Book Review

A review of P. John Williams & Belinda von Mengerson (Eds) Applications of Research in Technology Education: Helping teachers develop research-informed practice

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The book "Applications of Research in Technology Education" is a compilation of chapters drawn from recent PhDs in Technology Education written with the direct intention of providing insights from research conducted by technology educators from across a range of countries to support teachers in developing research-informed practice. It comprehensively explores the dynamic and evolving landscape of technology education.

Technology is pivotal in shaping societies, economies, and individual lives in today's rapidly changing world. Within these pages, readers will journey through the latest understanding of technology education, where researchers and educators explore cutting-edge strategies, best practices, and emerging trends. The book's chapters delve into the intricate interplay between theory and practice, showcasing how research findings can be translated into practical applications within classrooms, schools, and broader educational systems. By critically reviewing the diverse chapters contained in this compendium, our aim is to provide educators with valuable insights into the multifaceted landscape of technology education. This collection of chapters traverses a wide spectrum of perspectives and approaches to teaching in the field of technology education, thereby equipping educators with a comprehensive toolkit to enhance their pedagogical practices.

These chapters offer an array of educational resources that cater to both novices and seasoned practitioners in the realm of technology education. Whether you're embarking on the journey of teaching this subject for the first time or possess a wealth of experience, engaging with this book's articles promises to be a rewarding endeavour. Moreover, it fosters a continuous learning ethos, enabling educators to adapt to the evolving demands of the educational landscape and equip their students with the skills and knowledge necessary to excel in an increasingly technology-driven world.

In the first and last chapters, the editors provide their own overview and conclusions with respect to the chapters included. We have focused on the 15 research chapters in between. The textual composition under scrutiny is structured into three distinct segments, denominated as "Perceptions and Practices," "Skills in Designing," and "Curriculum and Pedagogy." Within the confines of these delineated sections, a compendium of scholarly investigations and analyses is presented, all devoted to the comprehensive examination of the overarching thematic precept of technology education. These thematic sections encompass a vast expanse

of subject matter, facilitating a profound and multifaceted exploration of the subject matter from an array of distinct vantage points.

Starting with Perceptions and Practices, the first of the studies is by Paul Mburu, Roehampton University UK. His chapter ***Leadership Perceptions in Design and Technology Education,*** presents an intriguing study that delves into the intricacies of leadership tools within a design and technology department, focusing on enhancing the subject's visibility among stakeholders. The investigation revolves around six incumbent subject leaders operating within various secondary school settings. Mburu employs diverse datasets to meticulously assess and juxtapose the efficacy of distinct leadership styles and tools. The study unravels a spectrum of perspectives concerning the utility of available leadership tools, shedding light on their varied deployment strategies.

Significantly, Mburu's research underscores the imperative of establishing a symbiotic link between classroom practices and team dynamics. This alignment is posited as a pivotal mechanism for augmenting overall team effectiveness, thereby positively influencing teaching, learning, and subject vision development. Notably, the chapter's findings transcend theoretical discourse; they hold practical relevance for individuals assuming subject leadership roles, both neophytes and seasoned practitioners. The chapter offers invaluable insights that are instrumental in cultivating a coherent and sustainable leadership style within the precincts of a design and technology department.

Mburu's work contributes substantively to the scholarship on educational leadership, providing a nuanced understanding of its dynamic interplay within a specialised pedagogical domain. Delving into the intricate nuances of leadership tools and strategies it enriches our comprehension of the multifaceted dimensions underpinning effective leadership in the realm of design and technology education.

Moving onto the next piece of work, Dawne Irving Bell of Edge Hill University UK looks at ***The formation of Science, Technology, Engineering, and Mathematics teacher identities: Pre-service teacher's perceptions*****.** Irving Bell's chapter has two major focuses. The first provides an account of the research undertaken for her PhD. As the title indicates, the research focuses on influences on the formation of teacher identities in pre-service STEM teachers. The account of her research is clear and straightforward and impressively accessible as she outlines the *what*, *how* and *why* of her study. Through her account of choice and use of research methods she provides clear guidance that de-mystifies research processes. Exploring the formation of teacher identities through semi-structured interviews with pre-service teachers she highlights how identities are influenced by those that taught them – both 'good' and 'bad' teachers. Collecting further data as pre-service teachers progressed through their courses, the focus shifts to the negative impact insufficient subject knowledge has on pedagogic approaches, often creating traits identified in 'bad' teaching experienced as pupils. My personal reflection took me back to my own school days, realising the lifelong impact of teachers who became my role models and just one 'bad' teacher who confirmed my intention as a 14 year old to become a teacher – to be better than her! The second focus is on negative impacts on pre-service teachers' professional identities, triggered when in situations where, for example, they had or perceived they had insufficient subject knowledge. Drawing from her research data she

