











Grasping Data Through Play: Exploring Co-Design Activities for Children’s Engagement with Personal Data

D Perera¹ , D Kaufmann¹ , A Ramírez-Duque² , A Atabay¹ , S Brewster² , C Wilson¹ , J Vines¹ , L Plowman¹ , U Hinrichs¹  and A Manches¹ 

¹University of Edinburgh, UK

²University of Glasgow, UK

Abstract

With the increase of “smart” toys and other devices that collect personal data from children and their carers at home and/or in public places, questions of how to raise an awareness of the value of personal data in children and how to promote an active engagement of personal data for the purpose of self-awareness have become more pressing. To address this, the Grasping Data project explores the potential of playful visualization and physicalization activities—designed with and for children—to make their personal data visible and to promote an understanding of collecting and analyzing such data for children’s own benefit. However, while research on personal data vis- and physicalization activities and bespoke toolkits exists, designing such activities for young children (3-8) and their carers is underexplored. At the same time, designing activities that focus on personal data comes with its own challenges: how “personal” data is defined in the first place, what are children’s perspectives on these, and how can navigate ethical and privacy concerns in a constructive way with children and their carers? Building on this, in this workshop paper we introduce a play-based activity to explore how adults engage and interpret personal data through play and tangible visualizations. Through this activity, we aim to explore and discuss how adults define ‘personal data’ and the potential of play and visualizations to help them ‘grasp’ the meaning and value of their data.

CCS Concepts

• **Human-centered computing** → **Information visualization; HCI theory, concepts and models;**

1. Introduction

The growing presence of personal data in children’s lives raises important questions about how young children understand, engage with, and make choices about their data [LW17]. For instance, from demographic and behavioural data collected through the use of digital devices to movement and preference data collected in public spaces, children generate a wealth of personal data often without realising it [LW17]. Children also face increasing risks from seemingly innocuous toys and devices that capture data through voice recognition, geolocation, sensors, and cameras [LW17,MP21]. These technologies allow third parties to gather and infer personal information about children including birthdays, heart rate, and location, sleep patterns, daily routines, and personal preferences. Children lack agency in these aspects, as consent for their data is either acquired through adult caregivers (who themselves may lack data literacy) or not at all. Only a few efforts to make children aware of personal data exist [MP21]. Data physicalization is used to communicate abstract concepts as it makes invisible aspects visible and tangible, enabling more immediate, sensory, and playful interactions with personal data [HHHVK23, JDI*15]. Data vis- and physicalization activities have shown some potential [HCT*14, THHC18] to explore certain data-driven topics, but,

to our knowledge, playful visualization activities that are tailored to raise children’s awareness of the value of personal data do not yet exist, nor has their impact been explored.

To address this gap, the Grasping Data project[†] aims to explore how to engage children in personal data exploration through playful visualization and physicalization activities, supporting children in representing data in tangible ways to help them ‘grasp’ its value and meaning. To address this challenge, as a first step in the project we are engaging with adults to understand what ‘personal data’ means to them and how we might design play-based activities to help them visualize their data. This will inform designing parallel activities with and for children. Therefore, to explore the potential of understanding personal data through playful visualization, we propose a play-based activity to be conducted during the VisGames workshop. This activity will help us explore how playful data collection can engage adult participants in sharing and constructing physicalizations to represent their personal data. Before we describe our play-based activity for the VisGames workshop, we first introduce

[†] <https://www.de.ed.ac.uk/project/grasping-data-empowering-young-children-understand-and-benefit-their-personal-data>

the Grasping Data project and the challenges it addresses. We then describe an initial framework we have developed to help characterize and explore the notion of personal data from different perspectives, in order to inform the design of bespoke activities. We then introduce the playful data collection and physicalization activity we would like to run at the VisGames workshop, also to further inform the Grasping Data project.

