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Definition

Design refers to "the plan, project, or working hypothesis which constitutes the 'intention' in intentional operations" (Buchanan 1992, 10). Or as Rittel (1971, 19) formulates it, "a [wo]man designs whenever [s]he has a purpose in mind and devises a scheme to accomplish this purpose". In this chapter, design thinking is defined as a human-centered problem-solving approach which was intended originally to aid in the development of novel products but has more recently been adapted to deal with system-level challenges and "wicked" problems (Buchanan 1992; Dam and Siang 2018; Von Thienen et al. 2014).

The meaning of words changes with time and the term *design* is no exception. In the 14th century, the word originated from the Latin *designare*, which means "to plan" or "to devise". In the 16th century, the Italian *disegnare* developed the meaning "to plot, to draw, to embroider", etc., which was absorbed into the French language in different forms and then passed on to English. In the English-speaking world, the term design covers all creative, planning, and drafting activities, various disciplines of both design and engineering, as well as the designed object itself. Only the noun and verb forms of the term are distinguished. As a noun, design refers to various disciplines and the designed object. As a verb, design encompasses planning and drafting procedures, i.e. process-oriented action.

The term *design thinking* originated and was used in 20th-century literature, e.g. in the *Architect and Engineer Magazine* in 1946, but it has mostly been used by researchers in the field of design since the 1980s (Dorst 2015; Rowe 1987). Starting from the 1990s, various models and understandings of design thinking have emerged, e.g. design thinking as a mindset, toolkit, method, and process (Dorst 2011). Dorst (2011) elaborates that there is a reason why people from diverse fields are interested in design: Designers have been dealing with complex and open problems for years, and they have developed professional practices to do so; therefore, adopting their practices can help solve such problems. Adopting design thinking in other non-design fields led to a demand for definite and clear knowledge about

design thinking, which included a definition and methodological guidelines for non-designers to understand and engage with. With a consistent gain in popularity, literature has reported a considerable number of success stories of the application of design thinking in diverse fields (e.g. Brown 2008; Brown and Wyatt 2010; Dorst 2010). However, considerable ambiguity still exists regarding the use of the term and its definition.

Using design thinking in education has a long history, and the use of the term varies in application. For example, Panke (2019) conducted a literature review on applying design thinking in different educational settings and concluded the review with seven themes. These themes identified design thinking as: (1) a method for instructional design for course material development; (2) a technique for curriculum development; (3) a strategy for teaching to achieve specific objectives; (4) a learning goal; (5) a facilitation technique to support students; (6) an approach for leadership and organizational development; (7) a method for product development or process improvement.

Background

Various models of design thinking have been developed over time based on Simon's (1969) design thinking process. Simon's design thinking approach was focused more on creating a way to change or adapt the existing conditions to ones compliant with the current context. Another discourse on design thinking comes from Schön (1983), who emphasized the role of reflection in design thinking and regarded reflection as a core of design thinking. Design thinking as a problem-solving activity is related to Rittel's interpretation and Buchanan's elaboration of the wicked problem's solution approach (Buchanan 1992). According to this approach, the process of design is divided into two segments, i.e. problem definition and problem solution (Buchanan 1992, 15). Another discourse by Krippendorff (2005) elaborates design thinking as an approach to create meaning rather than artifacts, and making meaning becomes the core of the design process while artifacts become the medium of communicating the meaning (Johansson-Skoldberg et al. 2013, 126) The most notable design thinking approach for its application in the field of education is developed by the Hasso Plattner Institute of Design at Stanford University (Hasso Platter Institute 2023; Melles et al. 2015; Plattner et al. 2009). This transferable approach emerges from the human-centered design principles and entails five iterative stages: (1) *Empathize* – building empathy by deeply understanding the problems and realities of people who are facing the problems; (2) *Define* – defining a specific problem by unpacking and synthesizing the findings from the empathize stage; (3) *Ideate* – generating creative and radical ideas to deal with the framed problem; (4) *Prototype* – bringing the ideas into some physical

form to eliminate ambiguities and check the feasibility; (5) *Test* – putting low-resolution prototypes into a real-world context and refining the solution idea further by gathering feedback from stakeholders (Hasso Plattner Institute 2023).

