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Challenges and Opportunities of Teaching Sustainable Interaction Design

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This paper explores the challenges and opportunities of teaching Sustainable Interaction Design within higher education. Focusing on the integration of sustainability aspects into interaction design curricula, the paper examines the pedagogical approaches used to educate students as well as the students experience of having taken part in sustainability-related courses. Through a combination of interviews about student experiences, educator reflections, and analysis of students' design projects, the study outlines key insights like the importance of students' personal awareness and difficulty in moving from theory to practice. We consider how these insights can represent both challenges and opportunities and end by proposing new directions and adjustments for sustainability-related curricula in interaction design.

Keywords: Sustainable Interaction Design; Design Education for Sustainability; Students Perspective.

1 Introduction

The importance of sustainability in the design and development of interactive technologies has grown significantly since Blevis introduced the concept of Sustainable Interaction Design (SID) in 2007 (Blevis, 2007). Within the fields of Human-Computer Interaction (HCI) and Interaction Design (IxD), research on SID tends to emphasize environmental sustainability over aspects like economic or social sustainability (Besana et al., 2024). However, despite the expansion of the SID literature and its relevance in addressing complex environmental challenges, we argue that significant gaps remain in how SID is taught and integrated into educational curricula related to HCI and IxD, in line with idea of developing 'sustainability-centered design' curricula by Kessler and Rieger (2024) . With this paper we extend this work and offer new empirically perspectives that highlight the challenge and potentials of how to teach interaction design in the context of the sustainability crisis.

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This paper aims to identify the challenges and opportunities of teaching SID, with the ultimate goal of improving pedagogical approaches within the IxD communities. By examining how SID is currently taught, we seek to improve strategies, methods, exercises and curricula that can better equip educators to teach students how to address sustainability. We believe that educating emerging designers on sustainability is crucial, as it enables them to shape the systems, products, and services they develop with increased awareness. This, in turn, could eventually generate a multiplying effect, extending sustainability's impact across industries and societies. We hope that by fostering a deeper understanding of SID among students, educators can help lay the groundwork for sustainable futures.

This paper explores pedagogical challenges and opportunities through a systematic analysis of students' perspectives, educational practices and the integration of SID into design curricula. Specifically, we draw on the experience of students who have previously taken part in SID courses, educators who've organized and taught such courses, and the outcomes of those the design projects in those courses. In doing so, we aim to contribute to a broader discourse on how sustainability can be effectively embedded into existing interaction design programs, ensuring that the next generation of designers is well-equipped to address the pressing ecological and societal issues of modern time (WCED, 1987).

2 Related work

2.1 Sustainable Interaction Design

Blevis' work (Blevis, 2007) has been a key source of inspiration and a starting point for researchers and academics across various disciplines. As a result, the field of Sustainable Interaction Design has evolved in response to shifting social contexts, the increasing interdisciplinarity of research, and the growing integration of sustainability into higher education in interaction design, also considering the diverse orientations and methodological approaches within the field (Goodman, 2009).

Drawing from Fry's definition of sustainability (Fry, 2005), at its ethical core SID promotes socio-environmental responsibility while ensuring economic viability throughout the lifecycle of digital products and services (Hazas & Nathan, 2017). Integrating sustainability principles into interaction design aligns with Blevis' original manifesto, which advocates "a way of thinking that is critical to our collective futures." However, these futures can only be realized if SID continues to be reinterpreted and transformed, evolving into dynamic practices that interweave sustainability, design, and technology in innovative and impactful ways. This has underscored the importance of (re)framing sustainability within the design of emerging interactive technologies (Besana, 2024).

In this regard, Besana et al. (2024), building on the foundational framework established by Mankoff et al. (2007), have sought to re-frame SID through two key lenses, by formulating that:

- Interaction design helps address sustainability objectives by developing solutions aiming at improving (i) environmental (quality), (ii) social (equity), and (iii) economic (prosperity).
- Interaction design can promote sustainability (i) "By Design", ensuring that sustainability is embedded within the fundamental designed properties of interactive technologies, making it an intrinsic part of the artifact or system, (ii) "Through Design", using interactive technologies as tools to encourage sustainable behaviours, where positive sustainability outcomes emerge

through user interaction, and (iii) “In Designing”, considering sustainability within the design process and methodologies, where sustainability is not necessarily a direct feature of the technology itself but rather a guiding principle in its creation.