1.1. Grasping Data Project

The Grasping Data project is an interdisciplinary initiative with researchers from education, visualization, and multimodal human-computer interaction design that explores children's interaction with personal data by co-designing physicalization activities with and for children. The idea is to combine embodied playing as a fundamental way in which children explore, learn, and make sense of the world around them [VYG78] with physicalization as a form of data representation that can make abstract data not only visible but also tangible [JDI*15]. Previous work has started to explore the potential of play-based approaches in data visualization [BYY*22]. Also, data physicalization activities that promote engagement with data among adults who are not necessarily familiar with data analysis and/or data representation techniques have been found to be beneficial [THHC18, HCT*14, HGH*17], and make their way also into contexts involving children such as playful learning [KSB*23] and physical activity [ESV*23]. Building on this emerging research, the Grasping Data project focuses specifically on raising children's awareness and promoting an understanding of the value of their personal data through playful, hands-on physicalization activities. Our playful approach does not strictly focus on games in the traditional sense with clearly defined rules and objectives [DDKN11]. Instead, we aim at designing a range of play-based activities [KSB*23] that integrate well in these formal and informal learning contexts; these will span the spectrum of more structured, guided activities, to more open-ended activities that invite children to shape these themselves. The challenges we face and aim to address in Grasping Data and the playful physicalization activities are as follows:

- Understanding how to leverage children's interest in personal data; what data is "personal" to children?
- Understanding the contextual nature of what is considered personal (as data that feels private in one context may be entirely neutral in another),
- Providing a balance between scaffolding physicalization activities while giving children room for free-form exploration,
- Creating activities that balance fun with educational goals,
- Giving children agency in the design process of activities, i.e., co-designing activities *with* them, rather than for them,
- Prioritizing re-usable and sustainable materials and tools that make for activities that can easily be set-up and taken down [MBB*07].

1.2. Introducing the Play-based Activity for the VisGames Workshop

In this section, we shall briefly describe the play-based activity that we propose for the VisGames workshop, and then we shall go into further detail in Section 3.

Title of the Activity - Sharing your data: How personal is too personal?

Abstract of the Activity This activity engages participants in playful data collection and physicalization, aiming to explore their perspectives on the value of personal data. During the activity, participants engage in different data collection tasks, recording personal observations, and collaboratively physicalizing their data using materials such as LEGO blocks, beads, stickers, etc. Through comparison and discussion, the activity will encourage reflection on how personal data is collected, represented, and interpreted in a conference setting. This hands-on exercise will simulate the challenges and opportunities of working with personal data in collaborative settings, aligning with the workshop's themes of play, collaboration, and data-driven storytelling.

In the following section, we shall introduce the initial framework we are developing to help characterize and explore the notion of personal data and explain its links with the VisGames workshop. We use this framework in designing the play-based activity for the VisGames workshop and we aim to enrich discussions by exploring research in personal data and how that can be used to enhance data literacy [LW17] in children through playful physicalizations.

2. Personal Data Framework: Context, Construction & Consent

Understanding children's personal data in play-based activities requires a structured approach that accounts for the context, nature, and awareness of data collection. For instance, a major challenge in personal data research is its dependence on context. We propose a work-in-progress personal data framework which can be used as a lens for designing and evaluating activities that (Figure 1) offers a method to classify and analyse children's personal data and interactions. By integrating insights from human-computer interaction, data visualization, and child-computer interaction research [BYY*22, FOB*17, HHHVK23, HTA*14], this framework can act as a lens to help in design meaningful and engaging activities, as well as evaluation of those activities.

We shall first introduce the framework and then discuss its use. The framework consists of seven interrelated layers:

Layer 1: Contextual Classification – Where is the data being generated?

The first layer considers the setting in which data is collected, as different contexts influence the type of data generated and the child's perception of it. For instance, at home settings, data is often private and collected under parental supervision, such as tracking sleep patterns or emotional states. In schools, data may emerge from structured learning environments and peer interactions, including engagement levels and academic progress. Play and entertainment settings, such as playgrounds or informal learning spaces, can generate data related to movement, preferences, and social interactions. Finally, public spaces, such as zoos, parks, and museums, introduce data collected in semi-open environments, where children's choices, interests, and behaviours can be observed and recorded. These distinctions help in understanding how context shapes the meaning of the data and its value [LW17].

