Chapter 23
Beyond Angry Birds™: Using Web-Based Tools to Engage Learners and Promote Inquiry in STEM Learning

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ABSTRACT

This chapter explores digital web-based tools for engaging learners and promoting inquiry-based STEM learning. Specifically the authors analyze a selection of technological supports in STEM education, including remote laboratories and simulations, within the context of inquiry based teaching and learning in physics. Teaching physics through inquiry continue to create high levels of anxiety amongst elementary school teachers, which in turn influences their pedagogical choices and limits the possibility of spontaneous events arising from student exploration in the classroom. The authors maintain that teachers will require professional development opportunities to work within the Technological Pedagogical Content Knowledge (TPACK) framework to ensure that they are able to select from a broad spectrum of technological supports. The authors highlight the potential of web-based digital tools to promote inquiry-based STEM learning, and engage both teachers and students, thus potentially improving attitudes toward teaching and learning STEM content through digital technologies.

INTRODUCTION

New realities of the 21st century demand individuals with different competencies than those considered appropriate for success in the past. The shift in our society's growing reliance on technology mandates that education emphasize technological/digital literacy including: digital competence (skills, concepts, approaches, attitudes), digital usage (professional/discipline application), and digital transformation (innovation/creativity) (Belshaw, 2011). Improving digital literacy underpins not only a nation's ca-

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pacity to provide individuals and groups with equity of access to social opportunity; it is a necessity for participation in the digital economy (Warsh, 2007). Research suggests that models of education are inadequate for addressing the challenges and opportunities facing 21st century learners (Barron & Darling-Hammond, 2008; Perkins, 2009). Consequently, education must change. Milton (2015) maintains that surface changes in education will not equip students for the 21st century and that change is needed at the core of educational practice. A shift must occur from the traditional view of educational practice to a transformative view, one in which "learning is a social process, with students and teachers working in partnership with each other and with experts beyond school, supported by digital technologies" (p. 9). Moreover, this shift must aim to incorporate technologies in schooling in a manner that digress from disciplinary experts' determinations of what and how students should learn – a classic perspective which has resulted in challenges for educators as they continue to search for strategies to effectively address the development of skills reminiscent of the preferred learning styles of today's students. Thus, in technology enriched environments teachers and textbooks are not the keepers of knowledge, as students are provided with new possibilities for pursuing inquiry and engaging in knowledge construction.

Overall, the research evidence over the last forty years on the impact of digital technologies (e.g., Integrated Learning Systems (Parr & Fung, 2000), interactive whiteboards (Higgins, Beauchamp, & Miller, 2007), mobile and handheld technologies (Cheung & Hew, 2006) and virtual learning environments (Passey & Higgins, 2011)) on learning consistently identifies positive benefits (Higgins, Xiao, & Katsipataki, 2012). Despite the educational value of web-based technologies, very few educators use them in any substantive way in teaching and learning. Technological tools, when used judiciously, have the potential to impact teaching and learning in STEM disciplines (DeCoito & Richardson, 2016). One specific STEM discipline, physics, continues to garner the least positive attitudes through educational experiences thus resulting in the highest levels of anxiety amongst elementary teachers. This in turn influences their pedagogical choices and limits the possibility of spontaneous events arising from student exploration in the classroom, as they feel ill equipped to troubleshoot (Czerniak & Haney, 1998). Thus, teachers will require professional development opportunities that focus on digital literacies. Specifically, how to navigate the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2009), since development of teachers' TPACK is critical to effective teaching with technology. It is not enough to simply know that remote labs or simulations exist, but rather it is necessary for teachers to understand how to incorporate these technologies into their classrooms to provide the best learning opportunities for their students.

In this chapter the authors explore the potential of digital web-based tools for engaging learners and promoting inquiry-based STEM learning. Specifically, the authors aim to analyze a selection of technological supports in STEM education, including simulations and remote laboratories, within the context of supporting teaching and learning in physics. The following questions guide the analysis:

1. How might these web-based tools promote inquiry-based STEM learning, in terms of helping students develop domain knowledge and inquiry skills?
2. How should teachers and/or learners be supported in developing their use of digital technology to ensure it improves learning?
3. What kinds of modeling and scaffolding should educators provide to help learners engage in this process?
4. What promises and challenges do these technologies hold in terms of transforming education practice?