedagogical approaches first as learners, then reflected on them as future teachers, and lastly incorporated some of them during the practicum. As a result, teacher-candidates gained experience in promoting technology-enhanced inquiry in STEM education and began developing positive attitudes towards technology-enhanced inquiry-based STEM education.

INTRODUCTION

This chapter explores how modern collaborative educational technologies can be implemented in STEM teacher education in order to support teacher-candidates in (1) acquiring inquiry-based teaching skills, (2) forming positive attitudes about inquiry-based STEM education, and (3) building resiliency in the face of initial failure of inquiry-based pedagogies (Milner-Bolotin, 2016b). The last two points are especially important, as there is ample research evidence that when instructors lack adequate support, they are likely to give up on implementing innovative research-based pedagogies in the face of early adoption failure (Lasry, Guillemette, & Mazur, 2014; Mazur, 1997a; Wieman & Perkins, 2005). Thus, inadequate support for K-12 and post-secondary STEM educators for reforming their teaching coupled with the limited opportunities for teacher collaboration result in an ever growing gap between research-informed and classroom-enacted educational practices (Cole & Knowles, 2000; Milner-Bolotin, 2014a).

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This explains why increased access to educational technologies does not necessarily guarantee a wider adoption of inquiry-based pedagogies and improved learning. In order to promote inquiry-based learning and active student engagement in STEM, K-12 and post-secondary instructors have to be supported in adopting new pedagogical approaches (Harris & Hofer, 2011; Shelton, 2015). This requires reimagining STEM teacher education, pedagogical preparation of post-secondary instructors, as well as in-service professional development (Lee & Tsai, 2010; Niess, 2005). If we fail to do so, many instructors will continue to ignore the mounting research evidence about how students learn and how STEM subjects can be taught more effectively (Bransford, Brown, & Cocking, 2002). Moreover, a large number of STEM instructors will inevitably revert to much safer but also less effective teacher-centered pedagogies they had experienced as students (Shelton, 2015; Wieman, 2012; Wieman & Perkins, 2005). This is one of the key reasons why the substantial governmental investments and half-a-century long education reform efforts in North America and in Europe aimed at promoting inquiry-based education have rarely brought the desired outcomes (Feder, 2010; Krajcik & Mun, 2014; National Research Council, 2012; Pollock, 2004).

The goals of STEM education, the role of inquiry, the tools available to modern students, as well as the population of students in K-12 STEM classrooms have changed dramatically over the last few decades (Cuban, 1990; National Research Council, 2013). In the 21st century we cannot afford to leave the majority of our population outside of STEM fields, as every student who disengages from STEM in K-12 closes multiple future opportunities for themselves inside and outside of STEM-related professions (Chachashvili-Bolotin, Milner-Bolotin, & Lissitsa, 2016; Let's Talk Science, 2013, 2015). In the current economic reality, STEM engagement should not be limited to a select few students, as it was common in North America during the post-Sputnik era, but should become an integral part of K-12 education for all (DeBoer, 1991; Let's Talk Science, 2012).

In this chapter we investigate how modern educational technologies can help to prepare the next generation of teachers who will be open to and capable of engaging their students in inquiry-based STEM learning (Jones & Leagon, 2014; Milner-Bolotin, 2016c). We focus on K-12 teacher education, as unlike their post-secondary colleagues, teachers in North America have to earn a teaching certification in order to be allowed to teach in the K-12 public school system. Teacher education is a perfect opportunity to expose future teachers to inquiry-based pedagogies and to available support networks. However, before discussing STEM teacher education that promotes technology-supported inquiry, it is important to highlight some relevant research on the topic.

BACKGROUND

Inquiry-Based STEM Education: Past, Present, and Future

A quick Google search for *inquiry-based STEM education* generates more than 1,210,000 results. There is little doubt that inquiry-based education has drawn ample attention from governments, educational administrators, and the community at large. Most of the documents produced by educational bodies in Canada, the United States, Europe and worldwide in the last decades emphasize inquiry, especially when it applies to STEM education (British Columbia Ministry of Education, 2015; BSCS, 2008; Crawford, 2007; Feder, 2010; R. R. Hake, 2007; National Research Council, 2013). Indeed, the term is often used broadly and indiscriminately. However, by labeling a "hands-on" classroom activity as inquiry-based, we cannot solve the problem of student growing disengagement from STEM fields and their declining