Chapter 5
Integrating Computational Thinking and Mathematics: A Case Study on Four K–8 STEAM Programs in Ontario, Canada

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ABSTRACT

Globally, computational thinking and coding in schools has become more popular as well as a growing area of interest in education reform. Coupling coding with creative thinking promises to meaningfully engage students in their learning and to improve their coding and computational thinking skills. This prompts discussions about STEAM (Science, Technology, Engineering, Arts, and Mathematics), which promotes creativity and innovation through the integration of the arts in STEM subjects. This study addresses the following question: What mathematics and computational thinking do students learn through different models of STEAM education in non-profit and in-school contexts? A small sample was taken of four different STEAM programs in Ontario, Canada. We carried out a qualitative case study with 103 participants, 19 adults and 84 students. The findings from this study have implications for designing, implementing and researching K-8 STEAM programs that promote coding and computational thinking skills in the context of learning mathematics.

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INTRODUCTION

Globally, computational thinking and coding in schools has become an increasingly popular and growing area of interest for educational reform (Miller et al., 2014). Miller et al. (2014) maintain that blending coding with creative thinking helps to engage students and to improve their coding and computational thinking skills. This prompts discussions about STEAM (Science, Technology, Engineering, Arts, and Mathematics) education, which promotes creativity and innovation through the integration of the arts in STEM subjects in areas such as computational thinking and mathematics.

Countries like Canada see the benefits in STEAM education, recognizing that elements of creativity such as design are implemental to mathematicians, scientists and engineers (Hogan & Down, 2016). One of the main goals of STEAM education is to provide students with an authentic learning experience. According to Reeves et al. (2004), students should have authentic tasks that have a real-world context, complex or multistep questions, multiple ways to approach a problem and integrate across the disciplines (Amory, 2014). Shaffer and Resnick (1999) maintain that "authentic learning… [is] learning that is personally meaningful for the learner… [and] relates to the real-world outside of school" (p. 195). Educators have approached STEAM education in different ways depending on the resources available, developing STEAM schools, after school programs, clubs, out-of-school programs, non-profit organizations and/or community partnerships. This study investigates several models of STEAM education and how STEAM programs provide students with different learning experiences in mathematics and computational thinking.

This chapter reports research on the following question:

1. What mathematics and computational thinking do students learn through different models of STEAM education in non-profit and in-school contexts?

Several studies inform this research, including literature on STEM/STEAM education, studies on art integration, the transdisciplinary approach to STEAM, and STEAM education in Canada.

BACKGROUND

According to the Council of Canadian Academies (2015), "STEM skills are necessary… but they are not sufficient on their own… Other skills such as leadership, creativity, adaptability, and entrepreneurial ability may be required to maximize the impact of STEM skills" (p. xvii). Current research suggests that integrating arts with STEM subjects develops creativity, innovation, critical-thinking and problem-solving skills (Jeong & Kim, 2015; Land, 2013) which are essential to learning STEM subjects, particularly mathematics. Furthermore, the integration of the arts provides students with multiple representations, multiple ways to approach a problem, multiple ways to express themselves, and multiple entry points for engagement (Robinson, 2013). Multiplicity in learning opportunities, Robinson observes, has the potential to bridge achievement gaps among learners.