Considering SID’s ethos, it is essential to examine how this framing and its approaches are and can be integrated into education to shape future designers.

2.2 Sustainability in Interaction Design Education

The importance of early education in environmental and social sustainability has been widely discussed across professional fields, raising questions about the necessary tools for educators and learners and what defines a sustainability-focused curriculum (Bonanni et al., 2011). As an interdisciplinary field that blends environmental, economic, and social principles to address global challenges, interaction design curricula must emphasize critical thinking, ethics, and systems thinking—empowering students to develop innovative, real-world sustainable solutions (Huang & Truong, 2008; Remy & Huang, 2015; Six Silberman et al., 2014). Interaction design education often relies on project-based learning, wherein students engage with real-world problems through design projects, and sustainability-focused projects are no exception. This hands-on approach encourages interdisciplinary collaboration, reflecting the complexity of sustainability challenges (Hanks et al., 2008; Hansson et al., 2021). As an evolving topic, SID and its pedagogy must adapt to broader societal shifts toward environmental and social responsibility. To prepare students for the challenges of modern sustainability, SID education must become increasingly comprehensive and interdisciplinary in relation to sustainability, equipping future designers with the skills to create innovative and responsible solutions.

2.3 Teaching Design and Constructive courses in Higher Education

"Some disciplines focus on analytic research and some disciplines focus on synthesis. Design disciplines are interesting because designers need to do both analysis and synthesis tasks" (Blevis, 2010). Others like Gaver et al. (2022) term this practice-led while, for example, Krogh and Koskinen (2022) term this way of operating constructive to emphasize that designers, together with other disciplines’ figures, like social scientists, engineers, and computer scientists, suggest futures through what they build. In our context, design is the capacity to produce, prototype, and invite exploration of what can be done in pursuit of sustainable ways of living.

To support the advancement of constructive practices for learners in the field of design, constructive educational activities often lean toward models for design thinking (Brown et al., 2008), double diamond (Design Council, 2015), and similar approaches. Furthermore, to qualify the steps, procedures, and iterations of intermediary results, as suggested in the models, university courses in design also invite reflections on the ontology of design, as found in the works of Fry (2009), Escobar (2018), and Winograd and Flores (1986), to mention a few. This consideration on design ontology becomes relevant in Service and Interaction design, wherein the sustainability aspects of what is designed are most prominent in the effect it has on human (sustainable) practices rather than the object itself. In the triangulation of models for advancement, manifestations of design ideas, and theories enabling critical reflection on design and its impact, such as value sensitive design (Friedman et al., 2017), ideals of economic impact [post-growth], and the research contributions of Research through Design (Zimmerman et al., 2007) and constructive design research (Krogh & Koskinen, 2022) emerge.

The educational activities reported on in this paper include both students in the early stages of learning design and more advanced learners using design with the objective to produce relevant solutions along with new research insights.

3 Methods

In order to better understand the challenges and opportunities of teaching Sustainable Interaction Design, we decided to build our insights from three empirical sources, which are all qualitative in nature, and have been synthesized through a thematic analysis process [9]. (i) An account of the student's experience of having taken part in courses related to sustainable interaction design. Like most good design, good teaching is also user-centric and rests on a fundamental understanding and curiosity of the felt experience of the "user", which in this case are the students. (ii) Educator's teaching reflections, which are personal, detailed accounts of teaching experiences, written by instructors and course admins. Lastly, (iiI) five diverse student design projects which serve as exemplars of project work conducted during a course, showcasing how students address SID.

We believe it is important to give voice to the perspective of the students in the design of curricula, as they are the vast majority of the 'users'. Furthermore, student experience has been emerging as an important strategic competitive factor for higher education providers (McInnis, 2004). If we aim to adapt IxD pedagogy to address evolving socio-technical challenges, it is crucial to understand how students experience teaching and learning on topics related to sustainability in interaction design. Gaining insight into their perspectives, challenges, and engagement can help refine educational approaches, ensuring they remain relevant and effective in preparing future designers for sustainability-driven practice.

