

*Design Thinking in Education as a Catalyst to Discover and Maintain a Sense of Hope, Agency, and Confidence for Students*

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**Abstract**

Learning about ‘wicked problems (WP)’ in sustainability such as pollution, urban waste, and food and water shortages could incur a sense of helplessness among students. WP is complex to understand and challenging to teach. Our experience suggests how these concepts are taught is as important for student learning as is teaching the concepts of WP. The following question guided our research: What pedagogical approaches do we need to ignite creativity and to foster hope of a sustainable future when teaching about WP? This case study explores students’ perceptions upon taking the WP Design Thinking (DT) program at Leiden University College (LUC in Netherlands). Students’ creativity and desires for a positive change were examined using content analysis of their reflective journals, in-depth interviews and a focus group discussion. We specifically focused on a sense of hope leading to fostered emotional stability, proactive engagement (e.g. creativity or innovative solutions) and learning in a time of pandemic, COVID-19. Based on our findings, students who applied the DT approach to tackling the WP of household urban waste, demonstrated readiness toward team cooperation, emotional resilience, and self-awareness of their own environmental behavior. Students found interdisciplinary and multifaceted approaches to learning helpful in clarifying personal priorities, concerns and values.

Keywords: Design Thinking, Education Innovation, Active Learning, Liberal Arts and Science, Education, Wicked Problem

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## **Introduction**

### ***Wicked environmental problems in sustainability***

Many environmental problems that are considered "wicked" due to their complexity and difficulty in finding a solution(Head & Alford, 2013). For instance, the rapidly changing global climate is one of the biggest environmental challenges facing humanity. E-waste, food waste, hazardous waste, plastic pollution, waste management are few of the major examples of sustainability challenge that can have significant environmental impacts. The wicked problem of households is one of the more complex challenges of the sustainability(Defries & Nagendra, 2017; Head, 2019). Household hazardous waste (HHW) refers to potentially toxic or dangerous substances that are generated from everyday household activities. The environmental problems associated with household hazardous waste in sustainability include contamination of soil and groundwater, air pollution, and health hazards. Improper management and disposal of these waste items can result in exposure to toxic substances and other health risks (Turnbull & Hoppe, 2019).

Teaching wicked environmental problems of sustainability are challenging due to several aspects (Cross & Congreve, 2020; Earle et al., 2021). Many environmental problems are complex, involving multiple interrelated factors, and can be difficult to fully understand and explain. This complexity can make it challenging to effectively teach the causes, impacts, and potential solutions for these problems. Moreover, there can be a lack of consensus around the causes and solutions for many environmental problems, particularly in the case of politically charged issues such as environmental pollution. Wicked problems often require an interdisciplinary approach, drawing on knowledge from various fields, such as science, economics, and policy. This interdisciplinary nature can make it difficult for teachers who specialize in one area to effectively teach these complex issues. Sustainability science is a rapidly evolving field, and new information and technologies are constantly being developed. This can make it difficult for teachers to keep up-to-date and to provide students with the most current information and perspectives. Many educational institutions face limited resources, including funding, time, and support, which can make it difficult to effectively teach environmental issues and to provide students with hands-on learning experiences.

Despite these challenges, it is important to teach students about wicked environmental problems of sustainability as they are facing these challenges in the future. A comprehensive and well-rounded education on these issues can help students understand the complexity of these problems, and encourage them to become active citizens who can work towards finding solutions.

Design thinking is a problem-solving approach that involves empathy, experimentation, and iteration. It can be integrated into a liberal arts and science college education curriculum as a framework for developing critical thinking skills and preparing students for real-world problem-solving. The steps of a design thinking curricula framework that are applied in education are: empathize, define, ideate, prototype, test, and to refine. It's an iterative cyclic approach where students continue to iterate on their solutions, incorporating feedback and making changes as necessary (Buchanan, 1992; Gerardou et al., 2022).

