# Advancing Sustainability at Universities through Design Thinking Education

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## Abstract

Teaching students Design Thinking (DT)—a team-based approach to solve wicked problems—by using real-life sustainability problems, provides an opportunity to develop solutions that benefit a university's ecobalance. To make this suggestion tangible, this chapter includes a case study describing how a student team, while learning DT, worked on the challenge to decrease the usage of disposable cups. This case study includes the workshop preparation, the course agenda, and the prototype *BackCup*, a deposit concept developed by the student team. Further, we illustrate how follow-up meetings with relevant stakeholders and the collaboration with a campus do-it-yourself platform raised awareness for the idea. Subsequently, we discuss how the team's efforts to implement sustainable solutions into the university's structures helped students to gain a better understanding of organizational dynamics. Future design thinkers learned that overcoming barriers towards sustainability requires several iterative process steps and the involvement of relevant stakeholders. For instructors who are interested to use a similar approach, it is explained how the DT course is integrated into the university's curriculum.

## 1. Introduction

Earth overshoot day, the annual date when humanity has used as many resources, as the world is able to renew, is antedated each year. In 2019, it was July 29, which underlines that human's usage of resources exceeds by far what the planet is able to repair. To tackle this issue, we need new and innovative ways to change behaviors within organizations and raise awareness for sustainable consumption on the one hand. On the other hand, it is important to educate the next generation of leaders to balance economic growth, social development, and ecological vitality. In this regard, universities take a critical role, not only because they educate these upcoming leaders but also because they provide a context in which newly developed sustainable concepts can be tested before they are transferred to larger society. Although this potential has been recognized (e.g., Sulkowski, 2017), concrete suggestions how a campus' sustainability could be enhanced are sparse (Disterheft *et al.*, 2012). Thus, we need tangible designs how sustainability can be implemented into university curricula.

Amongst the most crucial barriers that prevent the implementation of sustainable innovations into organizational structures are a lack of support from management and a lack of appropriate technology (Ávila *et al.*, 2017). Nonetheless, given the urgency to create sustainable solutions, waiting till these issues are resolved by structural changes is not an option (Tarrant and Thiele, 2016). Instead, we need creative solutions that circumvent these barriers and work in the existing parameters (Hill and Wang, 2018). One way to do so is by relying on participatory design interventions that involve those individuals that are expected to behave more sustainable into the problem-solving process (Disterheft *et al.*, 2015; Endrejat and Kauffeld 2018). Problem-based learning provides suitable and realistic methods how such a participatory approach can be taught to students.

However, the potential of problem-based learning is yet not fully applied in the higher education context (Leal Filho *et al.*, 2018). To fill this gap, we illustrate how Design Thinking (DT) education can be utilized as a problem-based teaching method to create new

sustainability concepts. DT engages interdisciplinary student teams to experiment, prototype, gather feedback, and design innovate solutions for wicked problems (Brown, 2009). Such a teaching approach asks students not to be passive recipients but to get involved, gather new information, and create solutions that meet users' needs. Thus, teaching DT skills answers society's demand for creative teams who help to meet organizational sustainability goals (Razzouk and Shute, 2012).

To outline how DT education can be used to create solutions for sustainability that fit into existing university structures, we first give an overview of the concept of problem-based learning and how DT relates to it. Subsequently, we report a case study of a DT team that worked on the challenge to reduce the usage of disposable cups at their university. Next to a summary of the course agenda, we also elaborate on how the collaboration with a project partner, a do-it-yourself campus platform, helped to gain support for the prototype developed by the DT team. Finally, we discuss the implications that can be drawn from this case study and lay out how further studies might increase our understanding about how to diffuse sustainable innovations into university structures.

## 2. Approach: Design thinking as a problem-based learning method

Problem-based learning encourages critical thinking, decision making, and the ability to determine the critical aspects regarding a given topic what, in turn, fosters an exploratory mindset in learners (Melles *et al.*, 2015). DT can be understood as a specific way of problem-solving that asks students to consider the interests of the project partners as well as the people affected by a solution and incorporate these interests into their solution. Thus, DT has the potential to be an approach that grasps the complexity and unpredictability of social structures because the points of view from all involved stakeholders are simultaneously integrated in the process of designing a solution (Leifer and Steinert, 2014). In doing so, DT builds upon action research (Lewin, 1947), an iterative plan making and fact gathering approach for

