Fostering Sustainable Making Practices in a Student Makerspace

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Abstract. Unsustainable consumption and production practices in the workplace exacerbate the environmental crisis. Student makerspaces are one such workplace that encourages student innovation by offering a supportive environment for experimentation and learning but also contributes to issues of overconsumption, disposal, and obsolescence. This research explores the question: how can student makerspaces support student makers in making more sustainable choices? We provide empirical insights into the experiences of student makers, identifying the factors that encourage them in, and the potential barriers that prevent them from, reducing physical waste throughout the prototyping process. Our findings offer potential design considerations for encouraging sustainable behaviour among student makers in a makerspace environment.

Keywords: Sustainable making practice · Student makerspace · attitude-behaviour gap · Design for behaviour change.

1 Introduction

Student makerspaces serve as communal workplaces that encourage collaboration, as well as the exchange of knowledge, tools and ideas while learning [1]. Makerspace activities typically involve a mix of coding, digital fabrication methods like 3D printing and laser cutting, and various forms of material exploration [1]. However, makerspace practices often have a high material impact and lead to the production of a large amount of physical waste, such as scrap materials, and unsuccessful or leftover encasings that are no longer useful after a project is finished. This highlights the need for student makers to reflect more deeply on the environmental implications of their projects [4, 2]. To engage in sustainable making, students must examine the consequences of their decisions beyond the design process, actively prevent waste, and manage the waste that they produce[2].

The question this raises is: How can student makerspaces be designed to support students in making more sustainable choices about the materials they utilise, and the waste their projects produce? We propose that studying the making behaviours and the factors shaping and influencing such choices can lead to the development of design guidelines for interactive systems and interventions supporting more sustainable makerspaces. A maker's decisions are frequently influenced by the socio-technical affordances of the makerspace environment.

While student makerspaces are typically built to facilitate learning[1], the organisational conventions of makerspaces (e.g. time and cost associated with a project, limited access to low-impact materials, restrictions to technical support or waste management practices) can hinder sustainability[5]. In this study, we aimed to investigate further how the configuration of a student makerspace, in terms of both community and material factors, can support or obstruct the development of sustainable making cultures.

2 Methods

In line with our aims, we carried out semi-structured interviews with 3 makerspace supervisors who oversee university student makerspaces, as well as a 10-day cultural probes study with 8 student makers whose degrees necessitate that they utilise these makerspaces for coursework. Cultural probes typically consist of a collection of artefacts like a diary, camera and prompts that capture participants' thoughts about a given topic [3]. We designed a probes kit (see Fig. 1) to elicit students' reflections on the waste that results from their making activities. The goal of both studies was to obtain both student and expert perspectives on the causes of physical waste in makerspaces, how constraints faced by student makers contribute to the production of waste, and potential approaches to decreasing and managing waste. In addition, the cultural probes study also aimed to understand what motivates students to engage with sustainable making more broadly. For each of the two studies, we used thematic analysis coupled with both deductive and inductive coding to analyse the data.

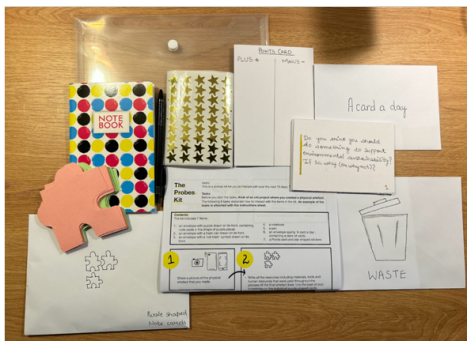

Fig. 1. Probes Kit - Instructions, a diary, puzzle-shaped note cards, 'Waste' & 'Not waste' envelopes, a self-evaluation points card, and ten daily reflection cards.

3 Findings

In this section, we synthesise our two studies to demonstrate, from the perspectives of both makerspace supervisors and students, what motivates student

makers to engage in sustainable making; what barriers to sustainability student makers face; and potential strategies that might support more sustainable making in makerspaces.

Motivating factors for sustainable making. Motivations are makers' beliefs, which encourage them to carry out a desired action. The students' probes responses showed that they believed that a sustainable makerspace culture where others adopt sustainable making practices would encourage them to make more environmentally conscious decisions. They also expressed that visualising the impacts of their actions such as how much they saved from being polluted, could be motivational. They also believed that making sustainable choices would be more motivating if they were coupled with a tangible benefit, such as a reward or recognition. Another motivation highlighted was the convenience of acting sustainably, for example having easy access to low-impact material options. The students reflected that if given the opportunity, they would reuse or recycle scrap material, but the options to do so in their makerspace were currently inadequate or inconvenient.

Barriers to sustainability. The makerspace supervisors felt that when students do not have to account for the cost associated with the materials used, this can often lead to ineffective planning and hence overconsumption and wastage. They also reflected that a lack of knowledge and experience of materials, machines and processes can result in inefficient use of resources. The supervisors also observed that students often face a pressure of deadlines which can lead them to de-prioritise environmentally sustainable making, while prioritising ensuring that what they make meets a particular deadline and is of high production quality. Lack of knowledge and instructions, as well as constraints tied to prioritising deadlines, were also barriers that arose in the students' probes reflections.

Another challenge highlighted by the supervisors was that waste is often invisible, as students may not observe or consider what happens to their project's output post-production. Consequently, they frequently leave unused artefacts for someone else to dispose of, despite being provided with skips for material waste and recycling bins. From the students' perspective, in turn, the cultural probes revealed that students feel a lack of designated space to store material for future reuse can be a major barrier to sustainable material usage. This is exacerbated when there is a lack of communication with other makers to find out if the scrap material could be used by another maker.

Strategies for supporting sustainable making. Finally, the participants across both studies came up with a number of strategies that could be adopted in student makerspaces to support more sustainable making practice. The makerspace supervisors suggested: supporting students to plan for the complete lifecycle of a prototype from the start; asking students to get involved in the process of "dealing with" the waste, for example by encouraging disassembly and appropriate disposal; encouraging the use of scrap material for low-fidelity testing;

and setting project tasks with constraints, like assigning projects necessitating designing with waste. These included supporting better planning to reduce material waste, for example, asking students to use alternate low-impact materials or techniques, making their prototypes easier to dismantle to feed the materials used back into the production cycle or considering what is recyclable before dismantling. Students, on the other hand, felt that analysing and understanding the impact of their design would inform their sustainable decisions and planning. They also brainstormed actions to manage waste produced such as recycling the used materials as well as storing used and leftover materials and prototypes for future reuse to avoid having them go to waste.

4 Discussion

Our research demonstrates a number of barriers, motivations and opportunities for strategies that should be considered when exploring how to support sustainability in student makerspaces. As we have demonstrated, student makerspaces are complex environments where a variety of interacting factors influence the extent to which sustainability is prioritised in the making process. For example, students' goals of meeting deadlines, together with a lack of knowledge about the sustainability of particular materials or production methods, and a lack of constraints on using new materials, can all lead to unsustainable making practices. Our findings of potential strategies for encouraging sustainable making, both from the perspectives of students and makerspace supervisors, also provide a starting point for exploring how interventions might be developed to ensure that sustainability is supported. For example, interventions that reward sustainable practices, make waste material visible and readily usable for future making, and support a learning culture that values material sustainability, can all serve as ways to embed sustainability at the core of the making process. We invite further research to address what behaviour change strategies could be incorporated into the design and how to assess their effectiveness.

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