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Book Review
Center of Excellence for Technology Education (CETE) Vol. 4: Future Prospects of Technology Education

Editors: Marc J. de Vries, Stefan Fletcher, Stefan Kruse, Peter Labudde, Martin Lang, Ingelore Mammes, Charles Max, Dieter Münk, Bill Nicholl, Johannes Strobel, Mark Winterbottom (2024). Published by Waxmann

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Future Prospects of Technology Education is the fourth and final volume of the Center of Excellence for Technology Education's (CETE) series on technology education from an international context. The first three volumes of the series focused on defining the discipline and its research methodologies, agendas, and impact. As the editors indicated, this final volume aimed to focus on the potential future pathways that may unfold within the context of technology education. As *de Vries* mentioned in the last chapter, trying to predict the future is no easy task and is fraught with speculation. There is a fair amount of worth in this volume in relation to some current and long-standing issues and trends within the discipline. While there are some glimpses and hints of what the future might hold after reading and reviewing the text, we would agree with *de Vries'* assessment of the difficulty associated with predicting the future.

The volume started with a single chapter under the digitization section. In *Gabriele Graube's* chapter entitled: **The nature of digitalisation and challenges for education systems and technology education** she explored the phases of industrial revolutions in relation to automation and digitization, focusing primarily on technological developments rather than their educational implications. She traced the progression from manual to mechanical labor, mass production enabled by electrical energy, and the rise of binary systems and computers. *Graube* highlighted the increasing complexity and autonomy of technical systems and their interactions with human users, culminating in the advent of Cyber-Physical Systems (CPS). These systems integrate networked, cloud-based interactions, responding to user input, past data, and contextual analysis - essentially describing modern Artificial Intelligence (AI) without explicitly naming it.

However, *Graube's* discussion of digitization's effects on education is limited. She briefly emphasized the need for adequate IT infrastructure, staff training, and digital learning media but did not explore these areas in depth. While she advocated for students to develop systems linking digital and physical realms, she overlooked existing technology education curricula that already incorporated CPS, input-processing-output (IPO), and monitoring, control, and regulation concepts.

Despite these shortcomings, *Graube's* chapter provided a thorough overview of digital systems development, making it a useful resource for understanding the sociotechnical landscape. It holds value for policymakers, who often lack technical expertise and may fail to consider the complexities *Graube* outlined when designing educational policies related to digitization.

The next section of the book contained two chapters and focused on methodology and design technology. *Stefan Fletcher's* chapter entitled: **3D printing in design engineering education** provided a comprehensive introduction to 3D printing, covering its types, applications, and significance in education. He explained why Fused Deposition Modeling (FDM) has become the preferred method for schools, citing its affordability, ease of use, safety, small space requirement, and lack of ventilation needs. These qualities make FDM printers ideal for design-focused courses in schools.

The chapter emphasized the design process as a cornerstone of engineering and problem-solving education, noting its consistent basic steps despite varying terminologies. *Fletcher* described design as a creative process based on knowledge and experience, aimed at optimal solutions. He highlighted how 3D printing bridges the gap between theoretical ideas and practical application, enabling students - especially those with physical limitations - to create and test prototypes. *Fletcher* cautioned against the uncritical adoption of 3D printing in classrooms, stressing the importance of thoughtful implementation. Teachers must stay informed about technological advancements to equip students with relevant skills and ensure that new tools are intentionally integrated without detracting from other educational priorities. Additionally, *Fletcher* underscored the motivational potential of 3D printing, as it transforms theoretical designs into tangible objects. This hands-on approach enhances learning for students who struggle with abstract concepts and fosters engagement by broadening manufacturing possibilities.

Concluding with practical guidance on integrating 3D printing into the design process, *Fletcher's* chapter serves as an invaluable resource for educators considering its use, offering insights into its benefits, challenges, and educational potential.

Phoebe Perlwitz and *Jennifer Stemmann's* chapter entitled **Serious games in technical education** explored the role of play and 'serious' games in technology education. They began by emphasizing the importance of curiosity-driven discovery and play in learning, citing extensive academic support. While play is often viewed as having no purpose beyond itself, the authors argued that its inherent engagement aligns with educational goals, particularly in technical education. Examples like robotics competitions demonstrate how planning, teamwork, and hands-on challenges can make learning more engaging.

