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An introduction to the special issue: Technology on the edge

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During the COVID-complicated preparations for the 39th Pupils' Attitudes Towards Technology (PATT) conference there was always a vision to extend the research beyond the time and space of the event itself. As has been the tradition with past PATT conferences, a special journal issue expanding on and highlighting the cutting-edge research curated and critiqued through the process of peer evaluation within the field was proposed. What you are reading now is the realisation of that vision and the hard work of many researchers, authors, reviewers, and editors with a passion for advancing technology education within the framework of general education. Over the past three decades, PATT has become synonymous with the international research and teaching community invested in technology education. It has also become an important venue for nurturing and supporting emerging scholars in the discipline, and this issue is a part of that tradition. While the name of this curricular area may change within local contexts, the idea of learning through technological problem solving seems to be the tie that binds this eclectic discipline together. This idea was demonstrated in the wide variety of subjects and content covered during the PATT39 conference, held at Memorial University of Newfoundland, St. John's, Canada between June 21 and 24, 2022. The conference theme of "Designing a Better World through Technological Literacy for All" allowed for a wide variety of themes to be presented and discussed in the vein of technological problem solving, literacy, pre-service teacher education, design and skills, emerging technologies, curricular developments, and a host of other areas affecting technology education locally and internationally. What this issue does is give a much more detailed and refined cross-section of a select number of presentations from PATT39. It is our hope that these articles will inspire individuals to enter or continue the conversation about technology education and its importance to the betterment of society moving forward. This special issue presents 11 of the papers presented at the conference mentioned above. Below is a summary of each.

Marthinisen and Luckay emphasise the need for school learners in South Africa to be technologically literate by the end of their high school careers. The inclusion of technology as a subject within the South African education policy framework was considered an important innovation, an attempt at making the curriculum compatible to the skills needs of a globalised

economy. Given this context, the goal of teaching the subject technology would enable both learners and teachers to acquire skills, values, knowledge, and attitudes to become critical and creative thinkers. This article explores the teachers' adoption of ICT into the teaching of the school subject Technology in two South African high schools. The theoretical framework drawn on in this study is the RAT model, which helps in the understanding of individual learners' and teachers' personal experiences of teaching, and understanding technology's role in teaching, learning, and curricular practices. The study investigated the presence or absence of ICT adoption and utilisation in the teaching of Technology, as well as techniques that were applied within pedagogical practices.

Isaksson and Persson identify that in a technology-intensive world, computing and programmed technological solutions have gained worldwide importance in curriculum. Sweden, along with many countries, has integrated computer programming into the compulsory school curriculum as an integrated part of the teaching of Mathematics and Technology. The new curricula also place significant emphasis on digital skills and on enhancing awareness of how the digitalisation of society affects us. Knowledge of computational thinking (CT) facilitates learning and understanding of programming. Thus, it seems that CT, as seen in the Swedish context, should relate to both programming and digital competence. This article reports on research that examines the presence of CT in Swedish research literature and as a part of the discourse around the development of the Swedish curriculum. A content analysis of the curriculum and a thematic analysis of research publications show that CT is not well integrated into Sweden's educational system. However, CT related activities are found in several subjects and research about CT and programming is thriving. Designers of complex systems need to understand humans and technology are equally important. The article concludes that the Swedish technology curriculum is well situated to this task. The authors conclude by suggesting that Technology within the Swedish curriculum should be revised to include greater focus on creativity regarding CT and the construction of computational technological artefacts.

Also focused on the Swedish context, Sultan's article focuses on the education of pre-service technology teachers within a STEM environment. Teaching technology education within an interdisciplinary realm is complex, possibly leading to STEM education's struggle with identity. One criticism against STEM has been that it can lead to Technology and Engineering often being downplayed in favour of science. Sultan suggests that STEM subjects are primarily taught isolated from each other, but by integrating the STEM subjects, students' understanding and learning can benefit through opportunities to apply interdisciplinary knowledge in everyday life or design. Teaching technology through a broad perspective can create more inclusive learning for students. In this article the author states that teaching technology education in a STEM package in Sweden is challenging because it is an interdisciplinary subject that includes crafts, engineering science, and technology history, but technology and engineering have the most classroom time when unifying the STEM subjects. Integrating Art (A) with STEM- STEAM further emphasises the importance of design, creativity, and innovation. This article reports a descriptive study that explores integrated STEAM and the issues when teaching technology education in relation to STEAM.

