Design and Technology Education: An International Journal

29.2

Guest Editorial: 40th Pupils' Attitudes Towards Technology Conference (PATT40) Special Issue

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We are delighted to present a collection of 21 peer-reviewed articles in this Special Issue of the DATE journal from the 40th Pupils' Attitudes Towards Technology (PATT40) conference, hosted by Liverpool John Moores University between 31st October and 3rd November 2023. As guest editors, we also want to pay tribute to our colleagues on the conference committee and review panel as well as all of the delegates who made the conference a significant and relevant contribution to the international community of scholars in the field of Technology Education. Please take time to read the excellent contributions in the conference proceedings (Davies et al., 2023).

For those who are unfamiliar with the acronym, PATT is a conference series that originated in the Netherlands, named after a 1984 study to determine the attitude toward and concept of technology held by students aged 12-15 years. From then it has grown and flourished over four decades, and it is one of the longest standing research conference series. The conference has met every year but one; due to the 2020 COVID-19 pandemic. An academic institution hosts the conference in a different country each year, drawing together educators and scholars with an interest in design and technology education, in its broadest sense. Over the past six years PATT has been held in Athlone, Ireland (2018), Malta (2019), Rauma (2020, albeit online), Finland (2021), St John's, Newfoundland (2022), and Liverpool, England (2023) – having last been in the UK in 2011. This year PATT41 is being hosted in Nanjing, China, in October, then Montreal, Canada, in 2025, and Norrköping, Sweden, in 2026.

The PATT40 conference theme was *"Diverse Experiences of Design, Technology and Engineering Education for a Contemporary and Pluralist Society"*, which was chosen to help advance research on design and technology praxis that contributes to a quality experiences for children and young people on school systems and curricula around the world. Sub-themes were developed to capture the uniqueness, diversity and plurality of our subjects and the impact that they had on children and young people, and society. PATT is a longstanding conference series that is all about meeting and sharing as a community of past, present, and future researchers. We celebrate equality, diverse and inclusion, seeking to nurture early career research and foster a plurality of views and experiences.

We are proud of the fact that PATT40 was the largest PATT conference to date, in terms of numbers of attendees and presentations. Over the four days of the conference, we welcomed 138 delegates, with 78 papers and 13 academic posters being presented. Furthermore, it was a particular joy to welcome at least 16 practicing teachers (about 12% of the delegates), nine of whom were from schools in the UK. Delegates hailed from 19 different countries across five continents, bringing their insights to bear on local, national, and international problems and

opportunities. From as far west from Liverpool as the United States of America and Canada and as east as China, South Korea, Taiwan and Japan. From Norway and Sweden in the north to New Zealand and South Africa in the south. UK delegates only represented 29% of the attendees, so it was a truly international affair. What was particularly exciting was the number of teachers of D&T who attended, some of whom are undertaking postgraduate studies, some who presented research, and some who just wanted to hear the latest research being presented. We also had some of the most diverse research topics being presented, making it difficult to identify specific trends or themes, which indicates a thriving community of scholars stiving to explore and expand the knowledge base of our subjects.

Overview

To give a taste of what you will find in this Special Issue, we summarise each article below to entice you to read on and learn more about the latest research in the field. These articles have been developed and expanded from the approximately 3000-word original papers presented at PATT40 Liverpool in 2023. They have been double-blind peer-reviewed to ensure that they are rigorous and significant. However, as excellent as they are, to say that they are the best 21 offerings from the 91 presentations at the conference would do a great disservice to the esteemed colleagues who did not take up the invitation to turn their research into a 6000-8000-word article for this Special Issue. Some will have submitted to other excellent journals and others will have chosen to focus their efforts elsewhere. As guest editors, we salute PATT40 delegates, one and all! This issue is organised into four themes bringing together articles focusing on curriculum, design pedagogy, STEM pedagogy and technology enhanced learning.

Curriculum

This section has eight articles from five countries, exploring design and technology curricula in Germany, Japan, New Zealand, Sweden and the USA.

Martin Fislake and Jana Schumacher (University of Koblenz, Germany) report on the “Technikkiste” [Tech Box] project, launched in 2018, which aimed to promote STEM education in Rhineland-Palatinate primary schools by distributing metal construction kits. A 2023 evaluation revealed that only 70% of respondents were aware of the kits, and just 43% had used them in classrooms. Key barriers included insufficient kits, inadequate teacher training, and lack of time. Despite these challenges, teachers generally found the kits useful and expressed interest in receiving more. Recommendations for future projects include better communication, more training opportunities, and ensuring sufficient resources for effective implementation.