provides suggestions for how experienced teachers can support others to develop strong professional identities.

Exploring Teachers' Perceptions and Strategies for Curriculum Practice in Technology Education by Elizabeth Reinsfield of University of Waikato, New Zealand, is the next area of research**.** Reinsfield's investigation delves into educators' perceptions of curriculum and its application for students. The research unveils compelling parallels between the theoretical foundations of curriculum and its practical implementation, akin to the persistent challenges witnessed with the English National Curriculum over the past decade. Notably, the study elucidates a prevalent inclination among educators to prioritise pragmatic outcomes in response to declining student engagement, thereby diverting focus away from the cultivation of specialised knowledge. Consequently, this shift in pedagogical emphasis transitions from immersive problem exploration and response, as embodied by the iterative design process, to a more knowledge-centric transmission approach.

Moreover, the research findings underscore a substantial enhancement in student engagement when learners actively shape the decision-making processes related to their educational journeys. This chapter accentuates the significance of ensuring that all stakeholders comprehensively understand the intricacies involved in curriculum planning. Reinsfield's work contributes to the discourse on effective curriculum development and its implications for educational engagement and outcomes by illuminating the challenges surrounding curriculum theory-practice alignment and the potential divergence towards knowledge transmission.

In the last chapter of "Perceptions and Practices" Andrew Doyle's piece focuses on ***Rhetoric to Reality: Understanding enacted practice in Technology Education*****.** Doyle, whose research took place while at KTH Royal Institute of Technology, Sweden, opens up the thorny challenge of unpacking the rhetoric of how Technology Education is perceived at an international level in contrast to the reality of what happens in the classroom at a local level – in the case of his research in the context of the Irish National Curriculum for Technology Education. Focusing on the enacted practice in classrooms in the space between beliefs about the broader nature of Technology Education and the professional knowledge base of an individual teacher he highlights the conflicts and conundrums that many technology teachers experience in considering what happens on a day to day basis. He highlights aspects that impact on this from National Curricula to assessment strategies, while maintaining his research focus on enacted practice including interviewing teachers reflecting on learning activities in their day to day teaching. Three overarching conceptions emerged: obtaining knowledge and skills for application such as woodworking skills to apply when making, gaining the ability to act in a technological way, for example learning a technological skill for future use and having the ability to think critically about various and new technologies. The research doesn't present answers but opens up space for reflection, possibly for a teacher to consider their own enacted practices, what lies behind them and how their reflection could impact on their future practice. The chapter is more philosophical than practical. It certainly provides food for thought.

Chapter 6 is the first within the "Skills in Designing" section where ***Enhancing Elementary Teacher Practice Through Technological/Engineering Design-Based Learning*** by Anita Deck, Concord University, USA, opens the next theme of the book. Deck's study investigates the

significance of purposeful and comprehensive Continuing Professional Development (CPD) for primary educators in teaching STEM subjects, particularly employing Design-Based Learning (DBL) through Technological/ Engineering (T/E) tasks across six elementary schools. The research is structured around three primary phases. Firstly, baseline understanding of T/E DBL's integration in elementary teaching is gauged. Subsequently, CPD sessions are provided to enhance participants' DBL knowledge for STEM instruction. Lastly, participants' feedback on CPD impact and classroom implementation is gathered. The study concludes that T/E DBL-oriented CPD positively enhances teachers' grasp of STEM topic delivery and alleviates pedagogical concerns. This reinforces the case for subject-specific, in-school CPD, particularly for primary educators with limited post-training CPD exposure. Additionally, Deck's findings suggest enhanced student comprehension through T/E DBL application, advocating for its broader curriculum integration. School CPD coordinators will find valuable insights in Deck's work to optimise CPD models for supporting holistic student understanding in various subjects.