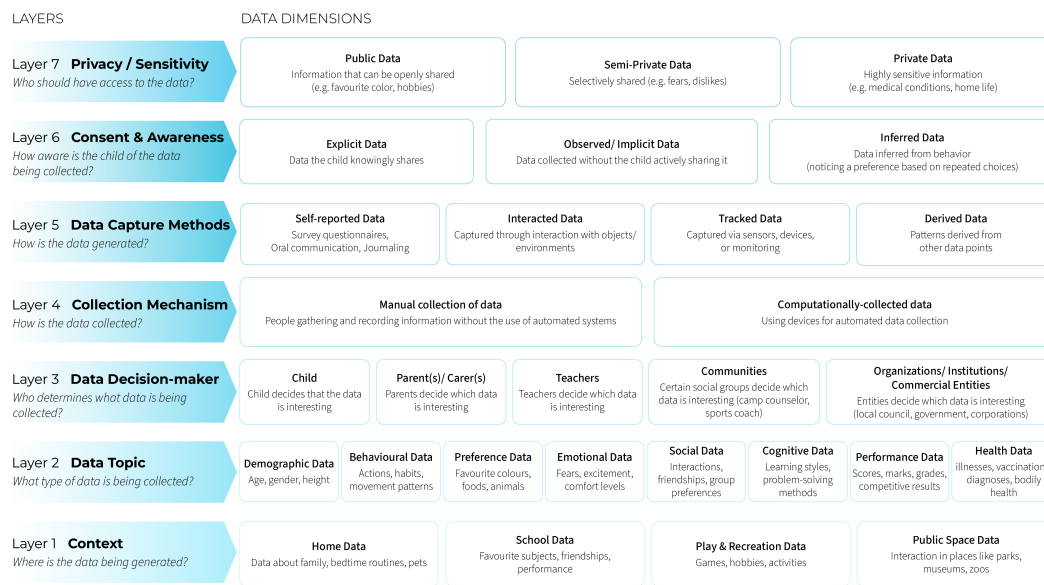


Figure 1: Proposed work-in-progress personal data framework for designing and evaluating personal data activities.

Layer 2: Nature of Data – What type of data is being collected? Children’s personal data varies in nature and purpose. For instance, demographic data, provides data about a child’s background such as age and language, height, weight. Behavioural data includes physical actions like steps taken or time spent in a location. Emotional data captures feelings and mood shifts, while preference data reflects personal choices, such as favourite colours or preferred zoo exhibits. Health data consists of medical diagnoses, bodily health, and vaccinations. Performance data contains scores related to scholastic or athletic performance, such as marks on a test or points scored in a game. Cognitive data relates to thought processes and problem-solving, while social data records interactions with peers, teachers, or parents. Categorising data types ensures that collection and visualization strategies align with child-friendly practices [BVY*22].

Layer 3: Who Decides What Data is Interesting? – Who determines what is collected? This layer highlights decision-making authority in data collection. Some data is child-led, where children actively choose what to record, fostering agency and engagement. In other cases, parents or teachers decide what data is relevant, such as tracking learning progress or behaviour. There can be instances where other groups of people decide what data is interesting and valuable to children. Recognising who decides what data is interesting, is important for ensuring that children have an active role in shaping their own data narratives.

Layer 4: Data Collection Mechanism – How is the data collected? Data collection methods can be either manual or computational. Manual data collection involves methods including direct participation, such as drawing, journaling, or selecting colours to represent emotions. This approach emphasizes reflection and engagement. Computational data collection relies on automated tools, such as wearables or sensors, which can track movement, voice, or facial expressions. While computational methods provide granular

insights, they also introduce ethical concerns about surveillance, privacy, and informed consent.

Layer 5: Data Capture Method – How is the data generated? The way data is captured influences its meaning and interpretation. Self-reported data is consciously recorded by the child, promoting awareness and agency. Tracked data is automatically collected, such as step counts from a fitness tracker. Interacted data comes from digital or physical interactions, such as selecting an option in a game. Derived data is obtained from other sources (i.e. detecting excitement based on voice patterns). Ensuring transparency in how data is captured is essential for fostering trust in child-centered research [Lup20].

Layer 6: Consent and Awareness – How aware is the child of the data being collected? Children’s awareness of data collection can vary; in explicit data collection, children knowingly participate in the data collection. However, observed data is noted by others with or without the child being aware of the data being collected, such as teachers tracking classroom engagement. Inferred data is collected without the child’s direct awareness, such as inferring personality traits through a child’s behaviour. Raising awareness about when and how data is collected supports ethical consent and privacy practices [VdH16].

Layer 7: Who has Access to the Data? The final layer determines data accessibility. Private data is highly personal which should be accessed only by the required people, such as medical records. Semi-private data is shared in controlled environments and can have limited access to necessary audiences. Public data is openly accessible, such as personal data displayed in a classroom about a child. Understanding who can access a child’s data is fundamental to ensuring that personal data is handled responsibly [LW17].