Luyckx, Dierick, and Ardies's article "Empowering Teachers' Gender Sensitiveness" reports that few girls in secondary and higher education opt for technology courses. This is further reflected in the labour market. In order not to lose the potential women can bring to technology related careers, education must focus on gender sensitive teaching, more specifically when it comes to technological activities. However, this requires insight, specific skills, and sensitivity

to effectively empower girls in science and technology. Research in this area is often broad and abstract and not translated into concrete practice. In this study, the authors drew on previous research to develop the Gender Sensitive Education Checklist (GSEC) to evoke a sense of urgency for and to empower teachers in this quest. They also identified four main pillars regarding gender sensitivity in education, namely attitudes, representation, interaction, and pedagogical methods. The GSEC can be used as a practical tool, or as a reflection tool when designing and organising their activities. Teachers can also be reminded to make small adjustments to their lessons and the checklist provided meaningful support for teachers. When using the GSEC, teachers were able to use a gender sensitive approach in STEM and see it as very important, but also admit that they had missed opportunities in the past. The workshop motivated teachers to teach in a more gender sensitive way, by focusing on some of the offered practical tools and tips.

Janicki and Tenberge explore the increasing digitalisation of primary school students' living environment and the need for teacher training on digital media in classrooms. This needs to incorporate theoretical and educational policy to promote teachers' digital-related pedagogical and content knowledge (DPaCK). Studies have also revealed a positive correlation among student teachers, teaching activities, and students' learning outcomes, especially in-service teacher education courses with flexible adaptive support. Against the background of various research studies on professional development of teachers, a corresponding model of tripartite learning outcomes has been established and serves as a broad theoretical framework. However, the specific relationship between in-service teacher education with adaptive support, DPaCK, and developing understanding of computational thinking in German primary school students within the technology-related school subject "Sachunterricht" has not been sufficiently studied. Therefore, the study reported in this article focuses on the presentation of the theoretical background and empirical approaches used to explore the development of teachers' DPaCK and the effects this has on students' computational thinking in "Sachunterricht".

Lee, Kostyrykina, and Washbrooke report on their investigation into online addictions. They begin by exploring technology within The New Zealand Curriculum—technology, which are taught through two technological areas: computational thinking for digital technologies and designing and developing digital outcomes. The authors state that technology education encourages students to conduct research, consult with experts, and design digital products. Increasingly, Generation-Z students use digital resources for learning, collaboration, and research, rather than face-to-face, phone, or letter communications, which are considered anachronistic. There is evidence that this improves the educational experience for most learners, but evidence for the impact on students and teachers who suffer from online and digital addictions is sparse. To ensure safe online practices for children, many countries have developed security guidelines and policies. Most of these efforts are aimed at keeping children safe from predatory interactions, preventing inappropriate content from reaching children, and minimising security breaches such as viruses, phishing, or scams. The strategies vary, but commonly include reducing screen time, implementing web security processes, and providing guidelines for parents and teachers. Generally, this protection focuses on protecting the user from others but not on protecting learners and teachers from themselves—particularly from compulsive online behaviours. With the recent advent of COVID and increased exposure to working, teaching, and learning remotely, online and digital addiction issues have been

exacerbated. This article discusses some current trends and issues related to online and digital addictions and their implications for technology education students and educators.

Fox-Turnbull explores a teacher professional development model aimed at engaging teachers in deepening their understanding and pedagogical skills in teaching technology. The Mātanga (Māori term for expert) Project aimed to engage teachers with needs-based professional development with a particular focus on the teacher participants' perspectives of their developing understandings. This article also explores the subsequent impact on teachers' students because of their engagement with professional learning and development (PLD) in New Zealand. The PLD programme, funded by the Ministry of Education's Network of Expertise Initiative and delivered by Technology Education New Zealand (TENZ), was designed to foster teachers' engagement with the technology education curriculum. It also aimed to develop teachers' specialist identity by focusing on notions of technological and technical thinking, by matching teachers with mātanga. The project was designed to reposition teachers' agency, whilst being supported by their professional community. The developers of the PLD programme envisaged that once a community of mātanga and teachers were established, teachers would feel more connected to local, regional, and national support through digital networks in self-sustaining ways. The study's findings indicate that teacher professional development was significant. Participants developed a deeper understanding of the benefits of authentic technological practice and the technology curriculum. Some participants also obtained a deeper understanding of the nature of responsive pedagogies, and the role of reflection in professional practice. The programme motivated technology teachers, which translated into a more positive learning environment for their students. In addition, the researchers sought feedback on the Mātanga Professional Development Model, identifying several key benefits. Specialist participants gained an appreciation for the theoretical and historical perspectives of technology, while generalist participants valued their increased curriculum knowledge. Participants found the year-long approach beneficial, particularly because they had access to experts in their area of technology.