The application of design thinking in the field of education is recent and varied. However, design thinking can effectively promote transdisciplinarity by connecting students to the practice via real-world experiences (Pohl et al. 2018). Transdisciplinarity is defined as the process of extended knowledge production that encompasses a variety of actors and requires openness to the different forms of knowledge produced by scientific and lay communities (Mobjörk 2010). Design thinking takes an interdisciplinary approach and put learners into diverse teams which expose them to a plurality of knowledge and perspectives – this set-up encourages transdisciplinary learning as it allows learners to establish a shared understanding of the content while considering multiple perspectives (Taimur et al. 2022). We need to encourage transdisciplinarity (Darbellay 2015; Polk 2015) in order to deal with wicked, real-world problems while collaborating with different actors from society and science to produce robust and action-oriented knowledge (Biberhofer and Rammel, 2017). Design thinking, as a problem-solving approach, aims to deal with wicked problems, and in an educational setting it can encourage real-world, practice-oriented learning experiences – hence, it can be regarded as a transdisciplinary didactic tool for training learners to deal with wicked challenges.

Debate and criticism

There have been elaborate discussions regarding the transdisciplinary nature of design thinking among educators (Buchanan 1992; Cross 2006; Welsh and Dehler 2013), demanding that more research is needed on design thinking in education from a transdisciplinary perspective. Most of the literature focuses on design thinking in education within a specific discipline. For example, in architecture and design (Lloyd 2013), natural sciences, technology (Mubin et al. 2017), entrepreneurship, and business management (Nielsen and Stovang 2015; Von Kortzfleisch et al. 2013), medicine (Deitte and Omary 2019), and engineering (Dym et al. 2005).

However, the application of design thinking in an educational setting requires individuals to consider multiple perspectives from different actors during the empathize phase in order to frame the problem well. If perspectives from a single discipline are considered to frame the problem, it may solve the problem in the context of that discipline but may end up creating problems for other fields. Therefore, educators must pay attention to how design thinking is being used in educational settings to promote transdisciplinarity. Panke (2019) explains that design thinking is being used in educational settings in different forms, and that this pluralism is worth appreciating. However, educators should be aware

that dealing with complex problems (in any field), which is the purpose of design thinking, requires individuals to consider multiple perspectives from diverse actors and be exposed to real-world experiences. Koria (2015) argues that deep and diverse disciplinary expertise should be brought into design thinking education to create disciplinary capabilities and promote interdisciplinarity, and that design thinking education should not be limited to teaching skills, but students should be engaged in the application of these skills, learning to collaborate across functions, people, and cultures.

Mobjörk (2010) discusses two types of transdisciplinarity, consulting and participatory. Consulting transdisciplinarity allows learners to consult stakeholders on their projects; however, the participation of actors is limited. On the other hand, participatory transdisciplinarity involves actors fully in the knowledge production process along with learners. Both kinds of transdisciplinarity can be promoted through design thinking, but educators should determine what kind of transdisciplinarity is relevant to their context and to the objectives of the educational program – specifically, when design thinking is applied in formal educational settings with time constraints related to its application. For example, one course is scheduled only for six months; in such a case, consulting transdisciplinarity works well to engage actors in the design thinking process (e.g. Taimur et al. 2022).

The application of design thinking in education also has ethical implications, as educators are required to organize diverse perspectives from different actors, disciplines, and functions. In this regard, educators (taking the role of facilitators) should ensure that they expose learners to all the perspectives (dominant and subservient) without concealing any perspectives based on their personal preferences to implement design thinking for promoting transdisciplinarity. The ethical considerations imply that applying design thinking may be difficult in undemocratic or authoritarian regimes as participants will not be able to encounter diverse perspectives or pluralism to develop the competencies required to frame problems in a real-world setting.

