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Article

Scaffolding a Design Process for Applying Calm Technology Design to Smart Toys

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Abstract

The notion of Calm Technology, which can move between our focal and peripheral attention, is a potentially valuable but underexplored concept in relation to smart connected toys. In this paper, we explored two interconnected research questions: (a) How can scaffolding support children in understanding Calm and designing for Calm connected toys? (b) To what extent can children contribute towards the design of novel connected toys that apply Calm Technology Principles? Building on UX practice and research we developed a participatory approach to working with children we call Design School, which gave children knowledge and experience of a design process. Additionally, we created design cards to use within the Design School, which scaffolded the inclusion of Calm technology design principles within children's designs. The Design School workshops ran over four days in a U.K. school with 30 children aged 10–11 years, design outputs were analyzed to answer the research questions. From our experiences and analysis, we make four contributions: (a) the success of design cards as a tool to scaffold children in operationalizing unfamiliar design principles, (b) an understanding of how different design activities afforded expression of Calm in design ideas, and (c) the Design School workshop format, which proved effective in enabling children to engage in design activities.

RESEARCH HIGHLIGHTS:

- This work took a novel and participatory approach to exploring the design of Calm technology in the context of Connected Toys.
- The work reports on a series of four workshops conducted with 30 children aged 10–11 years.
- We present our new "Design School" workshops format, which was valuable in priming and training children to contribute effectively in co-design work.
- Our work shows the effectiveness of design cards in scaffolding children in designing Calm technology.

Keywords: *human-centered computing; human computer interaction (HCI); HCI design and evaluation methods; user studies; interaction design; interaction design process and method; participatory design*

1 Introduction

Toys are important for children's play and development with archaeological evidence of children's playthings being dated to around 1000 BC (Crawford, 2009). Over time toys have progressed from static, to mechanical, then electronic, and presently to smart toys, which use sensors to become aware of their context and connect to the Internet. Toy designers and manufacturers often incorporate trending technological innovations in their products (Byrne, 2023). For example, "Teddy Ruxpin," a popular talking bear toy from 1985, featured autonomous moving eyes and a mouth. Inside the bear was a stereo cassette tape player—the "left" track was used for audio "spoken" by the bear while the "right" audio track carried encoded data, which controlled actuators. This is a prime example of a toy utilizing the technology of its time. Current smart toys are popular with parents and children and provide sophisticated interactivity with sounds and actuation that respond to a child's play (Ling et al., 2022), alongside internet connectivity and personalization (Mascheroni et al., 2017). However, many parents are beginning to value more traditional toys and playthings; the wooden toy market has seen a huge resurgence in the last ten years with projections of growth to more than US$30 billion by 2030 (Maximize Market Research, 2024). This shift in the toy market, away from distracting electronic toys (with sounds, lights, actuation, etc.) and towards more traditional playthings, mirrors Weiser and Brown's vision of calm technology (Weiser and Brown, 1995), which moves between the focus and periphery of our attention. Whilst visions of calm technology mainly concern adult technology, the approach, which emphasized that technology should serve us in the background, placing the human interactions front and center in a nonintrusive way, offers the possibility of combining both the technical advantages of a contemporary smart toy and the play benefits of a traditional ("nonsmart") toy.

Our research explores the notion of calm in the context of designing smart toys. Toy design is complex and typically the

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design of new toys is achieved by experts without input from children, except at the playtesting stage (Kudrowitz, 2021). Whilst recent work within the HCI community has considered calm in the context of supporting emotion regulation with children (Isbister et al., 2022; Gao et al., 2024), our work differs as it focuses on involving children in the design of calm smart toys. Our overarching goal is to explore smart toys, which do not interrupt play (Golembewski and Selby, 2010; Bekker and Antle, 2011; Mertala, 2020) and can move between the focus and periphery of attention during play, as a valuable but underexplored aspect of smart toys. Through this work, we aim to answer the following interconnected research questions:

- RQ1: How can scaffolding support children in understanding calm when designing smart toys?
- RQ2: To what extent can children contribute towards the design of calm smart toys?

To answer these questions, we took a participatory approach and worked with children directly to explore their design ideas for calm smart toys. As the notion of calm technology is generally unfamiliar to children, we created a set of design cards (*Calm Cards*) each of which was carefully designed to support understanding of a calm principle. To test the *Calm Cards*, we used an approach we call *Design School*, which began by providing children with experiences of design techniques within a design process. Children were then split into two groups where one group had access to the *Calm Cards* and the other did not. This between-subjects approach allowed us to understand the effectiveness of the cards within the design process through the analysis of the design outputs gathered. The *Design School approach* proved effective in enabling children to engage in a range of design activities. Our work makes two key contributions:

1) The success of design cards as a tool to scaffold children in operationalizing unfamiliar design principles in co-design activities when designing calm smart toys (*Calm Cards*).
2) An understanding of how different design activities afforded expression of calm in design ideas.