3.1 Participants

A total of 13 students from four different master's level courses - given the increased presence of SID-related courses in the participating institutions - across four universities and the 4 educators responsible for the course participated in the study. Each course focuses on sustainability in the design of interactive systems or digital interactions, providing diverse perspectives on sustainable interaction design practices within different educational programs in design. Table 1 details the participating institutions, courses, and the number of students involved.

Institution	**Course**	**Participants**
University of Lapland	Digital Technologies and Sustainable Development	P1, P2, P3, P4, P5
Indiana University Bloomington	Foundations of HCI and Design	P6, P7
Politecnico di Milano	Advanced Interaction Design	P8, P9, P10
Aarhus University	Innovation Course	P12, P12, P13

Table 1. Overview of participating institutions, courses and student numbers.

It should be noted in advance that participation was voluntary, and no compensation was provided, which arises an inherent and contextual bias in the study. The students who chose to participate were likely motivated by their interest in the subject matter and their (presumable) overall positive experience in the courses. This self-selection undoubtedly influences the findings, and the reported

experiences are perhaps more favourable than the average student, which leads to us overlooking the perspectives of the less engaged, less satisfied students.

Additionally, it is worth considering the degree to which each course emphasizes constructed practices. For instance, the courses at Politecnico di Milano and Aarhus University place a stronger focus on designing and prototyping concrete physical or digital solutions. In contrast, the course at Indiana has a lesser emphasis on the construction and a stronger focus on themes and concepts, while University of Lapland falls somewhere in between depending on the individual projects.

3.2 Materials

A format with a series of structured questions was initially administered to the various educators to gather written reflections on the topic while ensuring consistency in responses. These reflections include descriptions of the teaching context, the goals and methods employed, challenges encountered, and the outcomes observed. They often capture the instructor's thoughts and reasoning behind specific decisions, as well as their assessments of the integration of SID into overall educational programs. Additionally, a semi-structured interview (Muratovski, 2016) guide was developed for student interviews. The interview guide included open-ended questions designed to elicit detailed responses about students' experiences, challenges, and key takeaways from working with SID and its concepts during the four different design courses.

3.3 Procedure

3.3.1 Data Collection

The data collection process consisted of two stages: First, educators who have taught courses or content mainly related to sustainability in interaction design provided written reflections by responding to a predefined set of questions. These reflections detailed their experiences with teaching SID, the pedagogical strategies they employed, and their evaluations of student engagement and learning outcomes. Then, educators facilitated student recruitment for interviews by reaching out to potential participants. Semi-structured interviews were then conducted with students to capture their perspectives on SID coursework, including their learning experiences, design challenges, and reflections on sustainability in interaction design. All interviews were conducted by two of the authors either online or in person, except those with students from the Lapland who responded by email. Interviews were recorded with participant consent for research and transcribed for analysis.

3.3.2 Data Analysis

We conducted a thematic analysis (Clark & Braun, 2017) on the gathered materials. We started with the step of familiarizing ourselves with the data by reading interview transcripts and educator reflections to gain a comprehensive understanding of the content. We generated initial codes by identifying meaningful segments of the transcripts and coded them with representative terms to identify thematic patterns (Saldaña, 2009). We then inductively searched for themes by grouping codes into potential clusters that capture significant patterns across the data. Two of the authors were responsible for the iterative coding of the transcript, while the remaining, educators in interaction design, contributed to the refinement of the identified categories and the subsequent reflections proposed in the results section. Reviewing and validating themes ensured that they represent meaningful and interesting insights from the dataset, and that they are articulated clearly. We have chosen to focus on five themes as insights to be presented in this paper, and while they may not

exhaustive, they represent a specific take on the experiences of students and educators having actively participated in SID related courses.

4 Results

We present five themes from the analysis. They are naturally interrelated, and we have chosen to present all of them as both a challenge and an opportunity as highlighted by the study participants. Both challenges and opportunities are supported by either student's perspectives or the educator's reflections or both, but their prevalence is naturally not equal.