This work-in-progress lens for designing personal data activities is a conceptual framework with practical implications for design-

ing and evaluating activities around personal data. One of the main challenges in personal data research is the contextual nature of what is considered personal, as data that feels private in one context may be entirely neutral in another. This variability makes it difficult to design meaningful activities that respect the nuances of personal data. By using this lens, we can systematically identify which layers we want to engage with, whether it is the context of the data, the nature of the data itself, the level of awareness a child has about its collection, or how public or private the data is perceived to be. This structured approach allows us to characterise, analyse, and interrogate data, ensuring that the activities we design are relevant and meaningful.

This approach informs the activity that we propose for the workshop in the next section. The activity that we describe below is designed as a hands-on exploration of personal data, where participants engage in different data collection tasks, generating, physicalizing, and reflecting on various forms of data. The activity explicitly taps into multiple layers of the model, such as data type (Layer 2: preferences, behaviours, social interactions), and awareness and sensitivity (Layer 6: explicit, observed, inferred). By mapping our activity onto these layers, we can better understand how and why certain data feels personal in a setting, making the abstract concept of personal data tangible and playful.

3. Play-Based Activity - Sharing your data: How personal is too personal?

We shall now explain the play-based activity in more detail, presenting the goals and rules of play.

3.1. Short Description of the Activity

Participants (4 to 6) will pick different data collection cards (e.g., Emotional Data, Behaviour Data, etc.) and reflect on personal data they have generated recently based on structured prompts (Figure 2). We refer this activity to the personal data framework that we proposed earlier (Figure 1). Participants will record their observations in “data envelopes”, representing a personal data archive. In the next phase, the participants will physicalize their data, translating it into a tangible representation using LEGO bricks, stickers, or other materials. For this phase, the participants will be split into two groups, each taking on different data management roles. One group will physicalize their own personal data in the archive, whereas the other group will share their ‘data archive’ randomly within the group so that each participant will represent the archive they receive. For the final reflection and discussion, the groups will be brought back together to reflect on their experiences. The learning outcomes of this activity will be to explore and understand the use of playful and engaging activities to make participants aware of personal data, recognise the agency and understanding individuals have over sharing or representing their own data, and understand the contextual nature of the sensitivity of personal data.

3.2. Goals and Rules of Play

Goals:

1. Facilitate play-based data collection and visualization

2. Encourage reflection on personal data types, roles, and different methods of representation.
3. Explore different levels of comfort in sharing personal data within the group
4. Explore ethical considerations on how to handle discomfort around sharing personal data, especially as it relates to engaging children in the future
5. Demonstrate the challenges of working with personal data through playful engagement.

Rules of Play:

1. In the first phase, each participant draws a data collector card (e.g., Behaviour Data, Emotion Data, Social Data, Preference Data).
2. They follow the prompt on their card and collect data about themselves or their environment.
3. Participants record their observations on a paper slip and place it in their “data envelope”.
4. In the second phase, participants are split into two groups and transform their own data (group 1), or another participants’ data (group 2) into physical representations using LEGO bricks, beads, or other materials.
5. A guided discussion will follow, exploring patterns, comparisons, and ethical considerations in personal data collection.

3.3. Activity Manual

3.3.1. Phase 1: Data Collection

First, each participant receives a task card(s) that instructs them to represent a specific type of personal data (Figure 2); e.g. Behaviour Data, Emotion Data, Social Data, and Preference Data. They will be instructed to choose up to 2-3 cards to reflect on. Based on the card prompt, they will represent a personal observation about themselves through annotations and/or visual representations. Inspired by Dear Data [LP16], the cards contain a broad spectrum of prompts and explore topics not typically associated with data, such as personal feelings or experiences. Each card will include a data prompt related to the personal data type. For example, each card will include data prompts such as: 1) Behaviour Data Card: How many steps have you taken today, What are the physical activities you did this week, 2) Emotion Data Card: Record something surprising you noticed today, How are you feeling today, Draw a symbol representing your energy level right now, 3) Social Data Card: How many new people did you connect with today, 4) Preference Data Card: What are your favourite foods. Some cards prompt widely shareable data, such as favourite foods or social interactions, while others explore more private topics, such as emotional experiences (e.g. how many times someone cried this week) or financial details (how much someone’s credit score has changed as they’ve gotten older). Additionally, the prompts vary in sensitivity, allowing participants to express differing levels of privacy or comfort with sharing their data from “not all comfortable” to “totally comfortable” (Figure 3).

Participants will first write or draw their responses to the prompts on the cards. Then they will mark their level of comfort with sharing their data. Participants can then choose the cards they would like to share and put them in an envelope, which represents their ‘personal data archive’.