Following on from Deck's work, Dave van Breukelen, from Fontys University of Applied Sciences for Teacher Education, the Netherlands, investigates ***Teaching Science Through Design Activities*****.** Breukelen explores Design-Based Learning (DBL) within an interdisciplinary setting – in his case science and design. He highlights the value of DBL for skills learning but its lack of success for conceptual learning through research to identify strategies within DBL that support the learning of both concepts and skills. Four studies were undertaken, the first two were exploratory using a Learning By Design (LBD) approach, the second two taking what was learned from the earlier studies to develop pedagogic strategies aimed at developing both skills and concepts. His findings enabled the creation of a model for interdisciplinary design that opens up, makes possible, provides guidance and suggestions for teachers to engage in interdisciplinary teaching. Clear pedagogic strategies, based on his research outcomes, are presented giving much for teachers to reflect on and engage with. Principles, practical processes and clear and detailed guidance are highlighted as an 'overall picture' not a mandatory approach. Recognising pitfalls and challenges, the model provides plenty of depth and quality to reveal the value and possibilities of interdisciplinary design based learning and teaching. His aim is to improve learning processes and expand DBL supporting a continuum of teacher development from being a restricted to extended professional. In his words "be open minded, investigate opportunities, embrace iteration, and collaborate with colleagues and experts". Tackling interdisciplinarity in education is brave. This chapter provides a rationale and route to bring disciplines together. It provides the impetus to take an open approach within technology education as well as strong support for integrated STEM or STEAM projects whilst tackling the sticky challenge of enhancing the learning of skills and concepts.

The research in Chapter 8, ***Human-centred design pedagogies to teach values in Technology Education***, by Neshane Harvey and Piet Ankiewicz, University of Johannesburg, South Africa, focuses on using co-design as a pedagogic strategy in university level fashion design. The research was undertaken with Year 1 fashion students and explored the pedagogic value of role play when students worked as pairs, one taking the role of the designer and the other taking the role of the user, collaborating as co-designers to enable a 'mindshift' away from the norm of the 'hero designer'. Data was collected from the students and also from observations of two design educators. The results indicated an impressive shift as the students quickly moved towards an equilibrium as the 'users' became key to inspirational ideas and the designers demonstrated a level of empathy as a symbiotic relationship developed. There was also impact

on the educators as they were forced to consider the value of more traditional design approaches. Although set in Higher Education fashion design education, the approach taken to the research and the findings that emerged could be relevant to younger age groups and also to design areas other than fashion. The role play of the students clearly helped them develop deeper understandings of the potential of users and designers collaborating – and as a pedagogic structure the potential for creating a more critical and empathetic approach to designing is very high. Teacher practitioners of any age group, and in any context of user-centred design could be inspired by the pedagogic approach. While thought would be needed to adopt it, at its heart it has a practical and simple idea of people working together and valuing each other's ideas and views.

In chapter 9, ***Using Engineering Design in Technology Education,*** Euisuk Sung, New York City College of Technology, USA and Todd R. Kelley, Purdue University, USA report on a study that investigates the utilisation of the engineering design process in technology-based education. The research seeks to elucidate the purpose and mechanisms underlying the adoption of this process, particularly in aiding students' resolution of technical problems. The researchers analysed videotaped lessons spanning five academic years in Midwest US elementary schools to address these inquiries. Despite a prevalent belief among technology educators in a linear approach to the design process, it is acknowledged to be inherently iterative due to multifaceted influencing factors. Employing Halfin's revised coding system from the 1970s, the study categorises design-related tasks for statistical analysis, encompassing defining problems, analysing, predicting, questioning, designing, managing, and modelling (DF, AN, PR, QH, DE, MA, MO).

The analysis of collected data reveals two distinct pathways in completing design work: Questioning - Designing - Modeling - Managing, and Questioning - Designing - Predicting - Managing. Time allocation to various stages highlights that designing receives predominant attention, constituting approximately half of the students' engagement time. Nevertheless, even substantial emphasis on design does not guarantee an optimal design strategy. Sung and Kelley emphasise that the engineering design process should be perceived as an iterative endeavour rather than a fixed sequence, facilitating extensive exploration of design challenges. This research underscores the need for educators to adopt a more iterative design process model, promoting learner creativity and innovation in response to complex challenges. It contributes to enhancing pedagogical practices in design-focused education.