4.1 Insight 1: Sustainability and students' awareness

The concept of awareness is a recurring element surfaced by many of the students in the interview, but awareness in relation to sustainability resides on multiple levels. Student highlighted how they have personally developed to be more aware of their everyday actions and impacts on sustainability from having done a design project, as for example pointed out by [P4] who expressed how "*sustainability was actually not that far away*" and that the "*sustainability was moved closer to their lives by e.g. working on redesigning their own university campus*" or starting to "*rejecting cookies - the tracking technology, not the cake - after a lecture*". This type of sustainability awareness appears to be linked to the case where "*design contains a process of learning*" which have recently been referred to as sustainability in designing (Besana et al., 2024). On another level, awareness may have also be central to the students approach to their design project and was later translated in their effort to raise awareness in the broader population through their project (Mankoff et al., 2007). For example, [P8] highlighted "*lack of awareness about recycling benefits*" among families with children as a central theme of their own interest which led them to address such challenge with their project, creating a design space to deal with a specific sustainability challenge close to them. Similarly, another project started with the intention of designing a technology to clear up the plastic and oil from the ocean ended up as an awareness raising concept, which emphasized nature appreciation [P12].

4.1.1 Opportunity

Both theoretical concepts, lectures, exercises and design projects seem to work in raising awareness in some capacity for future designers during SID related educational activities. This is important as we, as educators, easily can move the perspectives or understandings of the students with various approaches.

4.1.2 Challenge

How do we move beyond students' discussions and awareness of sustainability which emerges during interaction design courses to concrete actions? An open question to be posed and answered by educators to reflect on whether a raised awareness is sufficient to impact students' future design choices. It emerged to be important to ensure connections between raised awareness and potential avenue for realizing this in their design process and project, which may require additional innovation in methods (Which is returned to in insight 3).

4.2 Insight 2: Personal relevance in learning

Many of the interviewed students expressed how they held or developed a personal angle or special interest in the broad topic of sustainability. For example, [P9] expressed how "*... personally am really interested in recycling practices and I already had a lot of information about recycling materials*", or

how [P7] ended up using examples from the built environment to illustrate the concept of humanity-centered design in a deliverable for the course, because this person used to be an architectural student during their undergraduate. This 'personalization' of the topic is perhaps an (un)intentional indirect consequence of the way much of the teaching was structured as evident from the educators' perspectives. For example, it appears that a large degree of the teaching is done in a "flipped classroom" style, and with a teaching philosophy that emphasizes openness, participation, and large degrees of freedom in exploring sustainability topics and issues close to students, which also allows them to approach topics proposed by peers. The 'personal relevance' of the topic is also mirrored by some of the educators. For example, the course responsible from institution A clearly shares the personal relevance to the topic: "*There is no particular motivation other than personal interest and values (..)*" and the educators as institution D clearly identifies the lacking awareness of peers as a motivation: "*the absence of a sustainability awareness among follow teachers and uneven concern among students"* thereby implying that this is perceived to be of high importance either professionally or personally.

4.2.1 Opportunity

Personal interests can help in bringing the concept close to the students themselves (e.g. the flipped classroom in praised by [P3]). By allowing students perspectives and personal interests to shine through we might deliver teaching in sustainability that is experienced as being more important and personalized to the students, also fostering peer-to-peer exchange which can bring less aware students closer to certain issues that are personally more related to others. This can contribute to the idea of a more open and flexible educational approach, allowing common sharing, self-reflection, and flexible assessment in sustainable design education (Mouchrek & Krucken, 2018).

4.2.2 Challenge

In one case, a student expressed how they initially felt concerned during the course as they did not perceive sustainability to be within their professional scope "*Is it really us who make a difference, or is it even our responsibility?*" [P13], which require educators to deepen and frame appropriately how interaction design and sustainability can coexist in their practice, also relying on real-world case studies as suggested by [Institution A]'s educator. Furthermore, students also pointed out the tension that "*...sometimes you also have to admit that innovation isn't necessarily sustainable*". While this specific potential challenge may pertain to professional and practice related relevance rather than personal, individuals seem to prefer and seek out (professional) environments and design challenges that are compatible with their personal beliefs and characteristics (Nye et al., 2012).

