Participatory Design of "Our Eco-Logbook": Supporting Children's Climate Action Through Interactive Data Visualisations

Participatory Design of "Our Eco-Logbook"

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Given the current climate crisis, there is an increasing need to get children involved in climate action, so they can champion pro-environmental behaviours into their adulthood. This paper describes the preliminary results from the participatory design of an interactive data visualisation (IDV) dashboard, "Our Eco-Logbook", aimed to support children's climate action in their schools. IDV are touted for their potential to foster critical self-appraisal and collaboration skills in other domains but has not been examined extensively in the context of climate action with children. We worked with an Eco-Committee and Eco-Coordinator at a partner primary school to develop an open-access resource for schools to use to plan, monitor, and evaluate their climate actions, and get others in the school community engaged. Our future work aims to examine the impact of the tool on children's identities as change-makers and develop the tool for more wide-spread use.

CCS CONCEPTS • Human-centered computing • Visualization • Visualization application domains

Additional Keywords and Phrases: data visualisation, climate action, sustainability, Eco-Schools

1 INTRODUCTION

Climate scientists have warned us: act now or it will be too late. Given the urgency of the present climate crisis, research is needed to understand how to embed climate action into our everyday lives. As budding independent decision-makers who will inherit the climate crisis, children and teenagers (henceforth, "children") can and should play major roles in climate action at local, national, and global scales. In the UK, 49% of young people report being very or extremely concerned about climate change and, whilst participation in climate action is increasing, another 26% avoid talking about climate change altogether [11]. Some researchers purport that a core problem is that the environmental curriculum in the UK teaches *about* climate change, rather than *for* climate change resolution [6]. Our educational systems rarely provide mechanisms for children to translate their environmental knowledge into

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practical action [10, 14, 18]. Thus, children's identities as change-makers are insufficiently nurtured in mainstream curricula, and those children who are motivated do not have readily-available means of acting on their climate knowledge, particularly as a coordinated collective.

In today's digital age, technology may inevitably play a role in enabling children to communicate, organise, and disseminate messages about climate action as a collective. Whilst an ability to "track results and showcase the positive impact of [students'] actions" [12] was identified by UK teenagers as the third-most motivational factor for engaging in climate action, there remains a dearth of digital tools that facilitate children's monitoring and evaluation of their climate action. For instance, our recent literature review of publications targeted to the child-computer interaction community found only a handful of digital interventions designed to support children's sustainable actions [22]. Furthermore, these interventions were largely limited to eco-feedback interventions, e.g., interactive data visualisations (IDV) that display households' or schools' use of natural resources (energy, water), to encourage reduced consumption [22]. However, children's climate action can be more diverse than reducing resource use, and can range from climate-forward life-style changes (e.g., plant-based eating, green transport, pollinator-friendly gardening) to organised activism practices (e.g., climate petitions, boycotts, protests; establishing anti-consumerist/degrowth movements) [15]. As such, a broader perspective on how IDV can support children's climate action is warranted. IDV is increasingly demonstrated for its potential to build skills necessary to support children's translation of knowledge into action (such as critical self-appraisal and collaboration skills) in other domains, like personal health [17, 23] and education [4], but exemplars as applied to climate action—particularly for younger children—remain scarce. We do not know how children might use IDV to inform their action and involve communities more broadly.