In ***Assessment of Real-World Problem-Solving and Critical Thinking Skills in a Technology Education Classroom*****,** Susheela Shanta, Governor's STEM Academy at BCAT in Roanoke County Schools, USA, provides a slightly constrained account of her research. Once again the research is set in the context of STEM, Problem Based Learning , Design Based Learning and authentic contexts but the research itself is more narrowly focused. There are clear and valuable intentions behind the research which aims to assess learners' application of higher order thinking skills and science and maths concepts in an authentic context in a design-no-make challenge. The research also focuses on developing an assessment rubric that scores learners' responses to the challenge presented, which could form the basis of rubrics developed with similar assessment intentions. There are two main research findings. The first is that the use of design-no-make in the learners operating within a design based learning pedagogy was higher than those in a "traditional" classroom setting. This is good news for those of us who believe in

design based learning, but it is frustrating that we have no detail of the comparative set. Second is that learners applying science and maths concepts beyond the classroom and in an authentic, real-world context scored more highly than those in a “traditional” classroom setting. Again this is a positive outcome and adds to other research that explores the impact of contextually based performance. But, again, the comparative “traditional” setting has no descriptive context, just the lower scores achieved. In addition is a concern about the choice of the “real-world” problem, set in “a village in a third world country” that provides a somewhat worrying stereotype. This is surprising when, later in the chapter, more appropriate and helpful suggestions on creating authentic contexts are provided. The chapter is interesting but also tantalising because of the details not included. However, readers who want to know more could do so by accessing the full PhD.

Chapter 11 ***The Importance of Spatial Ability Within Technology Education*** provides insight into a further PhD undertaken at KTH, Sweden**,** by Jeffrey Buckley and Niall Seery, Technological University of the Shannon, Ireland, Donal Canty, Limerick University, Ireland and Lena Gumaelius, Mälardalens Högskola, Sweden, is the last piece within the “Skills in Designing” section of the book. The nature and importance of spatial ability is one not frequently researched specifically in the context of technology education. As the authors comment, spatial ability if often related to STEM but focused on maths, science and engineering. However, the research in this chapter highlights the potential of technology education pedagogically supporting the development of spatial ability and the extent to which technology education enables perspectives on spatial ability that focus on aspects beyond the need for disciplinary knowledge acquisition, placing emphasis on knowledge application. The dual concepts of *crystallised intelligence*, which links to acquired knowledge and *fluid intelligence*, such as that needed for novel problem solving provide insight into ways in which technology education has specific value in developing spatial ability. Fascinatingly, they also reveal that fluid intelligence is the dimension of intelligence that correlates most closely with general intelligence.

Four research studies on spatial ability were conducted, each presenting different perspectives on aspects of spatial ability and how these could influence improvements in learning and tech in in technology education. Practical approaches to developing spatial ability provide a range of pedagogical approaches, including the concept of “spatialising the curriculum” by employing within existing curricula spatial symbolic systems such as maps and graphs, making use of analogy, gesturing and further ways of visualising thinking. The chapter does delve into some complex concepts, but in parallel presents a positive, uplifting perspective showing ways in which technology education can be a key lead in developing this critical aspect of learning and reasons why technology education should not be marginalised within STEM.

Appropriate Use of ‘Assessment for Learning’ Practices to Enhance Teaching and Learning by Chandan Boodhoo, Mauritius Institute of Education, opens the final section of the book “Curriculum and Pedagogy”. Boodhoo’s research delves into a critical area of educational discourse: the implementation of formative assessment, also known as 'assessment for learning,' in the context of design and technology education. While extensive literature exists on formative assessment in education, its application in design and technology has received limited attention. Boodhoo's study explores how formative assessment techniques can be effectively employed to support student learning in this domain. The research primarily scrutinises the utilisation of 'assessment for learning' strategies within design and technology

and investigates the decision-making processes teachers employ in integrating these strategies into their instructional practices.