Current forms of implementation in higher education

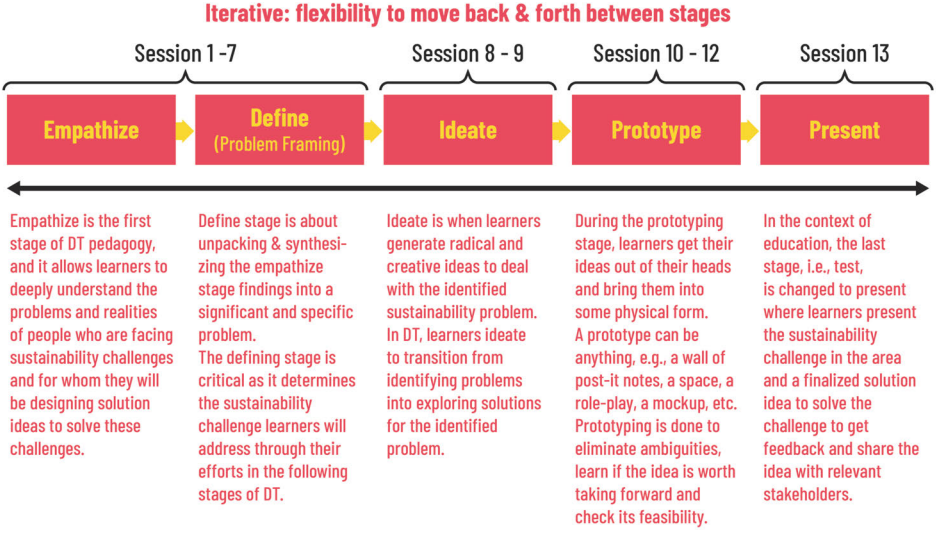
Multiple cases have been reported in the literature that focuses on applying design thinking in education to foster transdisciplinarity. Cases from Germany, Romania, Japan, and Switzerland identify the essential elements of design thinking for transdisciplinary learning by showcasing how this approach can be adapted to varying contexts.

A Romanian–German case study (Peukert and Vilsmaier 2021) focuses on the application of a specific aspect of design thinking: design prototyping. Design prototyping is a method of constructing small two- and three-dimensional designs to

develop and visualize ideas, which can then be discussed and revised. The application of design prototyping in transdisciplinary research processes differs from the application of prototyping in design disciplines in several ways. The role of a designer facilitates the prototyping process, prototyping context is detached from design or a product orientation, and the heterogeneity of the actors in a transdisciplinary team can be far more diverse than those of product development teams. Design prototyping in transdisciplinary research is strongly embedded in the process and is, therefore, in itself only an intermediate step in the overarching frame.

A case study by Taimur et al. (2022) identified the use of design thinking in higher education settings. That article used design thinking to implement a six-month-long, graduate-level field exercise course at a public university in Japan – where learning processes and environment were referred to as pedagogy. The course's overall objective was to deal with sustainability challenges in a specific context (Kashiwa no ha). Five-stage design thinking (adapted from Hasso Plattner Institute 2023) was used for pedagogy and all the stages of design thinking were implemented during the course, as indicated in Figure 2.

Figure 2. Stages of design thinking implemented during the field exercise in the sustainability science course (Taimur et al. 2022)

