Addressing Digital Competencies, Curriculum Development, and Instructional Design in Science Teacher Education

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INTRODUCTION

New realities of the 21st century demand individuals with different competencies than those considered appropriate for success in the past. 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. 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.

With each passing year, technology becomes a more predominant part of educational culture (Bolstad & Gilbert, 2006; Cox, 2008). Simply introducing technological tools and infrastructure into schools will not trigger beneficial and meaningful educational change. Moreover, technology cannot be effective in the classroom without teachers who are knowledgeable about both the technology itself and its implementation to meet educational goals, that is, teachers who are technologically literate. Thus, it can be said that, while technology use in the classroom is increasing, improving learning through the application of these literacies should remain the goal. Changes are inevitable if technology is to make a difference in curriculum design and address the needs of 21st century learners. The impact of technology and the changing face of curriculum, as well as the accompanying changes in the roles of teachers can no longer be ignored; roles must be reconceived in order to engage learners in many decisions about their learning (Bennett, 2002; Bolstad, Gilbert, McDowall, Bull, Boyd, & Hipkins, 2012). Achieving changes associated with the integration of technology in the overall learning environment will require efficient teacher training in teacher education programs (Brush & Bannon, 1998). This begs the question: What kinds of modeling and scaffolding should educators or designers provide to help learners engage in this process?

Teacher professional development (PD) is absolutely essential if technology is to be used effectively; PD should entail initial preparation/training – pre-service, in-service, and ongoing pedagogical and technical support for teachers as they address their daily challenges and responsibilities. Training and on-going inquiry-based approaches imply that support should go beyond teaching skills in technology use and focus on the effective pedagogical use of the technology to support teaching and learning goals (DeCoito & Richardson, 2016).

In this article the author reports on a mixed-methods study with a focus on science teacher education. Specifically, the study addresses the development of secondary science teacher candidates' (TCs') digital competencies as they

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explored the integration of digital literacies in a science methods course, and its potential to enhance teaching and learning in science, including curriculum and instructional design. The author maintains that in order to develop the necessary skills and application practices of technology integration, and enhance technological literacy, TCs must be presented with appropriate experiences in teacher induction programs.

BACKGROUND

Teaching and Learning in the 21st Century

The preparation of young people for lifelong learning in a 21st century knowledge-based information society has become an increasingly important objective of educational systems worldwide (Dagienė, 2011). Multi-literate, creative and innovative individuals are seen as "drivers of the 21st century and the prerequisites to economic success, social progress and personal empowerment" (Canadians for 21st Century Learning and Innovation, 2012). A primary challenge for education is to transform student's learning processes to engage student interest in gaining 21st century skills and knowledge. Lemke (2004) reported a link between 21st century skills and academic achievement, making the case for incorporating teaching activities, including digital technologies that nurture these skills (see further elaborations, National Research Council, 2011). Despite the fact that these skills have been around for a very long time, currently the challenge is, according to Bolstad et al. (2012), "how to achieve a shift that creates a more coherent educational ecology that can support what is known about good learning *and* that can accommodate new knowledge about learning and, importantly, new *purposes* for learning in a changing world". As such, there is a need for students to experience opportunities that will result in enhancing 21st century learning skills.

The acquisition of 21st century skills in teaching and learning will require a shift in what we teach, how we teach it, the tools we use and how we educate, train, nurture, and retain our teachers. It is undeniable that we cannot change how our students learn unless our teachers are equipped to teach in new ways (Murnane & Levy, 2004). Thus, the scope and components of the research underlying this article were informed by the conceptual framework of a constructivist model of learning applied to teacher education – acknowledging that for TCs to develop their ability to teach, they must be provided opportunities to actively construct their understandings of pedagogical content knowledge (Chai, Koh, & Tsai, 2010; Graham, 2011) and integrate new understandings with prior knowledge (Hollingsworth, 1989; Shulman, 1986) under a technological, pedagogical, content knowledge (TPACK) framework (Mishra & Kohler, 2006). The constructivist view of education suggests that the theory of individual learning is flawed and furthermore, is not conducive to multi-literacy pedagogy in multimodal environments. The constructivist view is that students learn best, not by assimilating what they are told, but rather through a knowledge-construction process (Bereiter, 2002). In order for individuals to learn how to construct knowledge, it is necessary that the process be modeled and supported in the surrounding community; that is, a learning community. In a learning community the goal is advancing the collective knowledge while supporting the growth of individual knowledge (Scardamalia & Bereiter, 1994). The defining quality of a learning community is that there is a culture of learning, in which everyone is involved in a collective effort of understanding. This was in fact nourished, supported, and modeled throughout the science methods course as teachers engaged with digital literacies on various levels.

Digital Literacies

Education today is faced with the challenge of adapting to an environment where literacies are