By incorporating design thinking into a liberal arts and science college education, students can learn to approach complex problems with empathy and creativity, and develop the skills necessary to find innovative solutions. Additionally, the design thinking process can help

students develop critical thinking and communication skills, which are essential for success in any field (Gerardou et al., 2022). Design thinking emphasizes empathy: Encourage students to understand the perspectives and needs of those affected by environmental problems by conducting field research, conducting interviews, or creating personas (Earle et al., 2021; McCune et al., 2021). This can help students develop a deep understanding of the problem and the people it affects, which is critical to finding innovative and effective solutions. It also enables students to experiment with different approaches and solutions to environmental problems, and to be open to failure and iterating on their ideas. This can help students learn from their mistakes and develop resilience, critical thinking, and problem-solving skills. Most importantly, design thinking framework encourages students to work in teams and to collaborate with experts, community members, and stakeholders to address environmental problems. This can help students learn how to effectively communicate their ideas, understand the perspectives of others, and develop skills in teamwork and collaboration. The agency and sense of hope is an important factor as design thinking encourage students to reflect on what they learned and what they can do differently next time. This can help students develop a growth mindset and maintain motivation to continue working on environmental problems.

By incorporating design thinking into a sustainability curriculum, students can develop the skills and mindset they need to tackle the complex and challenging environmental problems they will face in the future. This research hence aims to explore how Design Thinking can be applied to promote problem solving, and the ability to operate in new situations when addressing wicked problems with further examinations on ways to need to ignite creativity and to foster hope of a sustainable future when teaching about wicked problems.

### **Teaching wicked environmental problems - Design Thinking in curricula**

Designing the Future of wicked problems (Research Clinic 2021 semester 2) was taught in hybrid due to Covid-19 with assignments and associated written instructions disseminated via Brightspace during 2020-22 (1,5 years). Total number of enrolled students were 13 students with 16 weeks of project based learning (Table 1). Students worked in three- or four-person teams to explore the intersections of social phenomena critical to wicked problems of waste and sustainability. The course was broken into five stages following the design thinking model that correspond to the course lectures and assigned readings. Each lesson in the module includes comprehension activities and concludes with an ‘investigation’, a project-based activity where students explore a wicked problem of waste issue in their schools or community. Data collection was done through case study approach including student participant observations, focus group discussion, reflection journals, in-depth interview with instructors involved.

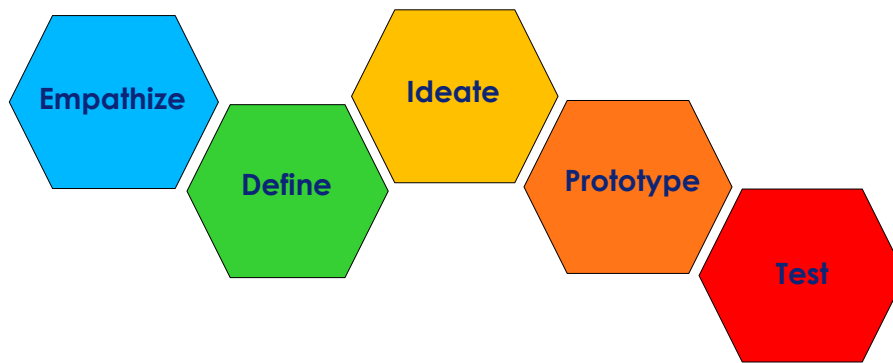


Fig 1. Design Thinking Framework

Table 1. Overview of students enrolled in Research Clinic for Design for the Future program

Research clinic name	Design for the Future: Wicked Environmental Problems in Sustainability and Health
Academic year	Feb - May 2021 (16 weeks)
Length	2 hours per week: (online) classes, lab session, office hours, walk/talk with students, pitch improvement session, fieldtrip, final pitch event.
Student Enrollment	13 Undergraduates
Format	Online / in-person hybrid (based on Covid regulations)