Ruth Lemon (Technology Education New Zealand) presents from her doctoral research at University of Auckland on the development and implementation of the Māori-medium Technology curriculum (Hangarau) in Aotearoa New Zealand. The study focuses on curriculum coherence and the integration of Indigenous knowledge in light of the challenges posed by Eurocentric influences and the need for alignment with Māori educational philosophies. The study draws on Ministry of Education archives and interviews with curriculum experts (mātanga). Key themes include the importance of language revitalisation, the integration of mātauranga Māori, and the need for localised curriculum development. The article recommends the need for greater governmental support, flexible curriculum design, and systematic research to enhance curriculum coherence and support Māori-medium education.

Deana Lucas, Greg Strimel and Vanessa Santana (Purdue University, USA) examine a polytechnic high school model that replaces traditional classes with industry-driven design projects, aimed at preparing minoritised urban youth for college and careers. This model emphasises integrated STEM learning through real-world problem-solving. From the surveys and focus groups with students, teachers, and alumni their analysis reveals that whilst this model enhances 21st Century skills and a sense of belonging, it faces challenges in traditional academic preparedness, particularly in mathematics. Their recommendations include balancing innovative learning with structured academic instruction and improving communication between high schools and universities to better support student transitions to higher education.

Jun Moriyama (Hyogo University of Teacher Education), alongside nine coauthors from across Japan, report on the development of a new framework for technology and engineering education by the Japan Society of Technology Education (JSTE) to promote STEAM education in the country. They surveyed 1,656 junior high students, finding positive attitudes towards technology classes and identified a lack of exploratory activities and problem-solving skills. The new framework emphasises a triple-loop model for engineering design, integrating physical and cyber technologies, and a STEAM learning model centred on engineering. The framework aims to enhance technological innovation and governance abilities. A survey of JSTE members showed general agreement with the framework, leading to its finalisation with some revisions.

Hisashi Nakahara (Oita University), Keita Sera (Nara University of Education), Tetsuya Uenosono (Hirosaki University), Atsuhiro Katsumoto (Hokkaido University of Education) and Jun Moriyama (Hyogo University of Teacher Education) examined Japanese junior high school students' perspectives on improving products and their user perceptions after materials processing technology lessons. A survey of 721 students revealed high engagement in practical tasks, with 91.7% enjoying making things. However, only 41.5% saw these experiences as beneficial for future careers. Students focused on safety (45.2%) and functionality (34.4%) in product improvements, often neglecting environmental and economic factors. Differences in user-oriented improvements suggest that descriptive reflection enhances safety awareness. The study highlights the need for curricula that link technological learning with career opportunities and incorporate societal and environmental considerations that connect with real opportunities of problem solving.

Per Norström, Susanne Engström and Birgit Fahrman (KTH Royal Institute of Technology, Sweden) write about how to ensure technology education remains relevant over time. They highlight the challenge of predicting future technological needs and the tendency of curricula to use vague descriptions to stay timeless. Interviews with Swedish teachers, teacher educators, and students revealed a focus on timeless skills like engineering design, problem-solving, and basic programming, rather than specific factual knowledge. The study emphasises the importance of fostering curiosity, critical thinking, and a positive attitude towards technology. It concludes that teachers play a crucial role in making technology education future-proof, despite limited guidance from curricula.

Maria Sundler, Ellinor Hultmark, Susanne Engström, Helena Lennholm and Annica Gullberg (KTH Royal Institute of Technology, Sweden), explore secondary school students' conversations about product life cycles and sustainable development. The article reveals that students discuss

all three dimensions of sustainability (social, ecological, economic) but focus on different life cycle phases for each dimension. Social aspects are linked to production, economic aspects to usage and transportation, and ecological aspects that span all phases. Students often view sustainability through anthropocentric and technocentric lenses, emphasising human-centred and technological solutions. The study offers practical solutions to enhance students' understanding of sustainability's complexities through the use of deliberative conversations that foster critical thinking and informed decision-making.

Alexina Thorén Williams, Maria Svensson and Dawn Sanders (University of Gothenburg, Sweden) use collage inquiry to understand primary teachers' perceptions and experiences of forests and urban areas in Sweden. The collage inquiry revealed teachers' emotional connections, perspectives, and curiosity about these environments, categorised into three themes: temporarily situated, place dependent, and emotionally connected. The method highlighted the importance of reflection and emotional engagement in teaching sustainability. The findings suggest that understanding teachers' relationships with natural and urban environments can enhance their ability to teach sustainability, bridging ecological and technological systems for a more integrated approach to education.

Design Pedagogy

This section has five articles from four countries, exploring design and technology curricula in Germany, the Netherlands, Sweden, the UK and the USA.