Figure 2: An example of the cards containing the data collection tasks that we aim to use during the play-based activity.

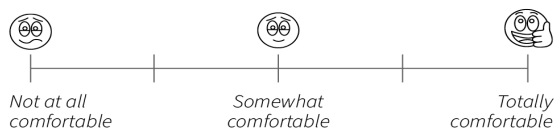


Figure 3: Differing levels of sensitivity that the participants will be prompted to reveal in Phase 1 of the activity.

3.3.2. Phase 2: Physicalizing the Data

In the next phase, the participants will physicalize their data, translating it into a tangible representation with our provided materials. We will provide participants with several materials, including LEGO blocks, beads, pens and pencils, wooden blocks or plasticine, small coloured tokens, tooth-picks, plastic cups, and pop-sicles [HGH* 17]. We will also inform the participants about how to use the materials and what each item corresponds to (e.g. the colour of the LEGO blocks represents a different type of personal data). Before they move into this phase, we will split them into two groups. Participants in Group 1 will physicalize their own data. We frame the participants in this group as the *Data Sharers*, as they act as active generators and communicators of their data creating visualizations for it. Participants in Group 2 will randomly exchange their ‘data envelopes’ within the group, so that each participant gets to physicalize someone else’s data archive. We frame the participants in this group as the *Data Observers* as they need to make inferences and observations through someone else’s personal data archive in order to be able to physicalize it. We aim to facilitate conversations about how data can be interpreted differently in visual/physical form, which is a teaching moment in itself, revealing the subjective nature of data representation. We also aim to explore criteria for evaluating the sensitivity of the data.

3.3.3. Phase 3: Reflection on the Activity

All participants from each group will then re-integrate into one group for the final reflection and discussion. During this discussion, questions will be asked to guide the participants to reflect on their data, their data roles, and further discuss the representations. Below we list a few guiding questions for the reflection and discussion:

1. What were the differences/advantages in drawing your data vs. physicalizing it?
2. (Group 1 participants) Reflect on your experience of physicalizing your own data. Did you choose to highlight/hide a specific aspect when knowing that your personal data would be shared with the group?
3. (Group 2 participants) Reflect on the process of making inferences and observations based on the data archive you received. How comfortable does the owner of the data archive feel about the inferences you made through their archive?
4. Did certain data types feel more personal, sensitive, or invasive to talk about? Why? Do we think children would find different data sensitive than what we do?
5. For the participants who chose not to share a certain personal data item (e.g. due to being ‘not comfortable at all’), why was that?
6. How can we redesign this activity to be conducted with children?

4. Discussion and Future Work

In this workshop, we aim to explore how playful data collection, visualization, and physicalization can be an engaging way of interacting with and grasping abstract data concepts [THHC18, HCT* 14]. Through our work-in-progress personal data framework, we aim to understand which play-based activities facilitate a discussion on the different challenges that arise in working with personal data, such as its contextual dependency and level of sensitivity. Our proposed play-based activity serves as a first step in the Grasping Data

project, which aims to combine embodied playing as a fundamental way in which children explore personal data to learn and make sense of the world around them. We aim to explore how we might redesign the activity for children and what challenges persist when working with them. For instance, when designing activities for children, we might consider shorter activities (10 to 15 minutes) using easily available, everyday items (e.g., paper, recycled materials, natural objects like stones or leaves) or purely verbal/role-play based activities.

Playful physicalization, using materials like LEGO, beads, or drawings, has shown potential as a way to externalize and reflect on personal data, reinforcing learning through embodied interaction [HGH*17, THHC18, HCT*14]. However, conducting play-based data activities with children in in-the-wild settings (such as a zoo or school) presents several challenges. First, the situated nature of the activities means that external factors (e.g., environmental distractions, limited time, or variations in children’s engagement levels) can influence participation and quality of data collection. Second, ensuring that children understand what personal data they are sharing and how it is being used is critical for ethical engagement [LW17]. As future work in the Grasping Data project, we will refine these activities through co-design, allowing children to shape both data collection and physicalization [Ste13, VML10]. We then plan to implement these activities first in schools, integrating them into classroom learning, before extending them to informal settings (such as zoos), where engagement may be more spontaneous. By exploring how children perceive and interact with their personal data across different contexts, this research contributes to child-centered data literacy [MP21, DBB*] and playful data exploration approaches [HGH*17, HGH*17].

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