4.3 Insight 3: Difficulty in moving from theoretical concept to practical implications

Moving from the theoretical concept of sustainability to the practical realities appears to have caused some frustration for some students who did constructive design projects, which for example stated "*I feel like it was also frustrating at times in the project because it is very much like, kind of, this is sustainable-like. (..) But it's kind of a fluffy concept. (...) So it's always difficult when you have to use it in practice to define or figure out whether you have actually achieved something you could call sustainable. (...) Because, and that's also the thing with this topic, it's hard to say, because there is always something that could be more practically [connected with sustainability]*" [P12]. Even though there are nuances to these viewpoints as expressed by few students who personally appreciated the theoretical aspects, it is important to acknowledge that some students differ and stated that "*there*

are also students who think this course is like not that useful because it is just too theory, uh, you know, like too theory-based" [P7]. Educators also highlight related obstacles in teaching prompted "*Balancing theory and practice on sustainability may be difficult at times (…)"* [Institution D] or as something observed in the students' projects: "*Typically, the concepts are too widely defined in the beginning and not focused enough*" [Institution C].

4.3.1 Opportunity

If educators succeed in moving bridge between theoretical constructs and practical implications - for example through case studies presentations or practical exercises - some students appear to hold the view that it is easier to absorb the material: "*some theories are difficult to absorb, and maybe some practice may be better*" [P2]. In other words, by moving beyond theoretical and speculative abstractions, more students will be able to take part in the SID agenda.

4.3.2 Challenge

When translating complex concepts of sustainability into simpler, more practical exercises, we might run the risk of losing essential nuance and depth. Sustainability as a theoretical construct is often multifaceted, encompassing environmental, social, and economic dimensions that are interdependent and context sensitive. Simplified exercises that aim to make sustainability more tangible may inadvertently lead to reductive interpretations, where students focus on surface-level indicators rather than engaging with the systemic complexities of sustainable interaction design, for example leading to the disregard of possible rebound effects [Vezzoli & Manzini, 2008] while designing sustainable interactive systems.

4.4 Insight 4: Request for simple frameworks and concrete methods in sustainability

Connected to the previous insights, students expressed a need for more concrete methods and structured frameworks for applying sustainability in interaction design, in line with recent research that tries to outline practical guidance for the design and development of interactive technologies, as in the case of Kiourtis et al. (2024). As one student noted, "*I think we were more introduced to principles of what sustainability is rather than concrete methods for sustainable design. It was more like, 'If it's sustainable design, it should follow these principles*.'" [P13]. This suggests that while theoretical foundations are covered, there may be value in actionable, concrete methods from the students' perspectives. We can speculate that this may come partly as a result of the norm of using methods in interaction design, as also expressed by a student "*Well, because we are used to having all sorts of methods for things like sketching, or prototyping, or...*" [P6]. From the educators' reflections on their own courses' curricula, it was also evident that while complex theories and advanced concepts were well-represented, there are few simple, accessible methods that could help students translate sustainability principles into practical design decisions.

4.4.1 Opportunity

Many of the tools and methods already present in the interaction design field - such as "*ideation, sketching, wireframing*" [P9] - appears to be employed for engaging with SID projects. These familiar methods presumably encourage iterative exploration and engagement of different interests. However, this clearly hinges on these methods also being suited to tackle sustainability considerations. If this is case, rather than requiring entirely new methods, educators might focus on reframing and contextualizing existing design processes to explicitly consider sustainability goals, somehow in line with recent efforts to adapt traditional tools and methods [Bornes, 2023].

4.4.2 Challenge

It could be argued that many existing design methods in interaction design prioritize qualities such as ease-of-use, efficiency, and good user experience [Cooper et al., 2014], which can, at times, stand in tension with sustainability. However, despite the availability of relevant methods like life cycle analysis [28, 32], or modelling of systemic impacts [6], they sometimes do not appear to be embedded in interaction design education, leaving students without clear pathways for applying sustainability in practice. This suggests a need for curriculum updates, ensuring that sustainability is not just a theoretical add-on to specific projects but an integral part of design training. A limited amount of dedicated teaching materials may also contribute to this issue.