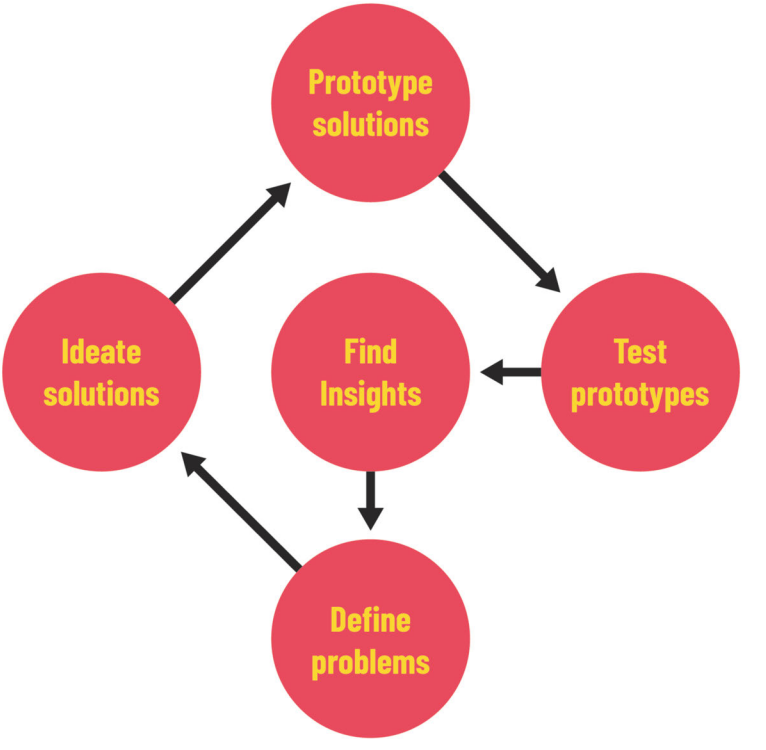


In this case, design thinking promoted consulting transdisciplinarity (Mobjörk 2010), where stakeholders collaborated with the learners to respond and react to their questions, projects, and research. The case study showed that design thinking can support the characteristics of transdisciplinarity as it allows learners: (a)

to understand the sustainability problems (which lack distinct system boundaries) and define these problems; (b) to move back and forth between different stages of design thinking and to iterate their shared understanding openly; (c) to collaborate with other learners and with the stakeholders outside the university settings. In order to establish a shared understanding of the problem and the solutions, it is crucial for learners to collaborate with each other.

Tackling Environmental Problems is a first-year bachelor-level course that is compulsory for students who are part of the Department of Environmental System Science at ETH Zurich. This intensive, year-long course builds on a tradition of using real-world case studies as a basis for group learning but also incorporates new elements of the integration of design thinking with systems thinking. The course provides students with the mindset and tools that allow them to analyze *and* take action on complex problems in the environmental field using the design thinking approach adapted from the process codified by Hasso Plattner Institute of Design at Stanford University (Figure 3).

Figure 3. The structure of design thinking followed in Tackling Environmental Problems (author's work adapted from Hasso Plattner Institute of Design 2023)



The transdisciplinary approach of this design-based course is exhibited in four ways. First, the course is an inherently interdisciplinary course because it not only introduces first-year students to methodologies or methods specific to a particular discipline, but also to the perspective of systems thinking as a whole. Second, the course makes use of approaches from a variety of disciplines to push students to understand the world through an analytical lens. It also introduces a design perspective to students that enables them to develop a sense of empathy for the people taking part in the systems they are studying and encourages them to identify leverage points in the system where action can be taken. Thus, the methodology interweaves qualitative systems modeling and soft systems methodology with design thinking (Pohl et al. 2021). Third, the course relies on the contribution of real-world stakeholders for the identification of case studies and for providing feedback to students throughout the course. Fourth, collaboration and self-reflection have a particular emphasis in the course.

Another case study described by Ambole (2020), Living Lab at the University of Nairobi, Kenya, highlighted a model for embedding design thinking in the African context. Through the Living Lab, design thinking workshops were facilitated for community engagement and to run problem-based learning programs from urban development. Most notably, workshops were facilitated in urban development for urban actors drawn from five East African countries; the purpose of the workshop was to engage local actors to co-create ideas for local solutions by contextualizing local expertise and knowledge through design thinking. Further, the study placed the design thinking work done by the Living Lab in the context of transdisciplinary research, as these workshops allowed the design teams to contextualize the design thinking tools to tackle local challenges. This contextualization enabled the researchers and learners to engage meaningfully with diverse multiple stakeholders and local actors to realize sustainable solutions. The study highlighted that design education, infused with transdisciplinary lenses, needs to gain prominence in Africa for sustainable development, because in Africa disciplinary boundaries are still concrete and the use of technology has not been rooted in urban development.