Table 2. Final research clinic structure

	Structure of the research clinic	
Week 1	Overview of the course - what is design thinking	Getting to know the clinic, the instructors and each other
Week 2	Understanding context - household hazardous waste global problem local action	
Week 3	Design thinking - empathy understanding the problem	Students start hands on application process of understanding the problem the community faces
Week 4	Design thinking define the problem within the context	Students start hands on application process of defining and focusing the problem the community faces
Week 5	Understanding context - expert from The Hague municipality waste management and pharmacy	

	association on household hazardous waste and medical waste	
Week 6	Design thinking - Application of knowledge - ideate	Students brainstorm for ideas based on their research/knowledge/context to find solutions for the problem the community faces on household hazardous waste challenge
Week 7	Design thinking - Application of knowledge - prototype	Students create prototype with the use of basic models or examples of the product to test to finetune their solutions on household hazardous waste challenge
Week 8	Spring break	Students keep working on prototype and do initial tests
Week 9	Design thinking - Application of knowledge - prototype	Students keep working on prototype with the use of basic models or examples of the product to test to finetune their solutions on household hazardous waste challenge
Week 10	Design thinking - Application of knowledge - testing	Students engage with the community and experts to rigorously test the prototypes. This involves active research methods including, but not limited to, online survey, qualitative research methods to gather data and finetune their solutions. Teams often use the results to redefine one or more further problems. Some students have returned to previous stages to make further iterations, alterations and refinements – to find or rule out alternative solutions.
Week 11	Fieldtrip to innovation centre of Leiden University	First official practice pitch of prototype and team bonding activities.
Week 12	Design thinking - Application of knowledge - Pressure cooker session	During the pressure cooker session, students are encouraged to revisit all design thinking steps that they have taken, within a limited amount of time. After revisiting all steps the students do a swot analysis on their prototype to find the strengths and weaknesses and to find out which next steps to take.
Week 13	Practice pitch/presentation to the community about their solutions How to communicate your idea	During the last class session, the students receive tips and tricks for their pitch and are given the opportunity to practice their pitch in front of a pitching expert.

Week 14	Final pitch/ presentation to the community about their solutions	Students present their ideas to their fellow-students, instructors and an expert panel.
Week 15	Lessons learned - focus group discussion	During the focus group, students are asked to reflect on the course, steps taking and lessons learned.

## Data Collection And Analysis

We used the case study approach with convenience sampling to explore our research questions. Our selection criteria on selecting students were that they were enrolled at Leiden University College during the time of the research 2020-2021. The data collection involved focus group discussion, in-depth interview with the students, reflection journals, and interview with the instructor team. The interview questions were developed to help participants reflect and share their backgrounds, general interests, and experiences of the course that could embrace their hopes and challenges in addressing wicked challenges. All interviews were audio or video recorded and transcribed for analysis. The researchers reviewed the interview transcripts by coding and came up with themes of the design thinking experience to discuss hopes and creativity. The initial coding was done individually, and later there was a collective discussion to share our interpretation.

## Findings

### *Awareness and recognition of wicked environmental problem*

When discussing about wicked problems and environmental issues, the students were quite alarmed at the magnitude of the issues. Some students expressed the shock with extent of the wicked problem.

*...medical waste is more of a big picture problem... when I signed up for this ... thought about it more with like antibiotic resistance...coming from hazardous waste...now I'm more thinking about it with like, there's a lot of different types... like we were talking about birth control. There's a lot of different kinds of medicines, and also like substances. Yeah, I think it's a much more diverse problem than I thought it was. (Student no. 1 FGD May, 2021)*

*We're learning, we're engaging with wicked problems or global challenges can actually be fun, because that's what [someone] already said, yeah this topic is horrible but I never felt negative in my classes or during my meetings. Whereas in other courses, when we discussed all the bad stuff, and there's so much bad stuff, but like at the end of the lecture, you're like, "Oh." (Student no. 9 FGD May, 2021)*



**A Step-by-Step Guide to Sustainable Medication Usage**

**align**  
and the planet's wellbeing

**Some facts about medical waste:**

- Medical wastes can cause toxic damage, the act behavior change is more important. Antibiotic residues increase the risk of antimicrobial resistance.
- 90% of unused medications are wasted every year in the Netherlands. 90% of unused medications are not brought back to your pharmacy.
- Only half of all patients in the Netherlands do not bring back their medication to their pharmacy.