4.5 Insight 5: Designing for Awareness

Differently from insight 1, in which awareness was related to the personal growth of student while dealing with SID related project (section 4.1), the students' design projects also demonstrated a clear tendency to focus on the 'sustainability through design' approach [26], where the primary goal of their design was to raise awareness about a particular issue or change behaviour towards the improvement of a specific un-sustainable condition, rather than focusing on sustainability 'by design', moving away the pragmatic problem-solving position toward a radical creative role [Zhuo Wang et al., 2024]. Accordingly, design was leveraged as a mean to "*fostering public awareness, engagement, and reconnection with sustainability*", as in the case of OceanEye, which is a Do-It-Yourself floating camera designed to capture underwater pictures [P12]. Another example of a student project is a visual campaign "*meant to serve as an awareness platform*" [P1] in tackling the role of colonization and the destructive practices of mining, waste disposal, and infrastructure building and how these have caused deforestation, emissions, and pollution. The design here is created by combining machine creations of a popular image GenAI tool with artistic inspirations (see middle of fig 1). A third example (right image, fig 1) is an interactive digital addition to a restaurant cutlery holder, featuring a small screen and controller. While waiting for their food, users can engage in playful challenges like trying to peel a crooked carrot in order to raise awareness about food waste and surplus produce. The whole idea here started with the concept of excess and making that understood by consumers and users "*But basically, to begin with, it was actually about excess — trying to get people to see that right now, a large part of food production, like vegetables and so on, is sorted out and discarded*" [P11].

Building on the previous insight 4, we can speculate that the preference for a "sustainability through design" approach may stem from the fact that sustainability is often framed as a thematic challenge within design projects, rather than as a core value to be systematically integrated into the design process. It is also less frequently treated as a parameter embedded within the technology itself, an aspect more closely tied to technical development. This tendency may also reflect the influence of the more established tradition within the disciplines - and therefore its education - that focuses on driving behavioural change through design intervention (Norman, 2013).

4.5.1 Opportunity

Although some researches have highlighted that sometimes sustainable technologies which focus on raising awareness and try to influence user behaviour 'through design' not necessarily lead to sustainable actions (Bornes, 2019; Knowles, 2013), the emphasis on awareness-raising through design among students have highlighted the potential for SID education to foster a generation of designers who are not only skilled in the traditional design competencies but are also conscious about broad

impacts of human behaviour on the planet and willing to transfer it in their design, more in line with activist stance on dealing with the complex issue of sustainability through design (Prost et al. 2014) and in line with the idea of technological developments to support social awareness and movements around sustainability (Perovich et al., 2023). Making users aware of issues is in many cases can be considered one of the first steps towards changing practices and systems.

4.5.2 Challenge

One significant challenge is ensuring that these projects go beyond awareness and lead to tangible actions and solutions. While raising awareness is a crucial first step, it is equally important to equip users with the means of also acting more sustainable through design. As a case in point, one might ask whether a greater appreciation of marine nature lead to lessening of the carbon footprint to counter oceanic acidification or the abandoning of synthetic clothing fibers to counter micro-plastics? Furthermore, the case of sustainability in design is rare; none of the student projects had the sustainability of the thing they designed in focus e.g. by looking at energy consumption of material footprint.

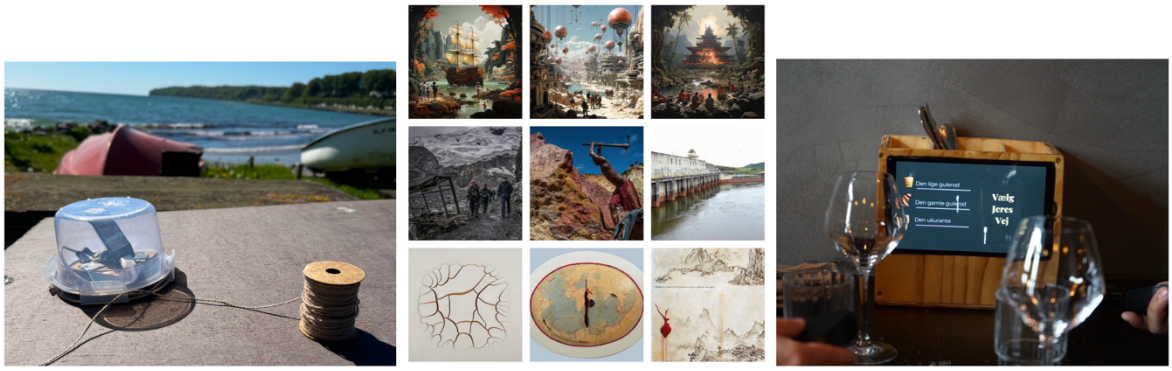

Figure 1. Three student design projects pertaining to Sustainable Interaction Design. Left: a floating camera for underwater discovery; Middle: A visual campaign; Right: an interactive cutlery holder with games related to excess food.