This paper reports on the early co-design phases of "Our Eco-Logbook" (henceforth, "Eco-Logbook"), an IDV dashboard designed to support children's planning, monitoring, and evaluation of their climate action, and share their action with their broader school community in the context of the Eco-School UK programme. Eco-Schools is an extracurricular programme that aims to "rally and unite young people to make realistic but dynamic change, creating positive impacts for our planet *now*" [7]. It outlines seven steps (S) toward supporting school communities to enact impactful climate action: (S1) forming an Eco-Committee (a group of children supported by a member of staff, the Eco-Coordinator), (S2) conducting an environmental review of the school around ten sustainability topics (e.g., biodiversity, marine ecosystems, litter), (S3) preparing an action plan to address three of these topics, (S4) linking these sustainability topics in everyday curricula, (S5) informing and involving the entire school community, (S6) monitoring and evaluating their actions' impacts, and (S7) developing an eco-code for sustained action at the school. Whilst these steps are a starting point for schools to follow, there is conflicting evidence as to the success of the Eco-Schools programme [3, 5, 9], due largely to the flexibility in how it can be implemented. We partnered with the Eco-Committee and Eco-Coordinator at a primary school in Oxfordshire, newly enrolled on Eco-Schools. It is within this context that we embarked on designing the Eco-Logbook, to support this Eco-Committee in engaging in climate action through the Eco-Schools programme. More broadly, our aim was to produce an IDV dashboard resources that could be used and extended by other schools, to increase the potential impact of this work.

2 THE PARTICIPATORY DESIGN PROCESS

We engaged in a participatory design process over a period of two months with seven children in the Eco-Committee (aged 9-11, five girls and two boys; one girl opted out after the first workshop) and the Eco-Coordinator. We followed the typical four phases of design-thinking [16], focusing on (i) *empathising* with our participants and

defining the design problem, (ii) *ideating* approaches to the IDV intervention, (iii) initial *prototyping*, and (iv) two rounds of *formative evaluation*. We conducted a 45-minute workshop with the Eco-Committee and Eco-Coordinator in each of phases i and ii and two workshops in phase iv. Additionally, we conducted short interviews with the six children, the Eco-Coordinator, and two of the children's parents, as well as observed Eco-Committee meetings, at the start and end of the design process (phases i and iv).

2.1 Empathising and defining

The first workshop aimed to explore what sustainability topics children prioritised in the Eco-Committee and their views of climate problems as they manifested in their school. To make this relatable to the children, we structured the workshop around an "Eco-Campaign" the children were tasked to design for their school. The eco-campaign activity helped us probe who the children wanted to involve in their efforts and why (S5), what information they wanted to monitor and inform people about (S6/S5), and how they negotiated their planning and decisions amongst themselves (S3). Importantly, it also served as inspirational context for the activities in later workshops. We first introduced children to the concept of an eco-campaign and "calls to action", then asked them to create a plan for their own eco-campaigns around one of their climate actions. Children worked in pairs on an eco-campaign plan for one of three focal sustainability topics (marine, biodiversity, or litter). The probe asked them first to list the different actions that the Eco-Committee was working on for that topic, circle one that they wanted to focus on for their eco-campaign, and choose the audience that they would target with their campaign (family, friends, classmates, other). It then asked them to describe what their audience should know about the environmental problem, what the audience could do about the problem (i.e., participate in their action), and come up with a call-to-action. Finally, it asked children to decide on the format of their campaign (e.g., pamphlet, poster, video, other) and plan what actions each member of the pair would take in making it happen. Figure 1 depicts the cultural probe completed by the marine-topic pair, who designed a "Less Fishy Fridays" campaign. The other two groups chose to focus on Weekly Litter Picking (litter topic) and a Wildlife Area (biodiversity topic) on the school grounds. Looking across the work from all three pairs, we found that children wanted to reach broadly to everyone in their community. Notably, two out of three pairs of children expressed concern about using paper products (pamphlets, posters) for their campaigns, as these "killed trees", so wanted to use digital methods. Children also wanted to be acknowledged as leaders on these actions in the school, wanting peers and family to see and appreciate the work that they were doing for their community.

In interviews with the Eco-Coordinator, as well as through observation of an Eco-Committee meeting, it became clear that the committee had difficulty negotiating actions that were feasible within the broader school ecosystem whilst still being meaningful (S3). To exemplify, they used the environmental review (S2) to inform where to direct their effort (e.g., toward sustainability topics that they performed least well in, like marine) but, ultimately, their choices of planned actions were driven by what was most quick and feasible for them to accomplish. They also struggled to determine effective ways of informing/engaging stakeholders beyond school walls (e.g., parents; S5). For instance, a monthly school newsletter was distributed to parents by email, but email was identified by parents as problematic, because of the sheer quantity they received from the school. Parents suggested that a more visual means of communication, that could be regularly and quickly viewed, would be more appropriate. Furthermore, the Eco-Coordinator expressed concern about not having systematic and practical ways to approach monitoring and evaluating their climate action (S6) in relation to the campaigns the children identified, as well as ways of communicating this progress to parents beyond email (S5).