understanding and changing behavior. Confronted with a complex challenge or problem, a DT team adopts a user-centered perspective to understand how the behaviors of organizational members can be channeled in a desired direction (Gruber *et al.*, 2015). Thereby, it uses a predefined, iterative process that results in concepts or affordances (i.e. artifacts that depict a desired human-object interaction; Norman, 2013) with a strong emphasis on the user perspective. The inclusion of potential users is necessary because credible and feasible solution strategies are only developed in collaboration with the affected stakeholders and do not arise form ideas developed by a lone genius. During this learning process, the role of an instructor is not, as in traditional teaching methods, to use top-down communication in a teacher-like manner but rather to become a facilitator. That means, instead of giving information and pointing out possible solutions, the facilitator provides an environment in which students can engage with self-determination in the solution process of real-world problems.

Furthermore, both action research and DT propose that a final solution is not attained through a linear process but rather iteration and feedback loops are necessary to integrate new insights. The iterative process applied in DT is a modification to classical problem-based learning approaches that rely on predefined and successive working steps. Another aspect that distinguishes DT from other problem-based learning approaches is that DT not only focuses on how a problem could be solved but puts equal emphasis on the aspects causing the problem and the factors stabilizing the current status (Razzouk and Shute, 2012). In other words, in DT understanding the problem is of equal importance as creating a solution. Instead of diligent analyzes and planning, there is a bias towards action. This is because, finding the correct answer for the wrong question is eventually a waste of resources. Thus, a DT team is encouraged to use the iteration steps to experiment which solutions might go in a direction that satisfies users' needs. This trial-and-error procedure requires a safe-to-fail, pragmatic experimentation climate (Tarrant and Thiele, 2016).

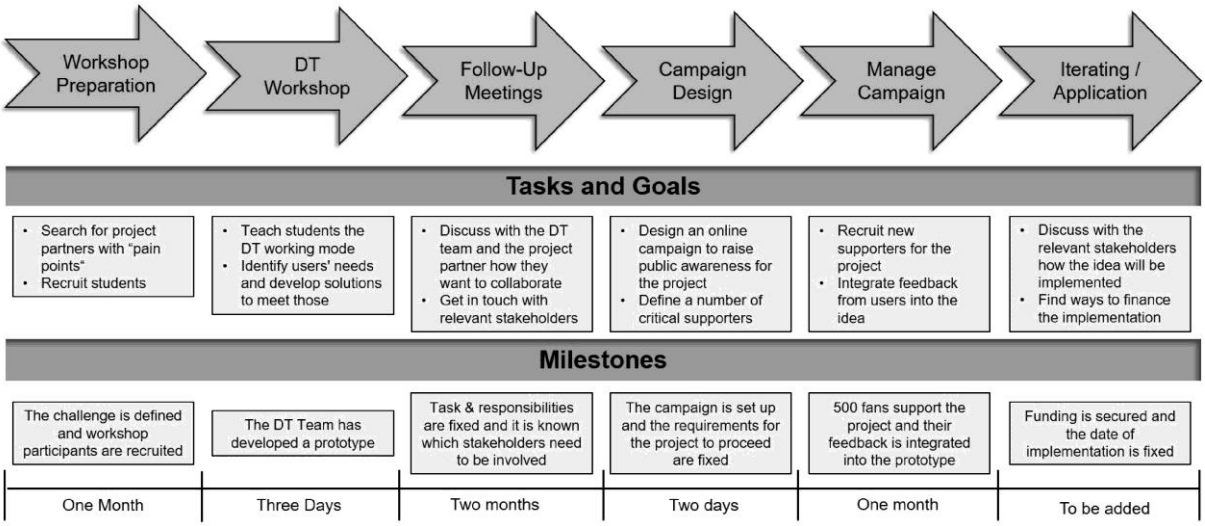
A complex, ill-defined challenge suitable to teach students DT would be to help a university becoming more sustainable (Kopnina, 2017; Shapira *et al.*, 2017). For instance, most students spend few thoughts to their consumption and waste, and when confronted with the consequences of their doing, many react with resistance (Savageau, 2013). Thus, we illustrate how DT can be applied to meet organizational sustainability goals on reducing the usage of disposable cups by integrating the perspectives of cup users.