Serious games, defined as games prioritizing education over entertainment, strike a balance by remaining enjoyable while ensuring students receive clear educational value. These games foster self-efficacy, or a student's belief in their ability to succeed, which the authors linked to greater achievement in technology education. They highlighted the gender gap in the field, attributing it to societal biases and limited early exposure for girls. Serious games, by building self-efficacy, can help mitigate these disparities and encourage wider participation. The chapter also argued for the value of serious games in teaching complex, intangible concepts that are increasingly prevalent in a digitized world. *Perlwitz and Stemmann* provided examples of games suitable for various grade levels, complete with QR codes for easy access to their readers.

Concluding with a case study, the authors addressed challenges in gamification, such as teacher skepticism and the difficulty of conducting further research. They presented robust arguments supported by research, making their chapter a persuasive resource for educators interested in integrating serious games into their curriculum.

Moving forward, the next section of the book focused on gender issues and contained one chapter by *Veronika Becker, Gabriele Graube and Ingelore Mammes* entitled: **On the connection between socialisation, stereotypes and gender**. In their chapter on socialization, gender, and stereotypes, *Becker, Graube,* and *Mammes* examined why women and girls remain underrepresented in STEM fields despite decades of efforts to close the gap. They argued that these efforts may have overlooked key influencing factors in school and career choices. Their analysis highlighted that while females often possess equal or superior technical skills compared to males, as shown in studies like the International Computer and Information Literacy Study (ICIL), socialization and internalized stereotypes often prevent them from recognizing or acting on this competence.

The authors adopted a socialization-theoretical lens, exploring how school and occupational gender stereotypes shape individuals' self-image, influenced by parents, teachers, and peers from early childhood. They argued that guiding children based on individual aptitudes rather than gender is crucial to breaking these stereotypes, though they acknowledged the difficulty of overcoming deeply ingrained societal norms.

While the chapter presented a compelling case for focusing on socialization, it has limitations. The authors overlooked the potential role of biological influences in gendered behavior, a topic gaining renewed interest. Acknowledging such factors could have added nuance to their argument without endorsing biological determinism. Additionally, untranslated German figures limit the accessibility of their data to a broader audience. Despite these issues, the chapter provided valuable insights into how stereotypes influence STEM participation and calls for a more individualized approach to education and career guidance, offering practical strategies for educators and parents to combat gender bias effectively.

The next section investigated the role of diversity in STEM teachers' perceptions with *Hao He, Johannes Strobel and Alexander F. Koch's* chapter entitled: **"Troublemakers"**. In their chapter, *He, Strobel,* and *Koch* redefined "troublemakers" as students who embrace free thinking and seek unique self-development, emphasizing their importance in technology education for driving innovation and problem-solving. The chapter aimed to explore teachers' perceptions of troublemakers as a basis for future research while addressing stereotypes linked to ethnicity and gender.

The authors reviewed literature on student misbehavior, attributing its causes to various factors while questioning the validity of many claims. They highlighted the pivotal role of teachers' perceptions and responses, noting that supportive teachers foster student motivation, while reliance on extrinsic incentives can stifle engagement. They also observed that repeated exposure to problematic behavior can erode optimism among teachers, potentially driving them out of the profession. Their study, though limited by a small, homogenous sample, revealed intriguing findings. For instance, seasoned teachers tend to perceive more behaviors as problematic over time, possibly due to shifting societal norms or accumulated negative experiences. This shift may create feedback loops where students feel

more stress, exacerbating troublemaking behavior and reinforcing teachers' negative perceptions.

The chapter critiqued the assumption that good students are inherently self-motivated, a belief that absolves teachers of responsibility for guiding less-driven students. Instead, the authors advocated adopting educational frameworks to better engage and guide all students, emphasizing professional development as essential for effective teaching. While acknowledging their study's limitations, the authors successfully argued for further research into the role of troublemakers, offering valuable insights into how perceptions and approaches to behavior can shape classroom dynamics and student outcomes

The next section dealt with language as *Julia Pötzl, Verena Rasp* and *Alfred Riedl's* chapter entitled: **Learning opportunities to promote language skills for industrial-technical occupations** examined the critical role of language acquisition in vocational education, particularly for students transitioning into the workforce in Germany. They argued that success in industrial technical classes and subsequent career readiness depends on mastering multiple layers of language: everyday communication, academic discourse, technical jargon, and professional language. The authors stressed that these linguistic competencies are especially challenging for language learners, as technical and professional terms often differ greatly from their everyday counterparts. The chapter highlighted specific hurdles faced by language learners, such as words with multiple definitions (e.g., "field" being a place to play soccer or an area of magnetic influence). This chapter again incorporated untranslated figures further restricting the effect of their arguments to a German context. The authors focused on German-language issues, but their insights underscored the universal need for tailored language support in vocational education.