Through our analysis of data in the empathising phase above, we defined that the IDV dashboard should aim to support Eco-Schools steps S3, S5, and S6. As such, our design question asked, "*how can IDV support children's planning, monitoring, and evaluation of their climate action, as well as inform and engage the school community more broadly?*".

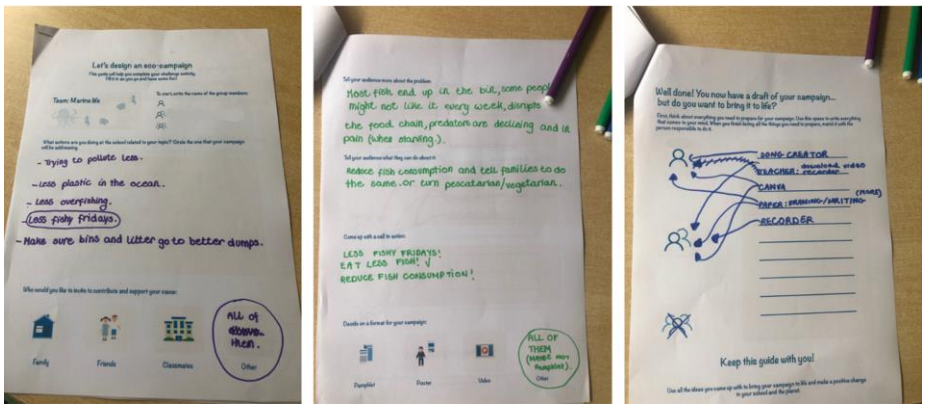

Figure 1. Cultural probe filled out by two children who planned a "Less Fishy Fridays" campaign to conserve marine ecosystems.

2.2 Ideation

We conducted a second workshop with the children and the Eco-Coordinator to ideate ways to answer our design question. We first introduced children to some simple data visualisation examples (e.g., map, bar chart, line chart, donut chart) and asked them to interpret these, to ensure they all had the same baseline skills. Previous work has identified that children can interpret bar, line, and pie (similar to donut) charts [2]. The children had a good grasp of the map example and were able to situate all their eco-actions on a printed map of their school. They were excited by this activity, and the Eco-Coordinator expressed afterward that mapping these out helped connect their actions to place. They also easily interpreted the bar and donut charts, which displayed the results of their environmental review. Children easily described their performance on different topics in reference to the charts. In their working pairs, they were also able to interpret line charts when a single line was used but struggled when more than one line/category was visualised.

Grounded in the most interpretable graphs, we then asked them to focus on the action they targeted in their eco-campaigns and brainstorm what kinds of data they could collect about the action. All groups thought that they should count how many people participated in their actions. The other data metrics they suggested were action-specific. For instance, for Weekly Litter Picking, children thought they could measure the amount of litter collected each week in kg, bags, or items. For the Wildlife Area, they suggested counting the number of animal shelters they crafted and how fast the wildflowers that they planted were growing (they did not reflect on the practicalities for making such measurements). Finally, for the "Less Fishy Fridays" campaign (which the pair now refers to as "No Fishy Fridays"), they suggested (i) asking the canteen cooks, on a weekly basis, how many fish were served to children, to see if the number decreased over time, and (ii) conducting a survey with their peers to ask who actually likes Fishy Fridays, to use as evidence for petitioning the school administration to ban Fishy Fridays and institute Vegan or Vegetarian days.

Following this open brainstorming, the children were then given craft materials, including stamps, markers, graph templates, and blank paper, to design their own graphs for their actions, allowing for a child-centric approach.

