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Editorial

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EDITORIAL

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Science, Technology, Engineering and Mathematics (STEM) education has been promoted by educators in recent years as a way to re-engage students in learning in the school subjects of science, technology and mathematics, and by governments as a necessity to enable learners to address socio-ecological and development issues in their futures. Its origins can be traced back to the 1950s as the world emerged from rapid scientific development and technological progress prompted by the Second World War, and a need to ramp up food production and a desire to explore space (Breiner et al., 2012). STEM came to prominence as an acronym twenty years ago, through its use by the United States National Science Foundation. It was greeted enthusiastically by educators as a positive initiative and derided by others as an empty slogan. Theorists and researchers have since sought to redefine what STEM is and how it can contribute to a young person's preparation for the contemporary world (Bybee, 2010; Vasquez, 2015).

In Aotearoa New Zealand, STEM education has been promoted as a means to equip young learners with the skills and competencies to flourish in a rapidly changing world (Te Kete Ipurangi, 2021). It provides the opportunity to approach learning in a different way, as a means to engage diverse learners, particularly those who might traditionally not achieve in the learning areas of science, technology, and mathematics (Buntting et al., 2016; Stewart, 2012). STEM approaches also provide opportunities for teacher professional learning, to counter assumptions that technology (for example) should be less valued because of its practical nature, or that it is only suited to less able and unmotivated students (Williams, 2012). Such an attitude may still be pervasive in some school communities, regardless of the nature of policy, curriculum and recommended pedagogy in the Aotearoa New Zealand context. This causes tension for technology teachers who have to navigate these barriers to teach the *official* curriculum (Ministry of Education, 2007; Reinsfield & Williams, 2015).

STEM education provides opportunities for students to engage in unique ways of thinking, practice and learning to explore multi-faceted content. This has potential for innovative and creative teaching, and to focus learning on students' everyday lives. STEM education offers a way to bring science, technology and mathematics together in curriculum implementation in Aotearoa New Zealand schools. It is integrated and interdisciplinary in nature, and emphasises learning in authentic and student-centred ways. Since the inception of STEM, arts educators have argued for inclusion, leading to the STEAM acronym. Such changes deserve consideration for educators, who need to mitigate the risk that the arts component is not merely seen as a servant to the STEM imperatives (Hurley et al., 2021).

There are potential challenges for teachers who are motivated to re-conceptualise their understanding of contemporary pedagogy and professional practice within their institutional constraints. For example, the prioritisation of some policies in Aotearoa New Zealand, such as preparing students for National Standards testing, saw a tendency for the narrowing of curriculum focus to literacy and numeracy in primary schools (Fox-Turnbull et al., 2021). Across sectors, some teachers lack recent experience and/or motivation in programme planning, curriculum implementation and the integration of some learning areas of the curriculum into their teaching and learning (Reinsfield & Fox-Turnbull, 2020). There is also the potential for some practitioners to think of STEM as a means to enact science or mathematics, meaning there are missed opportunities for collaborative, integrative learning that goes beyond the sum of the parts (Granshaw, 2016). For some teachers and schools, barriers can exist (e.g., expertise in technology education), which hinder potential for more practical approaches to learning that suit this type of interdisciplinary learning (Tytler et al., 2021).

In this Special Issue, we encouraged the inclu0sion of environment as an alternative to engineering in STEM, due in part to the lack of explicit focus on engineering, and the emphasis on environmental learning in *The New Zealand Curriculum*. We were keen for articles to provide useful insights into STEM education as relevant to the future practice of Aotearoa New Zealand educators. Key areas of

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focus emerged from the articles, including the importance of community engagement and partnerships, how integration can occur in diverse settings, and the engagement of learners in technology and engineering.

Community engagement and partnership through STEM education were important themes in the first two articles in this Special Issue. The potential of STEM education to be student-centred and authentic to students' lives is examined by Mildenhall and Cowie, who advocate for involving communities as a means to enhance STEM education. They focus on how engaging students with community issues can serve as a source of motivation, by getting access to community members for their knowledge, experience and support, and to explain how students can, in turn, contribute to their communities through undertaking STEM projects. The authors illustrate these ideas through examples drawn from their Australian and Aotearoa New Zealand contexts to communicate how computational thinking and scientific data use underpinned an exploration of the likelihood of bushfires in Western Australia. They signal how partnerships between scientists can be extended beyond the one-off visits, to facilitate students' learning about science and technology to teach community members about bee decline by using the board games they had made.