## 3. Case study: How might we reduce the usage of disposable cups?

In Germany, there is an annual usage of 2.8 billion disposable cups causing massive environmental problems (Deutsche Umwelthilfe, 2015 [Environmental Action Germany]). The negative environmental impact of disposable cups is mirrored by the fact that even the eco-friendliest one-way cup is two times worse for the environment than the most unsound reusable cup (Pladerer *et al.*, 2008). Given these numbers, there is a clear need to find a solution that does not forbid coffee or tea drinkers to consume their beverages but does 'nudge' them away from the purchase of disposable cups. Taking these requirements into consideration, we set up a DT workshop to let students work on this complex real-life-challenge and generate solutions that meet users' needs and simultaneously help them to contribute to a more sustainable university. The whole process is depicted in Figure 1.

### *3.1 Workshop preparation: DT as a key skill*

At Technische Universität (TU) Braunschweig (Germany), DT is integrated into the elective soft-skills curriculum. These courses are three-day workshops for students from all disciplines who receive course credit for their participation. These heterogeneous teams are a promising approach to work on a complex problem and due to divergent perspectives also requires members to develop their communication skills to function in interdisciplinary teams (Ávila *et al.*, 2017).




In accordance with the problem-based learning approach, we provide students not just with hypothetical challenges. Instead, we have developed various cooperations to introduce projects with real "pain points" that create an authentic learning environment in which students can gain the competencies to solve real-life challenges by creating a client-based project (Foster and Yaoyuneyong, 2016). The project partner for the cup challenge was *Sandkasten* (German for Sandbox), a campus do-it-yourself platform whose goal is to shape a campus that aligns with users' needs. Sandkasten enables organizational members not only to express their ideas but also helps them in realizing these ideas.

*3.2 The DT workshop: Teaching students to work in interdisciplinary teams*

Our three-day DT training concept is based on the *field guide to human centered design* (IDEO, 2015) that consists of the three process phases inspiration, ideation, and implementation. In the next paragraphs, we explain the goal of each phase and what the DT team has accomplished during these process steps.

*3.2.1 Inspiration: What are users' key needs?* The first day began with an input from the course facilitator about the DT mind-set and several short exercises to make students familiar with the DT working mode. Subsequently, the group of fifteen participants got

divided into three interdisciplinary teams, each working on a different challenge. For the sake of readability, we only focus on the cup project.

The team first reframed the challenge, meaning, they discussed how they could rephrase the task to make it more tangible. This step considers that concepts like ‘sustainability’ are usually too abstract to be worked on thoroughly (Kopnina, 2017). Afterwards, the facilitator provided an input about several methods that could be applied to collect insights of users’ or stakeholders’ perspectives, respectively. For the remainder of the first day and the beginning of the second day, each team split up into two sub-groups to conduct ‘field research’, using interviews or observational methods. These activities consider that change agents should be able to ask appropriate questions to grasp and understand the viewpoints of the involved stakeholders. While interviewing the student office, the team learned that the TU Braunschweig has a usage of 150.000 disposable cups per year, which underlined the relevance of the challenge.

*3.2.2 Ideation: How to create solutions to meet users’ needs?* Following field research, the two sub-groups got together and shared their learnings and observations with each other. In a next step, the team had to select the most important insights that they gained during field research. These were: 1) users value the to-go experience, 2) users hesitate to bring their own cups with them, since this is perceived to undermine flexibility, 3) many users consume their beverage not far from the location of purchase, and 4) most users consume their beverages within the next 15 minutes after purchase. Follow-up questions regarding why the users that consume within or near the cafeteria hesitate to utilize reusable cups revealed that queuing up again to regain the deposit or having not enough money for the pledge are the major hindrances against reusable cups.

To make these insights more tangible, the students created a persona, which represents behavioral and motivational aspects of target users (Veryzer and Borja de Mozota, 2005). The key needs of this persona were rephrased into ‘How to…’ questions, such as *“How to design*

*the usage of reusable cups as effortless as the usage of disposable cups?"* Through brainstorming sessions, the DT team created several creative ideas how these questions could be solved. The most promising ideas were elaborated further and transferred into prototypes.

*3.2.3 Implementation: Turning an idea into an innovation.* At the beginning of the third day, the DT team tested their ideas by sharing the prototypes with potential users to gather feedback. The refined final prototype was presented to representatives from Sandkasten. This presentation summarized the process and insights that led to the final concept. Feedback from the project partner and from other DT teams was structured using special feedback sheets which provided the opportunity to add ideas on how the concept could be enhanced further. The workshop ended with an overall reflection about the learning experiences and newly acquired skills.