5 Discussion

In this section, we reflect on the five insights presented above and consider their implications for the future of SID educations. The findings clearly highlight challenges but also show promising potentials when teaching sustainability in design contexts. We argue that these challenges are not simply obstacles but opportunities for educators to rethink pedagogical approaches, course structures, and the integration of SID into broader design curricula. We here propose concrete strategies and considerations for advancing SID teaching, drawing on the insights and examples from this study.

5.1 Balancing complexity and simplicity in learning sustainability

Teaching sustainability in interaction design differs significantly between first-year undergraduate students and master's students. The courses and student experiences analysed in this paper all stem from master/graduate level courses, which, judging by the educators' reflection, was taken into consideration when designing the curricula. While sustainability is an inherently complex topic and the educators in our study allowed this to be reflected in the syllabus, the way it is introduced to the students at earlier stages must consider the level of experience, maturity, and ability to handle abstract, systemic thinking.

However, this differentiation is not always straightforward, as design education does not necessarily follow linear models of learning progression, such as the Structure of the Observed Learning Outcome (SOLO) taxonomy (Bigg & Collis, 2014). While the SOLO taxonomy describes learning as moving from pre-structural (no understanding) to uni-structural (one relevant aspect), multi-structural (several relevant aspects), relational (integrating aspects into a coherent whole), and extended abstract (conceptualizing beyond the given context), design may cut across this model. For example, even first-year students in design are expected to engage in synthesis or the creation of 'things' by ideating, sketching, combining and making creative decisions. Conversely, master's students may still struggle with foundational aspects of sustainability if their prior education did not emphasize it, requiring a return to more introductory discussions despite their advanced design skills.

5.2 Integrating Concrete Methods into SID Teaching

Is the request for concrete, sustainability-related methods from insight 4 one that educators are to respond to? This dilemma is also observed by the authors of a recent review of the sustainable and IxD landscape, wherein they "see this tension between (a) the desire and need for impact (urgently!) and (b) the calls to shift from well-established, tangible HCI methods towards approaches that are more theoretical and complex as a cause for concern." (Bremer et al., 2022). Another pressing question is also what methods would be applicable and who are to devise these in a field that is shifting towards reflection and speculation (Bremer et al., 2022). Methods like Life-Cycle-Assessments might help interaction designers working in the realm of physical products or Tangible User Interfaces and systemic impact modelling (Bornes et al., 2024) might benefit designers of services. However, their appropriateness also hinges on the nature of the courses, which are clearly different in e.g. technical requirements as highlighted in section 3.1. Finally, we also need to consider whether teaching methods is the most important improvement to curricula, given the knowledge that mindsets prevail over methods for students once they become practitioners (Gray, 2016).

5.3 Increasing Student Awareness and Designing for Awareness

Educators appear to face two related challenges: first, how to meaningfully deepen and expand students' own awareness beyond the duration of a course, and second, how to guide students in designing for actionable awareness (i.e. interventions that not only inform or provoke, but also provide pathways for behavioural or systemic change)? One possible strategy is to link design for awareness more explicitly to social practice theory or systems thinking in design education. This would allow students to consider how awareness functions as part of broader change processes, rather than as an end in itself. Another approach is to require students to articulate and reflect on the intended outcomes of their awareness-driven designs, exploring what kind of change (individual, collective, policy-level) they hope to inspire, and what assumptions underpin those expectations.