The cases presented in this section have identified that design thinking can promote transdisciplinarity by encouraging autonomy, openness to appreciate diverse perspectives, and active learning in the real-world setting. This kind of transdisciplinarity develops learners' ability to solve real-world complex problems. The way design thinking has been implemented in the case studies differs according to the context, indicating that it can be applied to diverse teaching environments, but it has to be contextualized and adapted to the specific learning objectives and context. In all the cases, participants (learners) followed a specific sequence of thinking: (a) building early thoughts and views (how to visualize them, thinking which aspects are important, where feedback is necessary); (b) commu-

nicating the early thoughts and views; (c) thinking of how to test them; (d) openly giving and receiving feedback on early thoughts and views (giving appreciative feedback, taking different perspectives); (e) iteratively developing and rejigging the thoughts and ideas. This thinking pattern can also be termed as a design mindset for transdisciplinarity, which can be promoted via design thinking.

Transdisciplinary collaborations also come with many challenges, like managing the diversity in a team, translating different ways of communication, leveling power imbalances, bridging different epistemological approaches, dealing with personal and team issues, and keeping a common focus (Peukert and Vilsmaier 2021). Design thinking as a process and its methods, like design prototyping, do not provide a general cure in overcoming these challenges, but by adding for example a visual and tangible dimension (through working with drawings or prototypes) to the collaborative process, a further cognitive mode is added that complements written text and the spoken word. The common design ideas and objects in design thinking processes can act as boundary objects (Carlile 2002; Heiss 2020; Leigh Star 2010), which are able to improve communication, level power imbalances, bridge epistemic difference, and create a common focus.

References

Ambole, Amollo. 2020. Embedding design in transdisciplinary research: Perspectives from urban Africa. *Design Issues* 36 (2): 28–40.

Biberhofer, Petra, and Christian Rammel. 2017. Transdisciplinary learning and teaching as answers to urban sustainability challenges. *International Journal of Sustainability in Higher Education* 18 (1): 63–83.

Brown, Tim. 2008. Design thinking. *Harvard Business Rev*iew 86 (6): 84.

Brown, Tim, and Jocelyn Wyatt. 2010. Design thinking for social innovation. *Development Outreach* 12 (1): 29–43.

Buchanan, Richard. 1992. Wicked problems in design thinking. *Design Issues* 8 (2): 5–21.

Carlile, Paul R. 2002. A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization Science* 13: 442–55.

Cross, Nigel. 2006. *Designerly ways of knowing*. London: Springer.

Dam, Rikke, and Teo Yu Siang. 2018. *What is design thinking and why is it so popular?* Interaction Design Foundation. Available from https://www.interaction-design.org/literature/article/what-is-design-thinking-and-why-is-it-so-popular.

Darbellay, Frédéric. 2015. Rethinking inter-and transdisciplinarity: Undisciplined knowledge and the emergence of a new thought style. *Futures* 65: 163–74.

Deitte, Lori A., and Reed A. Omary. 2019. The power of design thinking in medical education. *Academic Radiology* 26 (10): 1417–20.

Dorst, Kees. 2010. The nature of design thinking. Available from https://opus.lib.uts.edu.au/handle/10453/16590.

Dorst, Kees. 2011. The core of "design thinking" and its application. *Design Studies* 32 (6): 521–32.

Dorst, Kees. 2015. *Frame innovation: Create new thinking by design*. Cambridge, MA: MIT Press.

Dym, Clive L., Alice M. Agogino, Ozgur Eris, Daniel D. Frey, and Larry J. Leifer. 2005. Engineering design thinking, teaching, and learning. *Journal of Engineering Education* 94 (1): 103–20.

Hasso Plattner Institute of Design, ed. at Stanford University. 2023. *Design thinking bootleg.* Available from https://dschool.stanford.edu/resources/design-thinking-bootleg.

Heiss, Leah. 2020. Iterative prototypes as "boundary objects": Facilitating interdisciplinary collaboration of a modular hearing aid. *Design Journal* 23 (6): 865–83.

Johansson-Sköldberg, Ulla, Jill Woodilla, and Mehves Çetinkaya. 2013. Design thinking: Past, present and possible futures. *Creativity and Innovation Management* 22 (2): 121–46.