“Participatory Teacher-Child Interaction in Advancing Teaching Coding and Robotics in Pre-Primary Education” is the title of the article by Korkeaniemi, Lindfors, Tanhuanp, and Luukka. They begin by stating that teacher-child interaction (TCI) and children's participation has been propounded as a factor in enhancing children's learning in formal learning settings, especially in pre-primary education. Consequently, learning basic skills in coding and robotics at an early age is necessary for constructing a knowledge base applicable in later studies. In the study reported in this article, TCI and children's participation is seen advancing young learners' (children of 6 years old) understanding in technology education. The theoretical framework applied in this study was the participatory teacher-child interaction model, based on earlier research. The model consists of three domains: emotional support, classroom organisation, and participatory instructional support. These domains are further divided into specific dimensions. The focus of the study was to recognise which domains and dimensions of TCI are applicable when teaching coding and robotics. Secondly, the study focused on the characteristics of participatory teacher-child interaction when teaching coding and robotics. Research results indicate that within classroom organisation, the dimensions of dealing with disruption and clarity of the programme of action are emphasised the most by teachers. As a result, putting effort into classroom organisation decreases participatory TCI in teaching coding and robotics. On the contrary, the teachers who support participatory TCI place more emphasis on emotional support and participatory instructional support, and act as more competent in teaching coding and robotics.

Ardies' Delphi study on the future of technology education accessed an existing study of USA experts' opinions on the future of technology education. Several concerns were expressed by participants, such as a shortage of teachers and funding. The study reported in this article conducted a similar study in other countries with the aim of identifying the extent to which the initial outcomes were USA-specific or whether they were more broadly valid. Experts from Flanders (the Dutch-speaking part of Belgium) and the Netherlands participated in the three-round Delphi study reported in this article. It became clear that there were some similarities with the USA study but also differences. Most of those differences are explained by considering the local developments in the different countries.

El Fadil states that STEM education is becoming popular at the primary and high school levels in many curricula around the world. Effective instructional STEM activities and design methods are required to ensure that students and teachers' needs are being met. One potential method is the Technology Design Process (TDP): a methodology that stresses the importance of creativity and collaboration. This article reports on a case study that focused on the use of TDP to design and develop teaching and learning materials to introduce variables and functions in mathematical context at the elementary level. The five iterative stages of TDP (design, make, test, infer, and iterate) were integrated into the development of the course materials. The results of this study show that STEM activities have a beneficial effect on both students' classroom engagement and their ability to learn new mathematical concepts. Additionally, STEM activities play a crucial role in developing problem-solving skills in a transdisciplinary context. The author suggests the findings of this research could inspire elementary school teachers to integrate more STEM-based activities into their teaching and place a stronger emphasis on the design process to improve students' critical thinking and practical abilities. It could also help pre-service technology teachers include the design process in their technology teaching activities and instructors to include the design process steps highlighted in this study in their teaching, thus, to facilitate the development of students' engineering design skills and stimulate their curiosity in STEM subjects.

Lemon, Trinick, and Lee's article examines the challenges and opportunities in the indigenisation of the technology curriculum to support Māori-medium schooling in Aotearoa New Zealand (NZ). Since the emergence of indigenous curriculum design in the 1990s as a response to the emerging Māori-medium schooling movement, English-medium education and its philosophies, beliefs, and needs have prevailed. Eurocentric beliefs and ideologies are often opposed to the key goals of Māori-medium education, including the aim of self-determination through the revitalisation of Māori language and mātauranga Māori (Māori knowledge). Māori-medium schools (51–100% of instruction in Māori) are officially required to implement the core national curriculum and national framework for Māori-medium contexts, including hangarau (Technology). This article shares initial findings about the development of hangarau curriculum to date by drawing on primary data from a series of semi-structured interviews conducted with three mātanga hangarau (hangarau curriculum developers) who were involved designing curriculum, authoring curriculum support materials, and designing of professional learning resources for teachers. Authors suggest that beyond the Aotearoa NZ context, this study has wider implications for the decolonisation of technology education in general. This involves balancing and negotiating the tensions between indigenous and western, commercial, and environmental, and general and local indigenous knowledge. The authors state that as the sociocultural political landscape changes, and spaces for indigenous knowledges are being claimed, there is a need to remember what is important to communities. They suggest it is

necessary to work at the micro level, that of whānau (family) and hapū (wider family) daily practices, reclaiming and reframing place-based knowledge, then identifying its significance for the hangarau curriculum.

These summaries aptly illustrate the broad range of intellectual, social, and cultural subject matter that is inherent in the study and teaching of technology as a part of general education around the globe. From issues of increasing the inclusivity to pedagogical strategies for scaffolding the academic outcomes of students, the research and insights presented in this special issue should give readers the opportunity to not only gain current knowledge of this maturing field, but practical insight for bettering their own practice. Again, we would like to thank the contributing authors for their rigorous work, and we hope you enjoy reading this issue as much as we enjoyed bringing it together.