Design and Technology Education – a lone discipline or a discipline that sees the value of collaboration?

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This issue of the Journal is rather special, in that, along with articles submitted in the normal way, it also includes a Special Issue of articles that have been prepared as part the BRACE project - a project that has formed a community of researchers, some of whom are practicing teachers and some of whom are university academics, all working together. So, following this editorial is a second Guest Editorial that provides background to the project and introduces the BRACE project articles. These are made up of a book review and the first four research articles in this issue.

In information about our journal displayed on the journal's website we state that the journal provides a "broad and inclusive platform for all aspects of Design and Technology Education, Design Education and Technology Education in primary, secondary and higher education sectors, initial teacher education (ITE) and continuing professional development (CPD)". Quite frequently articles are submitted that don't match these requirements, most commonly from authors submitting articles about educational technology with no connection to design and technology education. But sometimes articles are submitted that are on the cusp – a word that the dictionary tells us is "a point of transition" or "a pointed end where two curves meet". Making decisions about the suitability of such articles can be quite awkward – where do we draw the line, are we opening up floodgates, are we staying true to our mission? But while we champion the website statement, we also recognise that reality goes beyond disciplinary boundaries and that positive developments occur at points of transition and when two curves meet. Concepts such as "interdisciplinarity", "transdisciplinarity" and "postdisciplinarity" are increasingly breaking down barriers as people from different disciplines work together to address tricky challenges that can't be sorted by a lone discipline. So, back to the awkward decisions. Occasionally articles on the cusp arrive that are so interesting, that make a valuable contribution to design and technology education but that also are beyond the disciplinary boundary. In this issue we present several such articles, each of which we believe is important, interesting, and adds something special to this issue of the journal. We hope readers agree and would be pleased to receive any comments or future contributions on this topic.

Below are brief overviews of this issue's articles. We hope you find the overviews useful and enjoy reading the full articles.

We start with *The Place of Design Education in Achieving 4IR Sustainability through the 4Cs Skill-sets* by Peter Oluwagbenga Odewole, Tolulope Oladimeji Sobowale, and Festus

Osarumwense Uzzi, from Olabisi Onabanjo University, Nigeria who provide a highly detailed and valuable analysis of the challenges of addressing the United Nations' agenda for achieving the 17 Sustainable Development Goals, interlaced with the challenges of the Fourth Industrial Revolution. Within this they highlight the crucial contribution of what are commonly referred to as the 4C's - Communication, Creativity, Critical thinking and Collaboration – and the important role that design and design education have to play in conjunction with the 4C's in dealing with these challenges. The article provides an excellent scholarly review of research that highlights the importance and potential of design and design education as they address the future challenges faced. Each of these aspects focused is handled in a thorough and methodical way. Their scope is both wide and deep as they draw the main threads together and provides and extensive, rich collection of research and researchers, while making a strong case for design education. A valuable resource.

In *Preschool teachers' experiences of technological concepts in relation to everyday situations in the preschool*, Maria Svensson, Jonna Larsson, Ann-Marie von Otter, and Pia Williams from the University of Gothenburg, Sweden and Helena Sagar from the Municipality of Kungsbacka, Sweden conducted research with pre-school teachers to understand how they experience technological concepts in everyday situations. Starting with an outline of the importance of the teachers understanding technological concepts and the challenges they face in gaining this understanding, the authors report on research that was initiated by the preschool teachers approaching the researchers. Semi-structured interviews with twelve teachers involved a discussion prompted by photos that teachers considered to include technology in everyday situations. Analysis of the interviews allowed the researchers to build units from interview excerpts to compare and contrast. Four distinct categories emerged – exploring techniques, exploring techniques using artefacts, exploring artefacts as technology and developing constructions using artefacts. The researchers found that it was the last category where technological concepts were most developed. The categories and the examples given by the teachers provide valuable insight into pre-school teachers' understandings of technological concepts and, through this, approaches that can support teachers to understand how these concepts can be introduced through everyday activities.

In *Exploring Inclusive Design and Digital Humanities: Enabling Bilingual Digital Narratives for Deaf Children*, Cristina Portugal, Monica Moura, and Jose Carlos Magro Junior from São Paulo State University, Brazil and Marcio Guimarães, from Federal University of Maranhão, Brazil take an interdisciplinary approach in which design is seen as a cultural practice and is a central contributor to research that explores the potential of digital technologies in supporting the development of bilingual visual narratives where the bilingualism is between the language of Portuguese and Brazilian Sign Language LIBRAS. Taking inclusive design as an overarching approach, their research centres on creating bilingual digital stories in a digital book for deaf and hearing children. Research involved ten children aged between 5 and 7, five being deaf and five hearing, who interacted with digital books created by the authors. Close observation of the children focused on aspects such as engagement and interest, ease of use, comprehension of content and interaction with bilingual resources. It uncovered

insights into the value of the bilingual approach in relation to areas such as language development, contextualised learning and the use of visual stimuli. The research has led to important guidelines for integrating Portuguese and LIBRAS as well as guidelines for creating bilingual stories through visual narratives. This article is uplifting through the insights that can be gained not just because of the specifics of the impact of the bilingual digital stories but also through the recognition of the value of design within an interdisciplinary framework and, in this case, its impact on young children's learning. A glimpse of the digital stories is available through a hyperlink within the article.