One key critique is the reliance of Germany's dual training system ("Duales Ausbildungssystem") on schools for language development, with less emphasis on workplace training programs. The authors suggested that integrating language instruction into workplace training would not only support non-native speakers but also help all students master technical jargon essential for their careers. They offered strategies for workplace partners to better support apprentices with language needs.

The authors argued for prioritizing language proficiency to equip all students for the evolving workforce as automation continues to reduce low-skill jobs. They concluded by emphasizing the importance of collaborative efforts between schools and workplaces to ensure equitable opportunities and effective preparation for career success. This chapter provided valuable insights for improving vocational education systems, particularly in linguistically diverse settings.

The next section on curriculum development was the largest of the book, with four chapters dedicated to the topic. *Ibrahim Delen, Kadir Demir, Dury Bayram, Elise Quant* and *Ruurd Taconis's* chapter entitled: **Using technology to support design-based pedagogy in teacher education** examined how technology can support design-based pedagogy in teacher education, addressing the ongoing tension between information and communication technologies (ICT) or educational technologies and technology/design education. The authors explored this issue by reviewing literature on ICT in education and design-based pedagogy, with a focus on pre-service teacher education. They highlighted the misinterpretation of the role of technology in

education, particularly the conflation of educational technology and design-based pedagogy. The main interest driving their inquiry was how technology can support design-based processes in teacher education.

The authors used case studies from Eindhoven and Dokuz Eylul Universities to illustrate how ICT is applied in teacher preparation programs that incorporate design-based pedagogies. While the case studies were informative, the literature review that preceded them lacked methodological rigor and failed to clearly distinguish between ICT and design education. The Eindhoven case study, focusing on a curriculum design course, did not align with typical design-based pedagogy. However, the second Eindhoven case, involving AI-based video game design, more closely reflected design-based curriculum. The case studies from Dokuz Eylul University focused on courses in computer networks and computer-aided modeling and were not explicitly focused on design-based pedagogy.

Despite methodological issues with the literature review, the chapter concluded that further research is needed to understand how ICTs can enhance design-based pedagogy. However, the conflating of ICT/educational technologies with design-based technology education throughout the chapter makes the call for clearer distinctions between educational technologies and design education ironic. What this chapter did, by way of being a recursive example, is highlighted the importance of nuanced discussions to improve the integration of technology in technology education teacher training.

Esther Booth, Ingelore Mammes and *Dieter Münk* chapter entitled: **Career choices of women and men in STEM** analyzed gender preferences in STEM subjects and careers, comparing data from 1998 and 2018 to evaluate progress in gender equality. Unfortunately, this chapter covered much of the same ground as *Becker, Graube,* and *Mammes'* previous chapter on stereotypes and gender. This points to the ambiguous nature of the book's organizational structure. Regardless, they continued to focus on the underrepresentation of women in STEM fields, stating that females occupy about one-third of all positions in school and work globally, including in Germany. Their main research question asked whether emancipatory and political efforts have increased female participation in STEM, to which they concluded that the answer is largely "no." While some areas, such as chemistry and math, saw gains in female participation (e.g., rising to 49%), these were outliers.

The authors pointed to cultural stereotypes and societal perceptions of gender roles in occupations as key barriers to greater gender parity in STEM. They noted that in vocational training and non-university education, fields typically dominated by women have seen increased participation, suggesting that university-level initiatives may be more successful than those in vocational education.

Booth, Mammes, and *Münk* proposed early intervention at the primary school level to break down gendered occupation stereotypes, citing research that shows children as young as four internalize gender roles. They argued that changing these historical social structures is crucial not only for improving female participation in STEM but also for creating broader gender equality in the workforce, including encouraging men to enter traditionally feminine fields.

Martin Lang and *Wulf Bödeker's* chapter entitled **Education for sustainable development as a guiding principle of modern technology teaching** emphasized the urgency of Education for

Sustainable Development (ESD), connecting its principles to the United Nations' Sustainable Development Goals for 2030. They argued that achieving stable societies requires balancing ecological, economic, and social development, and ESD is key to advancing this balance. The authors stressed the integration of these goals into curricula, particularly in technology education, where they advocated for incorporating the "human-social dimension of technology." According to *Lang* and *Bödeker*, technology education should adopt Klaus Tuchel's 1967 model, which considers human needs, satisfaction, production, use, and evaluation in the context of technology, emphasizing that technology development is inherently tied to economic and social impacts.