*3.3 Follow-up meetings: Is there potential to bring the idea to life?*

The final prototype, BackCup, is a reusable cup system that does not require to pay a deposit or wait in a queue. BackCup has a special bin design, formed as a long tube with printed cups on its top (see Figure 2 for an image of the BackCup prototype). These inscriptions avoid misuse as the new bins are placed closely to nearest garbage bins. Like regular garbage bins, BackCup should be emptied regularly. To ensure that BackCup has the potential to become realized at the TU Braunschweig, the DT team and representatives of Sandkasten had several meetings to discuss how they want to proceed further and clarified the next process steps. Since the prototype also requires acceptance and support by the cafeteria staff, the team had meetings to take these concerns into consideration and involve this critical stakeholder group at an early stage (Tarrant and Thiele, 2016). For instance, the staff suspects that the bins will be soaked. This additional information led to to the printed cups along the tube. These should prevent users from putting their cups up-side down into the tube. Confronted with the question how the idea could be financed, the DT team developed a business plan based on the idea that the BackCup stands could be used as advertising spaces.


*3.4 Campaign design: How to raise awareness and acceptance for the prototype*

As a do-it-yourself campus platform, Sandkasten provides a website which is a participative tool for campus projects. The idea to make processes as transparent as possible and integrating users' feedback to increase the chances that prototypes become innovations (Leifer and Steinert, 2014). To promote their idea among students and staff, the DT team designed an online campaign, which required that 500 organizational members gave the idea their "Like" to proceed with BackCup. This quantitative mechanism aims to ensure that a

prototype is supported by a critical mass before resources are invested in its realization (Sammalisto and Lindhqvist, 2008)

*3.5 Manage the campaign: Gain further support from potential users*

The duration of the online campaign was set to one month, but within five days the idea was supported by 500 fans that was the target number to start with the realization of the BackCup idea. To stay connected with their fans and get further feedback, the DT team posted updates of the project's progress. Furthermore, fans were also able to join and support the project, e.g. by providing their expertise.

*3.6 Project application: Interweave the prototype into organizational structures*

A DT team needs to consider an organization's culture to ensure an implementation and acceptance of the innovation (Michlewski, 2016). Coping with these aspects is necessary to educate students to become change agents who are dealing with the complexities of sustainability and 'soft' issues in organizational change management. Thus, Sandkasten offered the DT team access to the university's institutional network and enabled a meeting with the staff of the university cafeteria company. By making their project public via the online campaign, the team received cooperation offerings from the elected student representatives, NGOs like Greenpeace, and a reusable-cup-company. Currently, the BackCup team works on the laundry cycle and prototypes the return mechanism.

## 4. Discussion

This chapter described a case study on how to develop innovative ideas to reduce the usage of disposable cups at a university campus through problem-based learning approaches. It thereby adheres to the call to create new approaches and methods that take account for the transformative nature of implementing sustainable strategies. By using DT education, we build on Herbert Simon's (p. 111) bon mot that "everyone designs who devises courses of action aimed at changing existing situations into preferred ones". Applying this approach

provides students with the opportunity to gain real-life competencies that they can use in other organizations to solve complex issues (Barth *et al.*, 2007).

We highlighted DT as an innovative and problem-based teaching method that fits into a university's curriculum and aims to develop both students' professional and interpersonal competencies. In the course of the DT training, students were encouraged to not only focus on the functional goal to reduce waste production, but also to tap into users' emotional spheres and gain empathy for their personal needs. Further, our DT training provides an example of how universities can integrate the topic of sustainability into courses that are usually unrelated to this topic. This aims at creating a connection in the minds of students between the subject in question and sustainable development (Sammalisto and Lindhqvist, 2008).

*4.1 Theoretical and Practical Implications*

The case study demonstrates that establishing collaboration between a DT team and a project partner with actual "pain points" can provide innovative solutions for a real-world scenario. While working on such issues, a team becomes motivated to learn and apply DT in a self-determined manner. By providing a challenge that affects a whole organization, students learn that complexity increases exponentially when several stakeholders with divergent interests are involved (Flood, 2010). In doing so, the students also acquired the competencies to cope with ambiguity: in a first step they learn to make a problem more tangible, so it can be worked on. Subsequently, they experience how it feels like when there is no predefined way towards a solution but how new information continuously impacts the process (Leifer and Steinert, 2014). By asking students to integrate their prototype into the organizational structures, they also learned other key skills such as creating a business plan or communicating with organizational members in a way that those support the developed solution.

