Design Thinking in TVET: Perspectives, Opportunities and Challenges

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Abstract
Design thinking, a human-centred problem-solving approach emphasising empathy, collaboration, and iterative prototyping, has gained considerable attention in various domains, including education. The article discusses Design Thinking as a process and mindset for collaboratively finding solutions to wicked problems in a variety of educational settings. Through a systematic literature review, the article collates case studies, reports, theoretical reflections and other academic work to deepen our understanding of the purpose, context, benefits, limitations, affordances, constraints, effects and outcomes of Design Thinking in education. Specifically, this paper explores three questions: (1) What are the characteristics of Design Thinking that make it particularly effective in education? (2) How can Design Thinking be applied in different TVET contexts? (3) What tools, techniques and methods characterise Design Thinking? The purpose of this article is to describe the current knowledge base to better understand the role of Design Thinking in TVET, to enhance the exchange of research and discussion of best practice approaches, and to map out near-term pathways for research and practice.
Keywords: Design Thinking, TVET, 21st SKILLS, Problem-solving, Creativity

Introduction
Technical and Vocational Education and Training (TVET) has long been recognised as an essential component of the education sector, providing students with the practical skills and knowledge necessary to enter the labour market. In an evolving and dynamic world, it has become increasingly evident that TVET programmes must constantly adapt and remain relevant. Design thinking (DT), an approach to problem-solving rooted in empathy, creativity and innovation Thienen et al (2017), is becoming a transformative approach in education. This paper provides an insight into the concept and application of DT in education and explores its potential to revolutionise vocational education and training.

In the context of Industry 4.0, teachers should consider applying DT in TVET to develop people with Industry 4.0 skills. If we "Google" the term "Design Thinking", we find an increasing number of results related to the ability of Design Thinking to foster creativity,

problem-solving, divergent thinking, the development of new 21st-century skills, and the power of DT to lead economic growth.

To explore the possibilities of DT in TVET, this study addresses the following three questions
1. What characteristics of DT make it particularly effective in education?
2. What tools, techniques and methods characterise DT?
3. How can DT be applied in different TVET contexts?

Literature Review
DT has been a hot topic worldwide since it was promoted by Stanford University's School of Design and IDEO Design until recently. DT is a human-centred approach to problem-solving that has gained considerable attention as a framework for tackling complex challenges in various fields. DT has been defined as an iterative, user-centred approach to solving complex problems (Talbot, 2022).

At the same time, DT has taken hold in many disciplines within and outside design schools (Panke, 2019). For essential institutions such as Stanford University and the Higher Institute of Industrial Design in Potsdam, there is no doubt that this approach is unique to technological innovation. Business and management schools have long advocated using DT for product and strategic innovation, competitive advantage and growth (Carlgren, Rauth, & Elmquist, 2016; Liedtka & Ogilvie, 2011). Furthermore, DT employs multidisciplinary collaborative teams to produce user-centred products, services or experiences (Lor, 2017), effectively contributing to 21st-century learning by undertaking complex interdisciplinary projects. Von Thienen et al (2023) argue that DT involves a 'focus on needs' and a commitment to 'radical innovation', and in addition, she further highlights the distinction between narrow needs, where a design project strictly follows user statements, and broad needs, where a project includes re-conceptualisation and visionary contextualisation. In summary, DT can help to solve pressing social problems and develop and introduce technological innovations.

DT differs from other approaches, focusing on the process rather than the product. As a creative process, it follows a human-centred, action-oriented, prototype-driven and non-judgmental approach. From an educational perspective, DT has the potential to foster the development of creativity and adaptability in students, thus enabling them to acquire the knowledge, skills and qualities needed to solve complex problems collaboratively. A student-centred approach makes learners active participants in education and equips them with the necessary skills. However, DT in education is based on developing creative confidence that is resilient and highly optimistic (Kelly, 2016). Unlike traditional approaches to learning, DT follows two intrinsic aspects: a mode of thinking and a dynamic, non-linear process (Serrat, 2017). In DT, teachers and coaches encourage teams to 'be creative', 'take risks' and 'build on the ideas of others' but rarely tell them how to implement these behaviours. These perspectives raise questions about the nature of the education required.

Existing typical phases of the DT process (problem identification, observation, perception, ideation, prototyping, and testing) are based on Stanford University research and applied to various disciplines.

Methodology

This study focused on extensive and comprehensive data collection and careful analysis. To elucidate existing theories and cases of DT in education to answer the research questions about constructing the possibilities of DT in TVET. Modelled on Elsbach and Stigliani (2018), this methodology is based on a protocol-driven approach combining an explicit search strategy and snowballing techniques to select articles for review, thus allowing the corpus to evolve as the research unfolds.

Data Analysis and Findings

The search results show fewer applications of DT in TVET. However, more literature refers to applying DT in specific disciplines. For example, pedagogically, design approaches can be seen as emphasising usefulness rather than devaluing authenticity (Simon & Alexander, 1996). Kolodner et al (2003) found that through 'learning by design,' students were better able to develop aspects of scientific knowledge and 21st-century competencies such as collaboration and metacognitive skills when faced with complex design tasks that required iterative cycles of investigation, design and redesign. Bereiter and Scardamalia (2006) emphasise the human-centred generation of ideas and the construction of knowledge: today's schools must be fundamentally redesigned to become knowledge-creating organisations. Their suggested primary goal is to foster DT in today's learners. They also advocate constructivism as the basis for a knowledge-building approach that engages students in DT models and uses their collective efforts to improve ideas.