Utilising a mixed-methods approach, Boodhoo employs various research techniques, such as lesson observations and interviews, to gain insights into how three Mauritian teachers incorporate 'assessment for learning' in design and technology education. The study's outcomes, however, reveal a discouraging picture characterised by teachers' limited proficiency and motivation in implementing formative assessment in their classrooms. A notable deficiency was identified in the teachers' questioning techniques, marked by a preference for simplistic, closed-ended questions over inquiries that could uncover student misconceptions. Boodhoo observes that these teachers seemed 'ill-equipped' to appropriately time and structure questions to engage students and gauge their learning progress effectively.

Nevertheless, it is essential to note that these findings may not present a comprehensive reflection of formative assessment practices within design and technology education. The study's restricted sample size suggests that a broader investigation, encompassing diverse geographic contexts, might yield more favourable outcomes, revealing the effective deployment of formative assessment strategies in design and technology instruction.

Integrating Design and Technology with Entrepreneurship in Lesotho by Nthoesele Mohlomi, National Curriculum Development Centre, Lesotho is the next chapter within the final section of the book. This chapter provides insight into an ambitious and progressive Design and Technology (D&T) National Curriculum reform for primary and secondary education in Lesotho. The focus is developing a curriculum that integrates D&T education with Enterprise education. Interestingly, D&T is located in the Creativity and Entrepreneurship learning area in Lesotho. Also that the reform was phased in, starting in 2009 with Grade 3, and having the approach throughout all grades by 2020. As with many countries, D&T evolved from craft education. Emphasis within the reform includes problem solving within design activities, developing technical, manipulative and graphical skills and awareness of Lesotho heritage and culture. Entrepreneurship promotes nurturing passion and talent, enabling learners to be visionary, risk takers, team players, creative, innovative and passionate.

Research questions asked what is the nature and purpose of D&T, why integrate with Entrepreneurship and what are the teachers' roles in implementation. A qualitative process drawing on interviews, observations and written documents was used. Participants were selected from the 70 schools piloting the new approach. It emerged that teachers were positive about the vision for the reform but that implementing it was challenging. The Curriculum reform highlighted projects, themes and scenarios that explored real-life contexts and integrated D&T's focus on production environment and evaluation with entrepreneurships' focus on creativity, innovation and being socially and economically productive. The teachers' role shifted from conveying knowledge to nurturing the learners' skills, talents, attitudes and values. Achieving this shift presented challenges such as class sizes of 40 and more and a lack of training to support moving from disciplinary to transdisciplinary approaches. But teachers also gained insights into learners, like how exploratory and resourceful they can be, utilising local materials, selling artefacts produced in class and organising events. Based on findings the researchers identified key strategies to support teachers but highlighted systemic challenges such as ongoing emphasis on summative examinations as academic goals.

The chapter provides an important case study of curriculum change. Teachers, researchers and curriculum developers across the globe will recognise the ambitions and challenges of what is effectively on ongoing story that is fundamentally educationally uplifting.

Chapter 14, ***Teaching Technology in a Play-Based Preschool—Views and Challenges*** by Pernilla Sundqvist, Mälardalen University, Sweden, presents a study examining the delivery of technology education in Swedish preschools, involving both preschool teachers and childcare attendants to provide a comprehensive perspective on the preschool curriculum. Utilising questionnaires, group interviews, and observations, the research seeks to elucidate their viewpoints, the subject matter covered, and the characterisation of individuals involved. The study reveals that preschool teachers characterise technology education in six distinct ways, leading to various categorisations. This diversity poses a challenge, resulting in varied approaches to the subject, thereby introducing inconsistency in children's education. A contributing factor to these inconsistencies, as Sundqvist notes, is the Swedish language itself. In Swedish, the words 'Technology' and 'Technique' are represented by the same term, "Teknik." This linguistic overlap can lead to confusion, particularly in distinguishing technology from other subjects like science when delivering the technology curriculum.

To address this challenge and ensure uniformity in technology education, it is imperative that staff become mindful of these distinctions. Sundqvist offers a straightforward guideline: anything created by humans constitutes technology, while the study of natural phenomena falls under the purview of science. This research underscores issues that transcend national boundaries, highlighting the importance of schools comprehending the subject matter before imparting technology education. It emphasises the necessity of providing a clear and consistent understanding of technology to enhance children's comprehension of this critical field.