The authors advocated for a design-oriented approach to teaching technology that incorporates ESD throughout, highlighting the importance of factual, human-social, and value-based perspectives in the design process. They concluded with recommendations for teacher training, suggesting it should mirror the principles of ESD by being an open learning environment where educators develop their own practices. Teacher training should be grounded in subject-specific knowledge while promoting cooperative learning and sustainable practices. *Lang* and *Bödeker's* chapter underscored the critical role of technology education in fostering sustainability, advocating for pedagogical approaches that emphasize long-term societal impacts and sustainable development.

The section on curriculum development ends with *Charles Max*'s chapter entitled: **Investigating learning and teaching practices in Elementary Science and Technology education.** In this chapter *Max* set the goal of developing "a conceptual framework based on a thoughtful orchestration of dynamic, interactive and context-sensitive approaches to conceive, enact and reflect on instructional practices in Elementary Science and Technology." *Max* wasted no time before diving into the positive aspects of using activity to foster growth in technology education. However, he was likewise quick to point out issues that may arise when student led activity is the main approach. Things such as interactions between groups or a single member being more knowledgeable can lead to obstacles in the learning process.

Max further developed the chapter by highlighting the importance of cultural entanglement in human reactions, both with handling and using technology, and in technology education itself. He referred to Cultural-Historical Activity Theory (CHAT), as developed by Vygotsky to help support the argument. This chapter paired well with the previous chapter on sustainable development as it reiterates the importance of social connectivity in the fundamental building blocks of technology education. Interactions with others and our environment will both give deeper meaning to aspects learned by the student.

The chapter concluded with *Max* fleshing out methods of implementing this action-based learning model in the technology education classroom. He gave the reader ample support and information for strengthening weaknesses in the approach and leveraging its strengths to ensure both teachers and students can get the most out of the model. In all, Max's chapter sets out a strong theoretical framework for how technology education could be implemented in the classroom.

The final section and chapter in the volume are entitled: **International communication in technology education – developments.** Author *Marc J. de Vries* summarized the importance of international collaboration within the technology education community to bolster support and

evidence for continued inclusion and elevation of the subject in compulsory education. The author focused on three main avenues of international communication and collaboration - conferences, journals, and networks. For anyone familiar with the technology education research community this is a nice summary of the most well-known avenues such as PATT, the International Journal of Technology and Design Education, and the Centre of Excellence for Technology Education - the network responsible for the book under review. *de Vries* highlighted the influence that international connections have had on strengthening technology education as a curricular area and reiterated the importance of personal connections making concrete differences worldwide. For anyone new to the area of technology education research, the chapter is also an invaluable starting point for understanding the resources and networks that exist within this space. The capstone chapter gave a good sense that we are not alone in our endeavours, and that was a really nice way to end the book.

As we have analyzed and discussed, *Future Prospects of Technology Education* does have some valid and interesting takes on technology education, but it does fall short of its stated aim of speculating on future paths forward. Whether it was the discussion of automation and computerization or the gender gap in technical school and work or the role of sustainability within the curriculum, these issues are all long standing themes within the technology education community. While a reader could assume that the topics covered in this volume will continue into the future, there was no concerted effort to forecast potential areas that might open new possibilities for the discipline - such as the return to space travel and interplanetary exploration or the cybernetic links between computers and humans that are just starting to turn science fiction into reality.

The organization and structure of the book are also weak as there is no thread or theme that winds its way through the entire book, even though the title and preface would suggest otherwise. Rather, the book really is a collection of disconnected chapters that struggle to meet the stated aim of the volume. While there is an attempt to group similar chapters together there is no balance as some sections only contain a single chapter and others carry much of the text. Overall, there are issues with grammar and a lack of English translations for multiple figures. While the editors do reflect on the German context of much of the book's content, if this is meant for an international audience more care should have been taken during the final copy edits. These structural issues should be seriously considered by anyone that would like to use this within pre-service teacher or graduate programs.

Overall, the book really feels like an intellectual "scrap quilt" that was advertised as something much more. That being said, "scrap quilts" do have their charm and this volume could be useful in a selective and purposeful manner.