For the Wildlife Area, one child drafted a bar chart of the growth of flowers, using the flower stem as the length of the bar. The other suggested just showing a large number for the number of animal shelters they created, since this is a one-off activity that is not tracked over time. The Weekly Litter Picking pair did not draw anything but described that they would show litter collected over time. Interestingly, they expressed confusion about whether seeing the litter going up (we are doing our job well!) or down (people are littering less!) would be best, reflecting some understanding of the types of bias that can occur with quantification [20]. For the No Fishy Fridays' pair, they visualised the consumption of fish by fellow students over time in a bar chart, as well as their proposed survey results (who likes Fishy Fridays vs who doesn't) in a density plot (Figure 2). Overall, the children's ideas demonstrate that they have a good understanding of visuals that show trends over time and how data can be represented by symbols (e.g., Figure 2, right) [1].

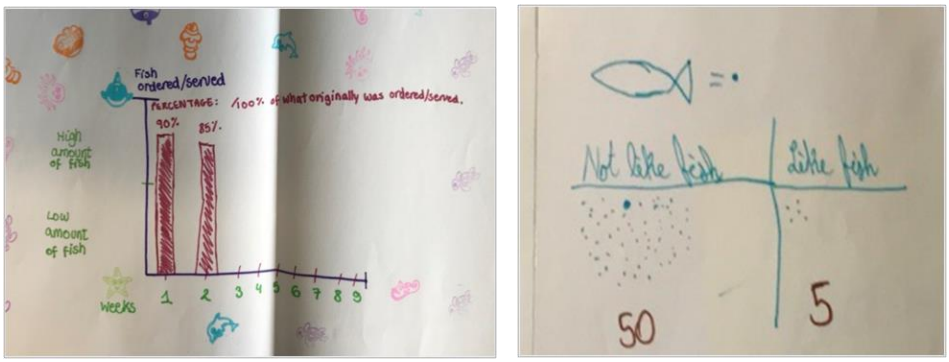

Figure 2. Children's visualisations for the "No Fishy Fridays" action, showing the consumption of fish decreasing (left) and the number of students who do/don't like fish.

2.3 Prototyping

Initial prototyping took place over two weeks. Following the ideation workshop, we developed rough sketches of an IDV interface to share with our participants and discuss their feedback via a Zoom call. We then went on to build higher fidelity prototypes, including (i) a storyboard based on the children's cultural probes of how they wanted to use the dashboard to inform and involve others, and (ii) a first interactive prototype using Tableau Public [19]. Notably, because of the amount of time we had for prototyping, some limitations in the functionality of Tableau (e.g., no density plot option), and considerations of best practices for data visualisation (line vs bar charts for data over time), there was not a direct one-to-one translation of children ideas from ideation into the prototype, which is common in co-design with children e.g., [8, 13]. However, we made sure that the children could see their ideas about data visualisation represented in some way and that we negotiated these compromises in the design with them, so that they felt that their voices were indeed heard and that they had control over how the project evolved. For example, we explained how the density chart idea was adapted into a bubble chart and used to show the number of participants across their eco-actions (Figure 3, left), and how their drawn symbols (e.g., fish in Figure 2, right) were integrated into the design (Figure 3, top right).

Overall, there were three pages to the prototype: (1) the Homepage, which displayed the school map with action pins, the results of the environmental review, and who has participated across their actions (Figure 3, left); (2) Action pages, which displayed a description of the action, a chart visualising the data of interest (either over time [e.g., fish eaten over time] or as a count [e.g., number of animal shelters crafted]), and who participated in the action

(Figure 3, top right); and (3) a Participants page, displaying who participated in each action, so that comparisons could be made across participant types and topics (Figure 3, bottom right).

2.4 Evaluation

Formative evaluation of the interactive prototype occurred over two workshops following similar protocols, but with increasing levels of fidelity. We first used the storyboard to contextualise the use of the Eco-Logbook. In pairs, children then explored the dashboard facilitated by a researcher who evaluated the usability of the interface and asked probing questions. These questions focused on understanding how IDV supported S3, S5, and S6.