Applying a Culturally Responsive Pedagogy to Promote Indigenous Technology in Teaching Design Skills by Richard Maluleke, Nkone Maruping Primary School, South Africa and Mishack Gumbo, University of South Africa, is a fascinating piece. The study focuses on indigenous technology in lessons and offers valuable insights into promoting equity in technology education. It highlights how many Western-oriented curriculums tend to perpetuate a specific design process—design-make-evaluate. In contrast, indigenous communities often create artefacts through experiential design rather than adhering to a prescribed design sequence.

The research employs semi-structured interviews with various stakeholders and lesson observations to explore how indigenous pedagogies are integrated into South African school lessons. Their findings emphasise that acknowledging learners' diverse cultural backgrounds can heighten students' interest in the subject. The authors advocate for culturally relevant pedagogy (CRP), asserting that teachers' reflection on their students' cultural diversity can significantly enhance educational outcomes. Furthermore, CRP in technology lessons can introduce learners to alternative design approaches beyond Western conventions.

This study illuminates the Western-centric foundations of many school curriculums. It underscores the importance of teachers incorporating their students' cultural backgrounds into technology lessons. Decolonising the curriculum is a prevalent topic in contemporary education, and this study provides practical insights into how technology educators can approach this task. It demonstrates how Western ideals are deeply embedded in curriculum planning and advocates for the challenge of offering students a culturally enriched technology

curriculum. By recognising and incorporating indigenous and culturally diverse perspectives, teachers can better prepare students for a globalised world and promote a more inclusive and equitable learning environment.

The final chapter in the book is ***Implementing Digital Tablet Activities in Swedish Preschool Education***, by Anna Otterborn, Örebro University, Sweden and Konrad Schönborn Linköping University, Sweden. This chapter focuses on pre-school environments in Sweden, exploring teachers' use of digital tablets in technology education and of implementing programming in pre-school practice. In Sweden teachers are expected to use digital tools as part of their pedagogy including with small children. This is another uplifting chapter that provides a clear focus on the positivity of the early years teachers and the enthusiasm of their young learners. The research focused on three overarching questions: how teachers use digital tablets in pre-school educational practice, how they do this within technology education and how they implement programming in their practice. Research data was collected via an online survey that afforded both quantitative and qualitative data. Within the overarching questions they also explored links to STEM and the programs and apps that were used. The major uses of digital tables were within technology, science, language and mathematics, focusing on documentation and reflection, cooperation and values, critical thinking, thematic approaches and fact searching. It was clear from the research that teachers (and their learners) were enthusiastic and innovative, blending the use of digital technology within the heartlands of early years learning. The chapter includes a wealth of information in respect of this and includes a vignette that illustrates this beautifully describing a project where six year olds prepared for a city walk via a projected digital map that allowed them to identify the route, landmarks etc and following taking the walk, the activities that followed including painting a large, illustrated map on the classroom floor using pictures taken on their digital devices, making some of the buildings and programming a Blue-Bot to navigate the route. Findings also showed that, whilst innovative, brave and enthusiastic, teachers still need clearer guidance and support. The authors propose key areas for practical approaches and advice including promoting digital competence and work strategies; preventing a 'digital divide'; choosing suitable applications; focusing on purpose, interests, needs and goals; dedicating time and holding teacher workshops. The pedagogy illustrated in this chapter is of value for educators at all levels demonstrating foundations of learning and teaching that we can all learn from.

This assessment of Williams and von Mengersen's publication, delving into contemporary research within the domain of technology education, aspires to serve as a valuable resource for educators in their daily practice. One of the primary challenges faced by technology educators when engaging with research pertains to the small number of subject-specific studies that can effectively enrich their pedagogical approach. Nonetheless, the book unequivocally underscores the wealth of research available across a spectrum of diverse topics within this discipline. Whether you choose to peruse the entirety of the book or concentrate on select chapters, it is our earnest expectation that both this review and the book itself can offer substantive insights to enhance the instructional practices of educators, ultimately fostering optimal outcomes for our students.