At the same time, it is crucial to validate awareness-raising work as a legitimate form of engagement especially in earlier stages if design education where empowerment and critical thinking are key goals. Rather than dismissing such efforts as insufficient, we suggest situating them within a trajectory of increasingly complex and impact-oriented sustainability interventions, guiding students to see awareness as the first step in a continuum that may include persuasion, facilitation, and structural transformation. In this sense, designing for awareness should not be seen as an endpoint, but as a gateway or a pedagogical and creative space where students begin to grapple with the challenges of sustainability, explore their values, and develop a critical stance on the role of design in shaping

futures. Educators can build on this by scaffolding subsequent learning experiences that expand the repertoire from awareness to action.

5.4 The Limits of Awareness

Counting on awareness alone to mitigate climate change is not likely feasible. The relationship between awareness and action apropos of climate change is non-linear. That is, one imagines that the more awareness, the more climate action. Actually, only the most committed are likely to take actions. Others may not take actions as readily, regardless of awareness. The point is made in the Harvard Business Review by De Langhe, Puntoni, and Larrick (2017), referenced in the IxD context by Blevis & Blevis (2022). There needs to be a decoupling of responsibilities for climate actions between only those who are committed and those whose awareness or even denial does not lead to action. In the educational context of Design and HCI this is stated in the latter aforementioned source as a Non-Linear Design Thinking Framework used in one of the courses described in this study. An example appears in that article, quoted here with permssion as

Linear	*we may expect that the more interaction designers understand SHCI, the more they will design for climate care*
Non-linear, Actual	*actually, only some interaction designers care about climate care and only those who care a great deal will focus on design with climate care in mind*
Non-linear, Needed for Impact	*rather than require specific knowledge of SHCI, seek and integrate broader appeal and impact into everyday interaction design decisions without requirements for such specific expertise*
Decoupled	*popularize design methods that encode climate care actions automatically, not unlike automated accessibility checking*

Table 2. Climate Care and SHCI

5.5 Individual, Community, Corporate, and Governance Actions

If individual awareness alone is not sufficient to mitigate and adapt to climate change, it stands to reason that we should not only focus on the individual. What are the alternatives? These may be to focus on community, corporate responsibility, design policy & governance, in addition to individual behavioural change. Now actually, this has been observed since the beginning of the SID corpus. Blevis's (2007) principles, namely (a) linking invention and disposal, (b) promoting renewal and reuse, (c) promoting quality and equality, (d) decoupling ownership and identity, and (e) using natural models and reflection apply equally to these levels of individuals, communities, corporations, and policy makers. To the point, one of the examples used in Blevis (2007) is the Leica Camera AG corporation who committed to a program of warranting that their digital cameras would always be upgradeable as new sensor technologies emerged. They have more or less kept their promise. At first in HCI, many projects focused on individual behavioural change. Over time, various authors have also engaged with notions that community, corporate responsibility, and governance are also critical to the success of the climate care mission. Now more than a decade ago in 2013, Pierce, Strengers, Sengers, & Bødker

(2013) organized a special issue of the *ACM Transactions on Computer-Human Interaction* motivated especially by this point.

5.6 Limitations

This study has several limitations. First, the participant pool was relatively small (13 students across four institutions), which constrains the generalizability of the findings. Second, participation was voluntary, and it is likely that students with more positive course experiences were overrepresented, meaning that more critical or disengaged perspectives may be underreported. Finally, while the qualitative approach allowed for rich and detailed insights, it also introduced a degree of interpretive subjectivity. The construction and validation of themes reflect researcher interpretations, which may have shaped the emphasis and framing of the findings.

6 Conclusion

This exploratory study offers insight into the challenges and potentials of teaching SID. Based on interviews with students who had participated in sustainability-related interaction design course, educators' reflection on the curriculum design of those courses, and student design projects, we reveal a landscape of experiences marked by both enthusiasm and complexity. Students show strong engagement when sustainability becomes personally relevant yet struggle with translating abstract concepts into concrete action. Educators face the dual task of fostering critical reflection while also equipping students with practical methods and tools. Overall, these insights point to the overarching concern of balancing theoretical complexity with simplicity and accessible, practice-oriented ways of teaching design. Ultimately, the challenges outlined in this paper point toward opportunities for innovation in teaching and curriculum design. By advancing pedagogical approaches that move beyond raising awareness to inspiring action, educators can help shape the next generation of designers who are not only capable of imagining sustainable futures but also of building them.

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