In his article, Pattison uses data from his Masters in Education dissertation to explore innovative opportunities for technology education learning resulting from an authentic school/industry partnership. Pattison's junior secondary school students worked with a technology company based in Auckland (VineLife Limited) to complete a design sprint and develop creative ways to scan trees for pathogens. Pattison explains the benefits of such approaches for students' learning but also acknowledges some challenges for teachers. He recommends the use of boundary brokers to take the pressure off teachers and serve to mediate the partnership process in professionally manageable and sustaining ways.

While engineering is not a learning area within *The New Zealand Curriculum*, it is included as part of the designing and developing material outcomes technological area. Learning in this context also draws heavily on mathematical and scientific knowledge. In their article, Swan, Cowie, and Paiti correctly identify the increasing need for diversity in engineering, which is a well-established goal of the profession, education, and the government. This article focuses on girls' engagement in engineering. Survey data of girls attending a university open day and interviews with practising female engineers were used to assist the understanding of the notion of 'possible selves' and to explain patterns in their responses. Both prospective and participant groups indicated that family, friends, teachers and societal messages informed and influenced their view of what engineering involved, as well as who could be an engineer. Practising female engineers also identified the impact of school subject choices, 'hands-on' and practical home experiences, and the nature of lecturer and peer support. The article contributes to discussions of when and how to encourage girls into engineering by offering evidence that a comprehensive approach to attract girls into engineering is needed that includes the community, schools, tertiary institutions, as well as the profession.

It is a natural assumption that to encourage girls into professions like engineering, they need to be exposed to learning which encourages them to consider it as a pathway. MacCallum, Rimmer, and Le Compte's article adopts a future-focused lens for STEM learning and advocates for authentic and real-world approaches to learning using project-based approaches. They illustrate how teachers' perceptions can influence the enactment of the recent changes to the technology curriculum, which expects teachers will support learners' engagement with digital technologies to move from consumption to creation, to develop artefacts that reflect understanding of a range of disciplines. They signal the necessarily-evolving nature of teachers' professional learning and describe how digital artefacts can be positioned to support learning in a Māori Performing Arts class by combining mixed reality and design thinking approaches.

The integrated nature of STEM education in schools was the focus of studies reported by Taylor and Lowe, and Hall, and Swanson. Taylor and Lowe draw upon future-focused inquiry approaches to explore the potential for STEAM learning in junior secondary classroom programmes in New Zealand and Japan. They acknowledge that whilst curriculum integration is well established in primary schools, there are some challenges when enacting such an approach in the secondary context. Practical suggestions are provided as a means to support such integration to increase students' engagement in their learning.

In her article, Hall explores how the STEM approach to learning motivates and engages her students. She explores STEM from the perspective of interdisciplinary integration, which is presented as being on a continuum between multidisciplinary and transdisciplinary approaches. Hall describes an interdisciplinary STEM unit of work she taught using the context of bushfires. This context was selected because of its relevance to her students at the time of teaching—the Nelson area in Aotearoa New Zealand had recently experienced a large bushfire. Students designed and developed an algorithm-based game, aimed to extend the players' understanding of the influences on, and impacts of, bushfires. Students learned and used scientific knowledge of weather and environmental factors of fire, mathematical knowledge to tabulate data and develop pre-algebraic sequencing skills, and technological knowledge through computational thinking to design and develop their algorithm. From there, they designed and developed their game using the software programme Scratch. Hall concludes that this approach motivated her students and increased their understanding of the relevance of science, technology, and mathematics to their lives in integrated ways.

Primary schools are often thought to be settings where integrated curriculum thrives, and Swanson was interested to know how science education was actually being integrated in these settings. Her study examined five primary schools in Auckland, drawing on interviews with senior management about how science is included in their curricula. A diversity of approaches was found, ranging from a 'science is everywhere' model that focuses on STEM projects, often connected to the community, to a more standalone subject taught by a specialist. Swanson argues that teaching of science in integrated STEM education appears to be fostered by recent professional learning for teachers, and the use of collaborative teaching approaches.

Collectively, this set of articles highlights that STEM education holds significant potential for innovative, integrated teaching and learning. The research and theorising reported in this Special Issue provide some guidance for teachers to engage in STEM and signal the possibilities for practice and research to further develop this field of educational endeavour.

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