Koria, Mikko. 2015. Four dimensions in learning design thinking: Capabilities, constraints, collaboration, and the diffusion of ideas. *Research in Arts and Education* 2: 15–26.

Krippendorff, Klaus. 2005. *The semantic turn: A new foundation for design*. Boca Raton: CRC Press.

Leigh Star, Susan. 2010. This is not a boundary object: Reflections on the origin of a concept. *Science, Technology and Human Values* 35 (5): 601–17.

Lloyd, Peter. 2013. Embedded creativity: Teaching design thinking via distance education. *International Journal of Technology and Design Education* 23 (3): 749–65.

Melles, Gavin, Neil Anderson, Tom Barrett, and Scott Thompson-Whiteside. 2015. Problem finding through design thinking in education. In *Inquiry-based learning for multidisciplinary programs: A conceptual and practical resource for educators*, eds. Patrick Blessinger and John M. Carfora, 191–209. Bingley: Emerald.

Mobjörk, Malin. 2010. Consulting versus participatory transdisciplinarity: A refined classification of transdisciplinary research. *Futures* 42 (8): 866–73.

Mubin, Omar, Mauricio Novoa, and Abdullah Al Mahmud. 2017. Infusing technology driven design thinking in industrial design education: A case study. *Interactive Technology and Smart Education* 14 (3): 216–29.

Nielsen, Suna Løwe, and Pia Stovang. 2015. DesUni: University entrepreneurship education through design thinking. *Education + Training* 57 (8/9): 977–91.

Panke, Stefanie. 2019. Design thinking in education: Perspectives, opportunities and challenges. *Open Education Studies* 1 (1): 281–306.

Peukert, Daniela, and Ulli Vilsmaier. 2021. Collaborative design prototyping in transdisciplinary research: An approach to heterogeneity and unknowns. *Futures* 132: 102808.

Plattner, Hasso, Christoph Meinel, and Ulrich Weinberg. 2009. *Design Thinking: Innovationen lernen- Ideenwelten öffnen*. München: mi-Wirtschaftsbuch.

Pohl, Christian, Pius Krütli, and Michael Stauffacher. 2018. Teaching transdisciplinarity appropriately for students' education level. *GAIA-Ecological Perspectives for Science and Society* 27 (2): 250–52.

Pohl, Johanna, Vivian Frick, Anja Hoefner, Tilman Santarius, and Matthias Finkbeiner. 2021. Environmental saving potentials of a smart home system from a life cycle perspective: How green is the smart home? *Journal of Cleaner Production* 312: 127845.

Polk, Merritt. 2015. Transdisciplinary co-production: Designing and testing a transdisciplinary research framework for societal problem solving. *Futures* 65: 110–22.

Rittel, Horst. 1971. Some principles for the design of an educational system for design. *Journal of Architectural Education* 26 (1–2): 16–27.

Rowe, Peter G. 1987. *Design thinking*. Cambridge, MA: MIT Press.

Schön, Donald. 1983. *The reflective practitioner: How professionals think in action*. New York: Basic Books.

Simon, Herbert A. 1969. *The sciences of the artificial*. 1st edition. Cambridge, MA: MIT Press.

Taimur, Sadaf, Motoharu Onuki, and Huma Mursaleen. 2022. Exploring the transformative potential of design thinking pedagogy in hybrid setting: A case study of field exercise course, Japan. *Asia Pacific Education Review* 23 (4): 571–93.

Von Kortzfleisch, Harald F. O., Dorothée Zerwas, and Ilias Mokanis. 2013. Potentials of entrepreneurial design thinking for entrepreneurship education. *Procedia – Social and Behavioral Sciences* 106: 2080–92.

Von Thienen, Julia, Christoph Meinel, and Claudia Nicolai. 2014. How design thinking tools help to solve wicked problems. In *Design thinking research*, eds. Larry Leifer, Hasso Plattner, and Christoph Meinel, 97–102. New York: Springer.

Welsh, M. Ann, and Gordon E. Dehler. 2013. Combining critical reflection and design thinking to develop integrative learners. *Journal of Management Education* 37 (6): 771–802.