Our educational concept can be used as an innovative teaching method in other universities and for other challenges. For instance, at the TU Braunschweig, DT teams also

work on other sustainability projects, such as redesigning the allocation of office spaces to reduce energy consumption, a challenge provided by the facility management. Such ideas and concepts are also in line with—and support—broader efforts such as *The United Nations Sustainable Development Goals* (Leal Filho *et al.*, 2017a; Leal Filho *et al.*, 2015). These goals include that the insights resulting from sustainability research are used by practitioners, such as understanding complexity as well as critically questioning systems, policies and routines that appear fundamentally unsustainable (Leal Filho *et al.*, 2015; Barth *et al.*, 2007). We provided several ideas how to contribute towards these goals by building on the beneficial effects of problem-based learning approaches as the theoretical foundation. By using the DT approach, practitioners can engage users to take part in the solution process, turning it into a bottom-up, participative method, rather than imposing changes top-down (Disterheft *et al.*, 2012). Moreover, by involving students and letting them reflect on the difficulties of how to motivate users to behave more 'greenly', our course educates future change agents to promote sustainability (Svanström *et al.*, 2012). In teaching a DT mindset, students are encouraged to work collaboratively, think critically, and apply systemic thinking which fosters the empowerment of students.

For universities that intend apply our approach and incorporate DT in their course curricula, we have three recommendations: First, qualified facilitators familiar with the DT approach and group dynamics are needed to guide students through the DT process. Second, universities should ensure the DT training can easily be integrated into the curricula. An extracurricular course program helps to ensure that they work in interdisciplinary teams. Third, an institutional cooperation network provides students to work with project partners that have real 'pain points'. In this way, students do not operate with hypothetical challenges but interact with stakeholders who need to be involved in the process. A do-it-yourself platform that supplies the resources and expertise to follow-up with an idea might be an optimal basis for such a collaboration.

*4.2 Limitations and further course advancement*

As TU Braunschweig's infrastructure was an important driver to foster the realization of BackCup, we cannot distinguish, whether project progress was due to the good idea and dedicated team members or the resources and support provided by Sandkasten. Nonetheless, previous research shows that the way in which intended change is communicated is important for its success (Ford *et al.*, 2008). Thus, an appropriate communication with organizational members that are affected by new ideas is critical to enhance the probability that DT projects become realized. Such an extension of the DT approach seems necessary, as thus far, DT does not fully unfold its potential to produce innovations (Arnold, 2017). Therefore, we encourage future research to consider combining DT education with *motivational interviewing*, "a collaborative conversation style for strengthening a person's own motivation and commitment to change" (Miller and Rollnick, 2013, p. 12) to advance DT projects. Whereas motivational interviewing originates from substance abuse treatment, it has been suggested as a suitable approach to improve existing management practices (e.g. team meetings, job crafting) related to organizational change (Güntner *et al.*, 2019). Motivational interviewing, as a solution focused communication approach aligns well with the optimistic and constructive DT mind-set. It emphasizes that people are not likely to embrace changes when these are imposed on them. Instead, motivational interviewing rests on exploring individuals' motives by using specific communication methods such as open questions, reflective listening, and affirmations. These basic competencies serve to understand others' needs, build up interpersonal trust, and help users co-create which aspects of an idea would enhance their motivation to change their routines (Miller and Rollnick, 2013). Therefore, we argue that teaching DT teams motivational interviewing communication methods would answer previous calls for expanding designers' empathic horizon to create innovations that meet users' needs.

Furthermore, the DT team worked on the challenge to reduce the usage of disposable cups at their university. This is a narrow and specific problem definition, as the team did not

further question fundamental assumptions related to the issue of today's disposable food and beverage culture as a general societal issue. Therefore, we think it would be interesting to see in how far a more experienced DT team would take a more holistic perspective when the goal is to cut out single-use cups and re-define the challenge to tackle a problem's core.

## 5. Conclusion

Aligning a course agenda towards solving sustainable issues while preparing students to become change agents in a complex world is an efficient way to approach environmental and educational goals. As an idea how to use these synergies, we described how a student team that learned DT created a prototpye (BackCup) to reduce the usage of single-use cups at the TU Braunschweig.

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