For S3, we probed how children would use IDV (e.g., Environmental Review donut and bar charts) to plan future actions. They generally wanted to plan actions around topics with low scores, thinking about ways to accomplish easy tasks for each topic to "make at least a bit of a difference", building on their strategy observed in the committee meeting.

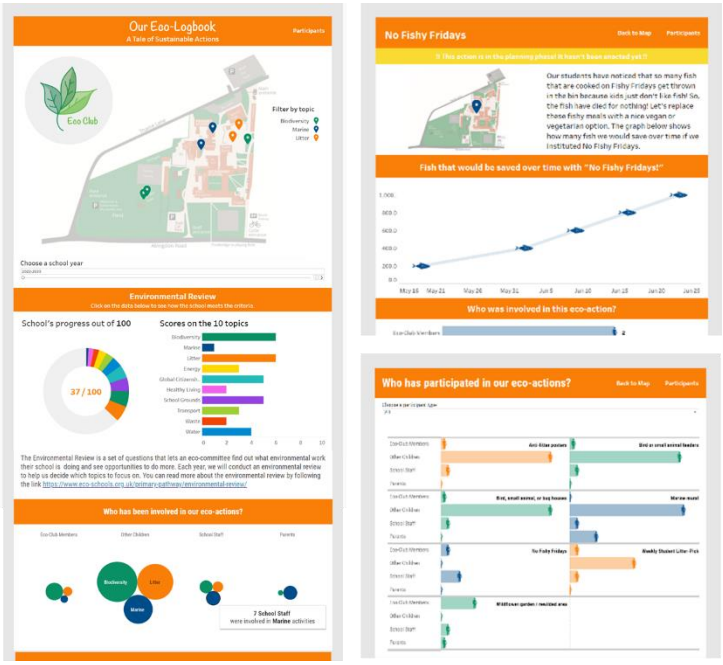

Figure 3. "Our Eco-Logbook" prototype v1.0: Homepage (left), Action page for No Fishy Fridays (top right), and Participants page (bottom right).

For S5, we probed how the IDV (e.g., participant bubble chart and bar charts) could inform who to recruit for their actions and if they thought these visuals would motivate their friends/family to get involved. For example, using the bubble chart, the marine pair identified which groups of participants were most or least involved in the activities, commenting that the participation of parents was "quite small" and "just sad". Children suggested how they would share the IDV with family members to get them more involved and suggested accessibility considerations for certain members (e.g., larger fonts for one girl's grandmother).

For S6, we probed if they understood the IDV for the action pages and how this informed their next steps. The charts acted as conversation starters between children, e.g., how to convince more children to reject fish on Fridays, how different committee members could contribute to an action to improve it. Furthermore, a child from the litter group suggested the potential impact of visualising their progress to others: "it's showing the headmaster that we're making progress and he's not kicking [the Eco-Schools programme] out the window." Figure 3 shows the design of Our Eco-Logbook v1.0, that was achieved by the end of this participatory design process.

3 CONCLUSION AND FUTURE PLANS FOR OUR ECO-LOGBOOK

This initial participatory design research on "Our Eco-Logbook" demonstrated the potential for IDV to support children's planning, monitoring, and evaluation of their climate action. Our results suggest new ways to foster children's climate action beyond narratives of resource management [21] and extend previous research in other domains touting the potential of IDV to facilitate self-appraisal and collaboration skills [4, 17, 23]. The participating children also saw potential for the IDV to engage other school community members in their actions—a crucial aspect of collective action [10]—though this has yet to be evaluated. We have recently acquired Knowledge Exchange funding to work with Keep Britain Tidy (who run the Eco-Schools UK programme) to further develop this tool, make it more robust, and extend its reach in UK schools. With this, we intend to further explore diverse implementations of the Eco-Logbook in primary and secondary schools nationally, to better understand how IDV can empower children to take leadership in climate action, foster their identities as change-makers in their schools, and engage their school communities in meaningful and impactful collective action. Open resources from this project, are available: https://tinyurl.com/vis-tech-for-eco-schools.

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