In their article, Anne-Marie Cederqvist and Per Högström (Halmstad University, Sweden) explore how to prepare student teachers to integrate sustainability into technology education. They highlight the need for deep technological knowledge, understanding the relationship between technology and sustainable development, and fostering critical thinking skills. Inner qualities like confidence, empathy, and creativity are essential, alongside pedagogical knowledge to teach these concepts effectively. The study emphasises a multifaceted approach, combining personal values, pedagogical competence, and transformative teaching practices to equip future teachers with the skills and attitudes necessary for promoting sustainability in technology education.

The article from Jeanna (Snjezana) de Haan-Topolscak, Merle Ebskamp and Pauline Vos-de Tombe (Technische Universiteit Delft, The Netherlands) describe how Dutch STEM secondary school students and teachers understand the concept of a 'model' in the Research and Design (R&D) curriculum. They reveal confusion among both groups, with varying definitions and interpretations of 'model'. The study is situated within a curriculum that emphasises real-life design problems and interdisciplinary learning and the findings highlight the diverse nature of R&D teachers, who often lack design knowledge. The study calls for a unified understanding of 'model' to ensure consistent and effective teaching. Their article suggests that collaborative learning and shared experiences among teachers could improve conceptual clarity and teaching practices in R&D education.

Dani Hamade, Jan Landherr and Peter Röben (Carl von Ossietzky University Oldenburg, Germany) discuss integration of a design-oriented approach to robotics education in Germany. The paper emphasises the importance of allowing students to design robots for self-set goals. Their study highlights the limitations of traditional methods that only use robots as tools for interactive learning. The authors use the paper to propose an innovative methodology that

encourages students to engage with the design elements of robots, enhancing their understanding of both theoretical concepts and practical applications. Initial examples from design-oriented robotics education events delivered through the authors University, show how this pedagogical approach can be used to encourage student technology teachers to develop their critical thinking skill and planning for innovative curriculum strategies in school.

Ellinor Hultmark, Susanne Engström and Annica Gullberg (KTH Royal Institute of Technology, Sweden) investigate teachers' scaffolding strategies in relation to students' verbal reasoning during the design process in Swedish secondary school technology education. Using sociocultural theory, they identify two reasoning types: means-end and cause-effect. Data from classroom observations and interviews reveal that teachers employ strategies of decreasing and increasing control, depending on the reasoning type. Decreased control involves questioning to encourage student thinking, while increased control uses instructive methods for specific guidance. The findings highlight the importance of teacher-student interactions in facilitating reasoning and learning in the design process.

Phil Jones, a teacher at Upton Hall School and doctoral student at Liverpool John Moores University in the United Kingdom, investigates integrating design thinking into the lower secondary school design and technology curriculum to foster 21st Century skills alongside subject-specific knowledge. Conducted with 12-13-year-old students in the North West of England, Phil highlights the importance of balancing knowledge and skills in education. The Design Thinking Integrated Learning (DTIL) model engages students in empathetic, creative, and analytical processes through real-world problem-solving. Findings suggest that this approach enhances creativity, collaboration, communication, and critical thinking, preparing students for complex future challenges. The study advocates for a curriculum that values both academic knowledge and practical, human-centred skills.

STEM Pedagogy

This section has five articles from four countries, exploring design and technology curricula in Canada, Germany, Sweden and the USA.

Brahim El Fadil and Ridha Najar (University of Quebec, Canada) explore the integration of STEM activities in education in their article, focusing on teaching variables and functions through practical applications like pendulum experiments. They highlight the importance of innovative pedagogical approaches, combining cognitive and social constructivism with technological tools such as virtual labs. The study demonstrates how STEM activities can enhance students' engagement, motivation, and understanding of abstract mathematical concepts. The findings suggest that hands-on activities and virtual labs foster critical thinking and problem-solving skills, underscoring the transformative potential of integrating STEM education with real-world applications.

Caroline Forsell (KTH Royal Institute of Technology) and Per Westerlind (Kunskapsgymnasiet – translation: Knowledge High School) explore students' understanding of mechanical stress and strain using a digital interactive lab setup. Conducted with 107 Swedish upper secondary school students, they revealed that the teacher's role was crucial for fostering learning. While digital aids were safer, they were also less impactful. Thematic analysis identified six groups based on students' knowledge before and after the virtual and teacher lead lab work. A significant difference in learning outcomes was linked to improved learning for the teacher and class. The

study concluded that while digital tools can aid learning, the teacher's influence remains paramount, especially in practical tasks involving complex concepts like mechanical stress and strain.