The empathy feature in DT is critical in DT research. Empathy is a fundamental concept in DT and human-centred design. Although different groups have different understandings of DT, many emphasise that DT is an empathic approach to innovation (Plank et al., 2021). Furthermore, DT adopts a "human-centred perspective, where innovators build empathy with users" (Verganti, 2009), design thinkers subscribe to a "human-centred perspective", and design thinkers are committed to solving problems "in a way that meets human needs", rather than a techno-centred view. Design thinkers think "with a focus on human values".

DT as a method of innovation has evolved from traditional design circles to a broader range of industries and specialisms. Jonathan Antonio Edelman has conducted a decade-long study of case studies. However, the impact of these results on DT education remains minimal, and the development and application of new DT methods, tools, and frameworks often need a rigorous empirical foundation. To bridge the gap between research and practice, the Edelman et al (2021) noted that performance modelling is a micro-interaction that can be articulated into warm-ups, drills and exercises for training purposes. Improvisation in teaching is the best medium for DT and effective team interaction (Talbot, 2022).

Researchers have attempted to incorporate DT into professionally constructed models. For example, Hölzle (2022) and her team to develop the DTE model proposed under entrepreneurship education, responds to the current needs of entrepreneurship education by prioritising identifying entrepreneurial opportunities with a user-centred approach and combining it with active practice, experimentation and reflection. In the DTE model, students create artefacts, present solutions, and learn to iterate their work and experiment. The DTE model is developed more broadly and holistically than entrepreneurship programmes that do not use the DTE model. The various parts of creativity come together better, and students

feel more confident in demonstrating what they have learned. DT in entrepreneurship education has also shifted attention from teachers to student-centred learning (Deale, 2016). Workshop formats and reflective journals help students to engage with learning in a way that is very different from the traditional way of learning at university.

In addition, Paula et al (2021) extended DT to multiple teams and created the DT@Scale concept for this purpose. The concept presents a series of DT workshops that allow multiple teams to work on design challenges in parallel. It contributes to academic research by developing and validating a concept that extends DT to multiple teams and applies the different results to a software product.

DT is more than just a helpful teaching tool for students. It can be an effective learning and development tool for teacher professionalisation. If teachers are to develop a design-orientated view of understanding among their students, they must first be proficient in DT and engage in design practice (Chai et al., 2013).

Pedagogical studies that incorporate DT are grounded in pragmatism and aim to develop and investigate practical design-based principles in the classroom. One thing they have in common is a determination to emphasise the importance of design in critical careers and to place design on a rigorous knowledge base.

Discussion

From the literature review, it can be inferred that DT has the following characteristics that can be used in education

1. A user-centred approach means educators can better understand students' needs, challenges and preferences. Designing solutions with students in mind can make educational experiences more engaging and effective.
2. An iterative process that allows educators to continuously improve and adapt teaching methods and materials based on student feedback.
3. Empathy and creativity are critical to understanding students' unique challenges and motivations. It also promotes creativity, enabling educators to develop innovative solutions to educational problems.
4. Collaboration, which can be encouraged among teachers, administrators, and students, promotes a more holistic and practical approach to education.
5. DT's focus on solutions can help educators address specific challenges in the education system.

Existing literature mentions tools, techniques and methods characteristic of DT: empathy mapping, improvisation (role-playing), brainstorming, prototyping, user testing and storyboarding. With these tools and techniques, the power of DT can be fully utilised.

By exploring the characteristics and tools of DT in depth, it is possible to explore the perspectives, opportunities and challenges of DT in future TVET pedagogical research in the following areas.

For the first time, DT can be used to develop a curriculum that is more relevant and engaging to students when facilitating curriculum design. Educators can think differently to

understand the industry's and student's needs and then work together to create a curriculum that meets actual needs. Secondly, for teacher professional skills development, DT helps identify the skills and competencies most needed in a particular trade or industry to develop more targeted teacher professional skills development programmes. Finally, TVET providers can use DT to continuously improve their programmes and services based on feedback from students and industry partners.

Conclusion
In conclusion, applying DT in TVET is a transformative approach to meeting the changing needs of the job market and increasing the relevance and adaptability of vocational education. The core principles of DT are transpersonal thinking, creative problem-solving, collaboration, iteration and user-centredness, which coincide with the goals of TVET. By adopting DT, TVET programmes can identify and solve real-world problems, foster creativity and innovation, promote collaborative learning and encourage rapid prototyping and testing. The benefits of this approach are numerous, including increased relevance, improved student engagement, development of critical soft skills, and alignment with industry needs.

Whilst there are challenges of resistance, resource constraints and evaluation difficulties in researching DT in TVET, the successful implementation of DT in TVET has been evident in case studies worldwide.

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