In *Exploring Girls' Narratives in Competition-Based Educational Robotics*, Thomas Kennedy from Memorial University of Newfoundland, Canada focuses on the perceived sense of comfort of girls engaged in an educational robotics competition. The research involved five girls, aged 15-16, in the Marine Education Advanced Education (MATE) underwater remotely operated vehicle (ROV) program in Eastern Canada. The girls engaged in a competition at two levels: a school based intragroup competition and at a provincial intergroup competition. The author conducted a qualitative case study with three phases. First was a questionnaire designed to gather insights into the participants' preliminary perspectives and begin to build a profile. The second phase involved semi-structured interviews based on a 1-to-1 basis to allow the girls to speak independently and also included observation of the participants. The final phase provided an opportunity for the participants to review the data collected on them. The findings provides a fascinating insight into the girls' views on engaging in robotics and in the competitions. The research highlighted aspects such as the extent to which the girls valued their relationship with their peers and confirmed that this relationship fostered comfort, belonging and a connected social identity. They felt safe, could take risks, make mistakes. But views on continuing without the others in their team was rather different, raising issues such as levels of competence and knowledgeability in comparison to other teams and concerns about their performance and acceptance. Interestingly the participants commented on stereotypical 'geekishness' amongst other (typically male) competitors, but felt themselves to be different, although were concerned about being stereotyped. The article provides detailed insight into the lived experience of these girls that is both informative and fascinating.

In *A framework for analyzing technological knowledge in school design projects including models*, Björn Citrohn, from Linköping University, Sweden, analyses three common school design projects to explore the technological knowledge associated with the physical models that can be drawn from these projects. Based on a framework from a previous study, he documented (via video) and analysed three complete design projects undertaken by learners in Sweden's Grades 7, 8 and 9. The projects were ones commonly used in technology education in and beyond Sweden – designing a bridge, designing a mini greenhouse and designing a pedometer. His data allowed detailed insight into the learning that took place in each project, based on the previous framework's categories plus new ones that emerged - technical skills, technological scientific knowledge, socio-ethical technical understanding, engineering capabilities and technological research capabilities.

The research would be of considerable interest to teachers in reviewing the learning potential within particular design projects, particularly as the categories in the framework that emerged provide insights that go beyond a narrow skills focus. This research opens up opportunities to analyse and plan design projects that are rich with learning opportunities.

Heillyn Camacho and Lone Dirckinck-Holmfeld from Aalborg University, Denmark and Geoffrey Tabo from Gulu University, Uganda present a rather different article that takes a Design Based Research approach focusing on *How to support teachers in becoming teachers as designers of student-centred approaches*. They present a range of literature on approaches such as design thinking and design tools that have been used more generally in education but then take a more embedded design perspective, focusing on "What is design? What truly happens during the design process? How can we approach problems with a designer's way of thinking? How can we perceive learners through the lens of design?" Empirical work was conducted using a design based research approach in a Digital Learning Innovation project and a Student-Centred e-Learning Implementation Methodology in two East African universities. University educators from different disciplines engaged in a prototype Learning Designer Workshop. The workshop involved a series of design tools. Drawing from their findings they identify a set of design principles to support teachers becoming designers. The combination of the workshop tools (that can be downloaded from the article) and the design principles that are outcomes from their research, creates an impressive and valuable resource, providing insights into detailed and deeply considered approaches to support teachers that have potential to benefit the professional practices of those whose backgrounds are from outside of design as well as design and technology educators themselves.

In *Educating designers with 3D printers: a postphenomenological perspective on maker design pedagogy*, Nenad Pavel from Oslo Metropolitan University, Norway explores the potential of maker pedagogy that is often more informal and that creates "practical, self-driven and solution-oriented" learning. This can be of considerable benefit in Higher Education and provide both fresh insights and sustainable pedagogic practices. Through an action research project of three cycles with first year undergraduate design students, he presents the reality for both a tutor introducing an alternative studio approach and the students' reactions to engaging with it. Through the three cycles the pedagogy shifts between being very open to much tighter, in what feels like an exploration of contrasts and conflicts between approaches. The article provides invaluable insights both into maker pedagogy itself and the affordances and constraints of introducing it into a more formal, structured, curriculum-based environment. The level of honesty and openness of the story told is impressive and this honesty makes this article a key contribution to understandings that are needed in considering how design education and pedagogy can develop and adapt to support future needs.

In *Effects of Curriculum Intervention on Divergent Thinking Abilities* Gökçe Ketizmen, and Hakan Keleş from Eskisehir Osmangazi University, Turkey continue the focus on Higher

Education and to the development of divergent thinking abilities in first year architecture students. The authors highlight the importance of divergent thinking skills in architecture education and present research aimed at identifying whether a one semester first year studio programme can support the development of such skills. The research was undertaken with 40 students and focused on a course entitled Thinking in Architecture Design that involved four design studio projects and also the Wallach and Kogan tests on divergent thinking, employed at both the start and end of the semester. The course placed emphasis on developing visual and verbal divergent thinking skills. The article reports in detail on both the projects and the pre and post-tests. In summary, the author's overarching findings indicated that the curriculum intervention led to improvements in both visual and verbal divergent thinking skills, particularly in the context of originality. The study highlights the value of engaging students in studio based divergent thinking courses early in their higher education experiences.