The study by Anna Perez (Linnaeus University), Maria Svensson (University of Gothenburg) and Jonas Hallström (Linköping University) investigates Swedish student teachers' perceptions of teaching programming in technology education for grades 4-6. Using a phenomenographic approach, they identify four categories of perceptions: following instructions in a logical order, learning a programming language, solving technological problems, and understanding and describing a technological environment. The findings highlight the need for student teachers to develop a deeper understanding of programming beyond basic instructions, emphasising problem-solving and the broader societal context. The study underscores the importance of integrating subject didactic knowledge with practical and conceptual understanding to effectively teach programming in technology education.

Franz Schröer, Claudia Tenberge, Nele Schemel, Malin Osnabrügge and Lea Schneider (Universität Paderborn, Germany) examine the integration of robotics into primary education to enhance teacher professionalization and inclusive technology education. It highlights the importance of combining theoretical knowledge with practical application in teacher training. Using learning robots like BlueBot™ and microcontrollers like Calliope mini™, the study demonstrates how these tools can foster computational thinking and problem-solving skills in students. The research underscores the need for a spiral curriculum that builds on students' prior knowledge and adapts to their learning needs. It also emphasizes the role of teachers in creating inclusive, engaging, and effective learning environments.

Marten Westerhof, Colm O'Kane and Gavin Duffy (Technological University Dublin) continue the flow of spatial literacy research coming out of Ireland in recent years. They describe using origami in an after-school makerspace to develop spatial literacy in primary school children. They argue that it is a crucial skill for STEM success, involving visualising, reasoning, and communicating about spatial relations. The article reports that the workshop allowed children to practice these skills creatively, with varied success - some struggling with diagrammatic instructions but engaging better with video tutorials. The study highlights the importance of spatial skills, knowledge, and self-beliefs. It calls for further research to define spatial literacy norms and develop pedagogical strategies to support children's spatial skills in maker education.

Technology Enhanced Learning

This section has three articles from three countries, exploring technology enhanced learning in design and technology, from Germany, Norway and Sweden.

Johan Lind (Malmö University, Sweden) explores how virtual reality (VR) images and verbal interactions support primary students' understanding of the nature and history of technology. Using VR in a classroom setting, students aged eight and nine demonstrated knowledge across all dimensions of technology, including its historical aspects. The findings suggest that VR images promote exploratory conversations and deeper comprehension of technological development. The study highlights the importance of teacher guidance and signalling in enhancing students' engagement and understanding. This approach can help teachers plan

effective technology education activities that integrate historical perspectives and interactive learning.

Tore Andre Ringvold, Ingri Strand, Peter Haakonsen and Kari Saasen Strand (Oslo Metropolitan University, Norway) explore how AI text-to-image generators can transform design education. Their article highlights the potential for AI to democratise idea visualisation, enabling those with limited artistic skills to create professional-quality images. The study emphasises the strengths of AI as a catalyse to stimulate creativity through the provision of visual aids that have the potential to generate diverse design ideas. However, the authors highlight some of the challenges associated with digital bias, ethics, and the risk of reducing traditional motor skills in learners. The article calls for educators to develop digital competencies and critical thinking skills to effectively embed AI into their teaching.

Tobias Wiemer and Marius Rothe (Carl von Ossietzky Universität Oldenburg, Germany) tackle the use of Augmented Reality (AR) in industry and technology education, highlighting its potential and challenges. They propose that in industry AR enhances production efficiency, safety, and training, and in education it can improve learning outcomes but faces barriers like high costs, lack of resources, and insufficient training materials. An exploratory study among teachers in Lower Saxony revealed that while AR is seen as beneficial, its implementation is hindered by these challenges. The article calls for targeted research and development to create cost-effective, user-friendly AR applications and comprehensive teacher training programs.

Summary

The 21 articles in this special issue draw together research and scholarship from ten countries and five continents, exploring issues that have intrigued the design and technology education community for decades, like how to teach design, to new technologies such as AR/VR and Gen-AI. The collection portrays a vibrant research culture around the world, grappling with thorny issues and changing social and technology circumstances.

As guest editors, we strongly encourage classroom teaches engaged in design and technology education to scan through the titles, abstracts, and key words, to find intriguing hints and titbits. Once you have found an article or two that interests you, jump to the conclusions to see whether your interest is warranted, before diving in and reading the full paper. There is enough in this Special interest to satisfy your curiosity, whether you lean more towards the STEM side of design and technology or towards the arts and design. Keep the subjects alive by engaging with contemporary research insights and sharing them with your colleagues. And you might even be tempted to contact one of the authors to engage with your own research. Farewell, and enjoy!

Reference

Davies, S, McLain, M., Hardy, A. & Morrison-Love, D. (Eds) (2023). *Proceedings of the 40th International Pupils' Attitudes Towards Technology Conference*, 31 October-3 November, Liverpool John Moores University, Liverpool, UK. https://doi.org/10.24377/PATT40.2023