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A commentary on recent literature regarding science, technology, engineering and mathematics education in early childhood education and predicted impacts on the New Zealand context

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This article was inspired by the buzz surrounding science, technology, engineering and mathematics (STEM) education. The term STEM education stands for a holistic approach to teaching and learning about science, technology, engineering and mathematics. It is the intention of this article to explore the origins and application of STEM education, which has become a global trend within education. Drawing upon current literature and knowledge of early childhood education in New Zealand I discuss STEM education, the common themes within the literature and propose that this current global trend is not a new idea to Aotearoa/New Zealand early childhood education (ECE).

Hom (2014) describes STEM education as an inter-disciplinary approach to the traditional subject content areas of science, technology, engineering and mathematics. This integrated approach has interested educationalists at all levels internationally with many excited by the applications for children's learning as illustrated in recent articles on STEM education.

Origins of science, technology, engineering and mathematics education

Perhaps surprisingly, the acronym STEM originates in the United States (US) immigration policy and a recognised need by the US government for a higher population of workers with science, technology, engineering, and mathematic qualifications. President Barack Obama in a speech delivered in 2015 articulated, "Science is more than a school subject, or the periodic table, or the properties of waves. It is an approach to the world, a critical way to understand and explore and engage with the world, and then have capacity to change the world…" (as cited in United States Department of Education, n.d.). The emphasis within STEM education is the development of "21st century skills such as critical thinking, creativity, curiosity and collaboration of individuals" (Soylu, 2016, p. 38). Science, technology, engineering and mathematics education is fuelled by a need to ensure that the future workforce has the skills to seek solutions to problems that have not yet been considered. Investment in STEM education has been deemed critical to not only economic success of countries but also to social wellbeing, with the committee on STEM Education National Science and Technology Council [coSTEM] (2013) stating that "STEM education is critical for building a just and inclusive society" (p. vii). It has been noted internationally that women and minorities are under-represented within these fields (coSTEM, 2013) which correlates with Brown's (2016) assertion that women in New Zealand hold only 28% of roles within the STEM industries. McClure, Guernsey, Clements, Bales, Nichols, Kendall-Taylor and Levine (2017) propose that STEM education and the associated competencies should be part of the early learning of all children. These views are very much part of a discourse that has led to a global trend in seeking to enrich education across the STEM fields. Although the previous Minister for Education in New Zealand, Nikki Kaye has advocated for "more opportunities for exposure to STEM and digital technology at a younger age" (Ministry of Education [MoE], 2017b, para. 3) combined with the "high demand for innovative thinkers in New Zealand…" (Curren, 2016, para. 2) discourse and literature about STEM education and learning in early childhood education in New Zealand seems to be limited.

From the literature

CORE Education in their 2017 top ten trends listed STEM education at number eight. This demonstrates that the buzz around STEM is beginning to impact on education within the New Zealand context, yet much of the discourse around STEM in early childhood education is being driven internationally. The literature suggests that the trend toward STEM education is being motivated by the long held discourses that current methods of education will not provide children with the skills that they will need in the future, and that encouraging children to think creatively and across subject content areas will foster skills to productively contribute to society and the economy (McClure et al., 2017; Gartrell, 2016; Soylu, 2016). Katz (World Forum Foundation, 2011) asserted "the soundness of an idea is not related to the amount of people that subscribe to it". Just as many 'experts' push for the implementation of STEM education there are some who are hesitant that this latest trend may not be appropriate within "holistic early childhood education [and that] STEM might morph into a developmentally inappropriate academic pushdown of curriculum and teaching methods" (Gartrell, 2016, p. 52). However, the popular themes within the literature negate this argument. The themes that emerge from the literature on how STEM education can be implemented within an early childhood setting focus on aspects such as relevance to children's experiences, supporting children's natural curiosity, process before product, learning and teaching of inquiry based skills and the teacher's role.

Sociocultural theory and science, technology, engineering and mathematics education

Connections between sociocultural theory and STEM education can easily be drawn. The underpinning pedagogical practices of STEM education, essentially learning by doing in context with children's social and cultural context, blends well with the New Zealand Early Childhood Curriculum. *Te Whāriki: He Whāriki Mātauranga mō ngā Mokopuna o Aotearoa: Early Childhood Curriculum* (*Te Whāriki*) (MoE, 2017a) is underpinned by sociocultural theory where "learning leads development and occurs in relationships with people, places and things, mediated by participation in valued social and cultural activities" (p. 61). McClure et al. (2017) identify the essential nature of relationships and the environment in STEM education and how the quality of these relationships support the child's developing skills, knowledge and understanding. The sociocultural theory connection is highlighted in the literature that espouses the importance of hands on experiences that are contextualised within children's prior and current experiences. Soylu (2016) asserts that STEM education provides children with opportunities to "engage in real life issues and use questioning, problem solving, collaboration and hands on activities to figure out the solutions" (p. 39). Soylu's (2016) statements are supported by Smith (2016) and Linder, Emerson, Heffron, Shevlin and Vest (2016) who declare that STEM processes encourage co-operation, teamwork and collaboration. Science, technology, engineering and mathematics education that is based around a question that inspires investigation and that is relevant to children encourages children to work together, collaborate, share ideas, problem solve and hypothesis.

Supporting the development of critical thinking and inquiry based skills

The importance of process versus product has been a long held belief in early childhood within the New Zealand context. Allen (2016) agrees with this and declares that the learning process is just as important as content, although the content of each subject field (science, technology, engineering and mathematics) is different, "the essential concepts and dispositions of inquiry are similar" (Linder et al., 2016, p. 87). The inquiry learning that underpins practice within STEM education comes naturally to young children, young children are constantly questioning, hypothesising, creating and testing their ideas (Allen, 2016; Draper & Wood, 2017; Kinard & Meadows, 2017; Soylu, 2016), children are active, creative inquirers like scientists (Katz, 2010 as cited in Soylu, 2016). Allen (2016) asserts that "learning to do inquiry and think critically is more important than memorising concepts without any real understanding" (p. 58), supporting and encouraging children to ask, imagine, create, design, test and improve upon their ideas and hypothesis is the foundation of STEM learning. The focus on inquiry-based skills within STEM education comes from the

understanding that these skills are transferable across the subject content areas of science, technology, engineering and mathematics (McClure et al., 2017).

Teachers' role

The impact of the teacher's attitude to STEM subjects upon the children's learning outcomes was also emphasised within the literature. Much focus has been placed upon "STEM-phobic" (McClure et al., 2017, p. 21) teachers, and the impact of teachers own negative early experiences with these subject content areas (Allen, 2016; Soylu, 2016). Sharapan (2012) suggests "many early childhood educators feel uncomfortable and unprepared to address concepts in these science related fields" (p. 36). However, a focus on harnessing children's interest, encouraging and teaching inquiry-based processes where children are supported to develop capabilities to engage with the world (Museum of New Zealand Te Papa Tongarewa, 2016) may overcome these challenges. Within early childhood education in New Zealand, a holistic approach to integrating subject content knowledge within curriculum has been espoused for over 20 years. The recently revised *Te Whāriki* (MoE, 2017a) declares that kaiako (teachers) in New Zealand will possess the skills and abilities to integrate subject knowledge into the curriculum.

In conclusion, STEM education could be seamlessly implemented within early childhood settings in New Zealand in accord with the national early childhood curriculum with a continuing focus on children's interests.

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