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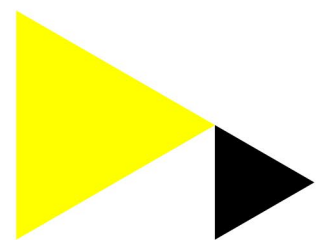
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# Engaging in (Un)Sustainable Practices: Making Data Physical

in Workshop Settings

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This work explores the potential of *doing collaborative data physicalization* for discussing (un)sustainable practices. For this purpose, it draws on experiences from several data physicalization workshops during the period of 2018-2022, conducted in Amsterdam, The Netherlands, which were available to mostly inexperienced groups of people, including almost a hundred primary school students. This paper particularly focuses on a recent held dataphys workshop with over 20 adult participants, such as including international students and climate activists. Based on learner reports (self-assessment questionnaires) ( $N=20$ ), and observations, it was found that the *process of making data physicalizations* in workshop and educational settings can be beneficial for engaging in collaborative creative and critical discussion of (un)sustainable practices. Particularly, the participants positively indicated to have learned from the dataphys workshop on a 5-point Likert scale and agreed that it enabled (1) critical thinking, (2) data understanding, (3) creativity, (4) collaboration, and (5) awareness of (un)sustainable practices. This paper presents the workshop format, including ingredients such as live cartoon capturing, and challenges in realizing such value in the context of sustainability, such as including a wider public, the conscious use of data and materials, and discussable effective outcomes.

CCS CONCEPTS • Human-Centered computing • Sustainability • Education • Visualization

**Additional Keywords and Phrases:** Data physicalization, Workshops, Sustainability, Education, Creativity, Co-creation

## 1 INTRODUCTION

Data physicalization -crafting visual representations of data- has gone through a long tradition and uprising research interest. According to Jansen et al. [11] “*Traditional visualizations map data to pixels or ink, whereas physical visualizations map data to physical form.*” There is a growing list of physical visualizations and related artifacts (see [4]) that help imagining this phenomenon. Such examples and other research (e.g. [5,11,19,22,23,26]) have begun to demonstrate the potential for physical representations to aid in the understanding and discussion of data and abstract

occurrences. There are several general challenges and opportunities for data physicalization as outlined by the HCI community [12,29,30]. One of the next challenges are to better explore what, and how data physicalization *activity* can support abilities and skills such as learning and communication [12], and further help support 21st century skills [2], namely creativity, collaboration, critical thinking, and data literacy [14,15]. In the context of *doing data physicalization*, previous work points to the need to scale [10]; providing democratic, interactive means and formula for also including a wider group of non-experts [8,9] and engage beyond particular maker- and research sub-cultures [24,34].

The creative method of data physicalization has been explored in various domains, such as in HCI teaching and workshop settings [9,10,27]. For sustainability goals, physical representations themselves have particularly shown interesting opportunities for visualizing matters of climate change and impact, such as for dietary choices, showing pollution and motivating the use of renewable energy sources [7,13,28,32,36]. Further uncovering this potential, this work explores on leveraging the potential value of data physicalization activity in workshop settings for engaging a larger group of mostly inexpert people that were introduced to this method. It particularly focuses on the *collaborative act of doing data physicalization* for engaging in sustainable practices.

### 1.1 Data physicalization in workshop settings

To uncover the potential of data physicalization activity and developing an effective format in general, a series of workshops and teaching activities was first undertaken. All workshops were conducted in Amsterdam, and a total of 132 participants took part in the period just before the COVID-19 pandemic outbreak in 2020. The workshop format was based on previous work [9], and outcomes of each workshop, that iteratively informed the next workshop approach. The number of workshops mainly included: (1) A pilot workshop with (semi) experts (n=6), (2) A dataphys workshop, openly advertised to the wide public (n=32), (3) A dataphys and didactic design session with primary school teachers (n=6), and (4) A dataphys course with primary school pupils from 9-12 years old (n=90). Given the realistic and changeable settings of such open workshops (such as available time and participants), a mixed-method approach was used to evaluate the various outcomes, which mainly included live-observations (all), completed learner reports (a type of self-assessment questionnaire [21,33][18]) (for ws 2 and 4), and video interviews (for (ws 4)). Results are shown in [15], and demonstrate that *the act of physicalization* of various data of societal matters (from human connectedness to environmental waste) in workshop settings can be enjoyable and engaging for a large, varying audience, and support participants' self-reported way of critical thinking, creativity, collaboration, and data literacy. The workshop and class activities were found effective in introducing mostly inexperienced participants and teachers to the basic concept and act of data physicalization and engaging them in this yet uncharted territory.

### 1.2 Data physicalization of (un)sustainable practices

According to Clarke Snell [31] "*Climate change is boring [...]*", yet due to its pressing matter, "*it requires that we finally all work together if any of us are to continue working at all.*" Seeing previous workshop results and the challenge of engaging collectively in matters of sustainability, data physicalization activity might help towards realizing this goal. After the peak of the COVID-19 pandemic, in October 2022, a dataphys workshop 'Co-creating beyond green' was conducted during the Society 5.0 festival (<https://society5festival.com>), that was organized and open to our applied university network partners and widely targeted at 'designers, artists, policy makers, researchers, teachers and students'). More than 20 participants joined -from climate activists to international students, and with different technical, social or design backgrounds and familiarity to the workshop theme (see also Fig. 1). Given our lessons learned based on previous activities, the workshop format consisted of these key ingredients:

1. **Intro activity:** As a collaborative introduction, at entrance, all participants were given the assignment to write down their sustainable (#WOW) and unsustainable (#OWW) practices of the day on green and red cards. They hung these cards on a visible line in the workshop room, thus for everyone to see. This was then followed by a short introduction.
2. **Dataphys examples:** The presented introduction included several examples of data physicalization (such as collected from [1,16,20]), particularly in the context of sustainability. These were also hung as posters in the allocated festival space. Participants often indicated this to be an important source of helpful inspiration.
3. **Data sheets,** as in short descriptive stories with facts and figures regarding sustainability issues, were prepared beforehand. Given the short workshop time frame (one and half hour), the participants could so focus most of their time on translating suitable data to physical forms, as also recommended in [14]. There were several sheets to choose from [17], such as from national sources as Statistics Netherlands (CBS) [3], and from more local sources, for example about energy usage in different university buildings. Interestingly, not all data is easy to obtain or approved for public sharing; the extent of sustainable policies, actions and actual impact can be sensitive matter.
4. **Visual capturing:** The capturing of all workshop activity, such as for further study, can be challenging at a larger scale, as different interactions are happening the same time. Sufficient observers, and video capturing, as well as interviews with consenting participants afterwards, can be useful for understanding the different perceptions of all involved. A new workshop addition was the introduction of a live drawing artist, who was also new to the subject, and translated the happenings in 2D live-drawings for gaining a different creative perspective (see [6], and Fig. 1,2).
5. **Conscious usage of materials:** The workshop materials that contained all sorts (based on [9,15]) were organized in individual boxes and set on the different table groups to ensure a neat flow. In creating data physicalizations, the conscious usage of materials forms an extra challenge in the sustainability context. Materials were recycled, bought from shops with mostly sustainable ideals or collected from nature. There was more scarcity of materials due to a larger than anticipated public, and the sustainable desire to not overconsume these. Also, the participants' physicalizations were mostly deconstructed afterwards for the re-use of material, but thereby losing the materialistic aspect of the representation for further discussion or interaction afterwards. Interestingly, the material itself, such as cut flowers, also invited for discussion on (un)sustainable matters.
6. **Face-to-face group discussion:** Individuals were set in table groups, and often new to each other. Particularly after the COVID-19 pandemic and imposed regulations of social distancing, physical face-to-face interactions such as in this workshop appeared as a welcome change [25]. Getting to know and understand each other's perspectives and physicalizations through discussion was considered an important part of engaging in the workshop activity. Also according to [31] '*The climate is collective*'.



Figure 1: Live cartoon of data physicalization workshop (left), and photos of the setting (right).

## 2 RESULTS & DISCUSSION

The method of dataphys was welcomed as another way of doing and thinking, as one participant reported: “*I learned so much on data physicalization and would like to apply it to my projects*”. According to the completed learner reports (self-assessment questionnaires with open and closed answers on a 5-point likert scale, N=20), the workshop was overall liked (95% positively scored 4 or 5 on the scale) and considered insightful (85%), which respond to our previous workshop results. The large majority agreed that data physicalization and its visual approach enabled the explanation of ideas (95%), coming up with a solution (94%), supported creativity (95%), critical thinking (74%), collaboration (90%) and data literacy (89%). For all workshops, participants often reasoned that this happened because of the visual physicalization activity, and the rich presence of all kinds of materials. For data physicalization in sustainable ways, this is however an extra challenge to consider. The final data physicalizations took on many forms, and on its own these were not always self-explanatory. Yet, the workshop methodology introduced to participants invited for lively discussion on (un)sustainable practices (see Fig. 1, 2 and 3) which was considered most important. Although these results need to be further verified, this was also supported by the observations. For this purpose, the challenge is coming up with effective evaluation instruments that work within different large-scale context and realistic changeable workshop settings. Also, even though this workshop was short due to the festival constraints, (more) time for discussing and creating was reported as important for successful dataphys.



Figure 2: Data physicalization has many forms... and these are not always self-explanatory or easy to explain. Live-cartoons, matched with photos from participants showing data physicalizations of energy consumption, and (un)sustainable practices on a circle platform.



Figure 2: Photos of the dataphys workshop and data sheets (left) and data physicalization as interpreted by live-cartoonist (Right).

Physical thematic analysis of participants' 33 red and 29 green cards (N=62) from the intro activity (Fig. 3) uncovered that participants' input mainly focused on sustainable travel -e.g. 'cycling to the workshop'- and consumption -e.g. 'Using a refillable bottle'-, while the latter might not make the highest sustainable impact. On the other hand, other (un)sustainable practices, namely digital ones such as in the use of technology and data storage and their potential climate impact, were hardly mentioned (n=1). The challenge appeared in uncovering, discussing and focusing on the kind of actions that in comparison will make the most effective impact [35]. The HCI community and data physicalization could play a positive identifying role in this matter.



Figure 3: Shown are the workshop intro activity and the physical evaluation with the cards with noted (un)sustainable practices in red (#OWW: Unsustainable) and green (#WOW: sustainable).

In conclusion, this paper discussed the format and challenges in applying data physicalization for collaborative sense-making in workshop settings for wider engaging in sustainable change. According to our workshop experiences, data physicalization appealed to the various types of participants with different theme familiarity. Participants learned to “deal with data in a different way” and largely agreed that data physicalization supported creativity, critical thinking, collaboration and data literacy. As such, co-creating data physicalizations can help to (a) creatively engage a wide group of participants in a challenging and complex topic -which is particularly helpful for an abstract theme as sustainability, (b) uncover perceptions on what participants see as being (un)sustainable, and what they might be missing, and (c) trigger collaborative creative discussion for effective sustainable action. The extent to which *the collaborative process of doing* dataphys in workshops helps to support sustainable collaborative solutions needs to be further evaluated. For this purpose, effective evaluation methods and suitable data for sustainable practices are needed. Building on the dataphys challenges as already put forward by the HCI community, further verification of the value of *doing* data physicalization and its key ingredients for collective large-scale sustainable action that is most impactful is the next challenge.

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