**What can you do?**

- 1. Limit medication usage:** only purchase what you really need in the right quantity
- 2. Bring back leftover medication** to your pharmacy; make use of the medication leftover lines if available
  - Prior to that, remove stickers from the medication packaging [2]
  - Bring back all sorts of medication/medical accessories (e.g.: pills, liquid medication, needles) [2]
  - The sooner the better: Potential to reuse brought-back medication that is less than 10 days old [2]
  - Speak up: urge your pharmacist to fulfill their duty to take back medical leftovers
- 3. Spread the word** to family and friends; through ALIGN the problem of incorrect medication disposal can be addressed

Source: [1] Breda, G. (2020). "Medicines sustainability in the Netherlands." Sustainable Pharmacy Culture. [2] Final Communication: alignproject.com/align-project-in-actieve-2020

**EMMA**

- ★ 16 years old
- ★ Highschool student
- ★ Struggles with acne since she was 14
- ★ Hobby: swimming
- ★ Lives in an urban area
- ★ No siblings

**Thoughts & feelings:**

- sometimes she feels that she's not good / beautiful enough
- does not understand why this is happening to her and not to her friends as well
- has tried home-made remedies found on the internet but these not worked
- wants to solve this issue so that she can feel more confident

**Family & Background:**

- her family noticed she was unhappy so her parents want her to get help - cannot afford very expensive treatments though
- her parents also struggled with skin-related issues when they were younger

**Lifestyle:**

- sporty, goes swimming two times a week
- loves chocolate and sweets
- highschool work is very stressful
- does not have a proper skincare routine
- loves going out with her friends and meeting new people

Fig 2. Student addressing wicked problems through design thinking education framework

## Emotional Resilience - Overcoming Concerns/Values

Students understood the goals and outcomes that need to be achieved; yet, they were at times challenged how they could take the goal-oriented actions for tackling wicked problems. Through experiencing each phase of design thinking students were at times challenged and at times despondent to start over. However, they were still optimistic and hopeful for the outcomes.

*I also was surprised to discover that “killing your darling” and starting over is not really as scary as it seems (if you do it with the right people maybe). I was very afraid by that at the beginning, but we reached that point in the end and it was actually a change for the better, now looking back at our entire journey. (Student no. 4 FGD May, 2021)*

*I am a perfectionist person as well as an indecisive person because I don't want to make the wrong choice. I think that this clinic did not help me overcome this necessarily, because it forced me to be more indecisive and more perfectionistic due to the iterative process. Therefore, a skill I could work on is being confident in my own decisions. (Student no. 11 FGD May, 2021)*

*Two very important skills that I got from this research clinic are adaptability and patience. Feedback-giving exercise at the end of the clinic and I think it is very useful. I am definitely going to incorporate the lessons learned in this clinic in my personal life as well, not only in my professional one. (Student no. 9 FGD May, 2021)*

Proactive engagement (e.g. creativity or innovative solutions) and learning in a time of pandemic, COVID-19.

The COVID-19 pandemic forced a rather dramatic digital transformation in education. Students were forced to move all their learning from in-person to digital realm which led to disruptions in their learning and motivations alike. Students were faced with both positive and negative outcomes as great burden was placed on students who suddenly had to possess a variety of skills, competencies, and resources. The design thinking curricula, even in its hybrid form, provided positive influence on students' engagement in leading to better learning outcomes.

*How collaborative the classes were and the diversity in the type of material we had to prepare with from podcasts to videos. It allowed for multiple types of learners to be included in the classes and thus be able to comprehend the material beyond just reading. I also liked the activities that were encouraging our creativity and improvisation. (Student no. 6 FGD May, 2021)*

*I feel that there was also a lot of structure to the clinic and again, the instructors made sure to give us a solid framework within we could elaborate on our process of designing a solution for the problem of HHW. Another very pleasant surprise was to notice how, irrespective of the time point within the clinic, the team that I was part of had always been very pleasant to work with. (Student no. 11 FGD May, 2021)*

## **Conclusion**

Applying Design Thinking into curriculum content does encourage a sense of possibility (and agency) in students to overcome hopelessness in university classrooms and beyond. We recognize the academic breadth and depth can be at odds, faculty and students are already typically overextended, hence solving wicked problems in sustainability will depend on more than innovative undergraduate training programs. Nevertheless, our own efforts to achieve the vision we propose here is to underpin our optimism that innovative, interdisciplinary undergraduate training programs can be realized.

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