In this paper, we provide an overview of related work in the fields of calm technology, designing with children, and the co-design approaches applied in our study. The paper then details the methodology followed and presents the findings from a co-design study involving 30 children. The results from the study outline the findings from participants, design methods that support calm technology design ideation, and our process for analyzing child participant outputs. We then discuss the significance of our findings along with future work.

2 Related work

In the following literature, we highlight key prior research underpinning our work. Starting with a brief look at smart toys and then at calm technology, we then look at the inclusion of children in design while outlining some methods related to our work.

2.1 Smart toys

Most definitions of toys describe them as items intended for children's play. Until the late 19th century, toys were handmade by parents; the mass production of toys created competitive commercial markets along with new ways of thinking about, and choosing, toys. While many traditional toys are still very popular, there is nowadays an entire genre of toys referred to as smart toys. Smart toys often include artificial intelligence, voice and facial recognition software, location, proximity, and movement sensors (Mascheroni et al., 2017). Such products aim to extend the digital realm into the physical world of play. Recent discussions on smart toys highlight the need for clearer categorization within research (Holloway and Green, 2016; Ihamäki and Heljakka, 2018; Arnott et al., 2019; Ling et al., 2022). The "Internet of Toys" (IoToys) covers a diverse range of hybrid play objects, electronically linked to other devices or the Internet using common technologies found in everyday "Internet of Things" (IoT) devices (Wang et al., 2010). The key difference between smart toys and IoToys is the ability to connect to the Internet to enable sharing and processing of data collected by the toy (Ling et al., 2022). Due to their nature, IoToys prompted debate within the HCI community around the ethics of technology-based toys for children, many concerning autonomy, consent, safety, privacy, and security (McReynolds et al., 2017; de Albuquerque et al., 2022). For example, the "Hello Barbie" doll by Mattel used speech recognition to respond to children's conversations and the voice data that was collected from these interactions was sent to a centralized server for processing, which raised well-documented privacy concerns (Maundrill, 2023). Despite many ethical questions and privacy concerns, there is still a large market for such products (Harlow, 2013; Jones and Meurer, 2016), but as technology becomes increasingly prevalent in children's lives, there are growing concerns about its social and cognitive impact on children (Ihamäki and Heljakka, 2018; Manches and Plowman, 2021; Van Brummelen et al., 2021).

2.2 Calm technology

In the 1990s, Weiser and Brown proposed calm technology as a way for technology to be unobtrusive in our day-to-day lives where "Calm technology engages both the center and the periphery of our attention, and in fact moves back and forth between the two" (Weiser and Brown, 1995, 1997). Our research examines the feasibility of applying calm technology principles to smart toys as a counterpoint to contemporary toys, which are often inherently designed to be monopolize child attention. We align with the views of Rogers (2006) who observes calm as a tool for appropriate engagement, as opposed to creating calmness or the feeling of calm. We are also interested in how appropriate engagement or calmness might be measured. Several authors have published their methods for measuring calm in ubiquitous applications (Riekki et al., 2004; Bashir et al., 2014; Carvalho et al., 2015). For example, the Goal Question Metric (GQM) method employs survey-style techniques to assess to what degree an application can interact with a user at the right moment and how effectively it can use a user's peripheral and focal attention; the authors call for further work in this to expand into what influence calmness has on different technology characteristics (Carvalho et al., 2015). It appears from the literature on measuring for calm that evaluation methods need to be changeable depending on what technology characteristic is being evaluated. For example, a voice-activated personal assistant would be evaluated differently than a service elevator when considering notifications that meet user expectations of calm.

While guidance for designing calm smart toys has not been considered previously, Amber Case contextualized Weiser and Brown's (1995) vision into a set of eight calm technology design principles for unobtrusive design (Case, 2015) to support designers of technology in understanding calm technology theory. These principles emphasize the importance of the "Periphery," where technology should seamlessly integrate with the natural environment, using sensory indicators that blend in rather than disrupt; both supporting calm and potentially mitigating attention fatigue in children (Radesky and Christakis, 2016).

2.3 Designing with children

Within the HCI community many techniques have been used to understand and gather children's perspectives. These methods include activity theory (Nardi, 1995), gamification (Dodero et al., 2014), and design-thinking techniques (Larsen and Hedvall, 2012; Paracha et al., 2019; Van Mechelen et al., 2019). Much work has focused on methods for co-design with children (Walsh et al., 2012; Read et al., 2014; Woodward et al., 2018; Orvokki Nygren et al., 2021) and on considering the position/agency/roles and participation of children in co-design processes (Frauenberger et al., 2015; Iversen et al., 2017; Montreuil et al., 2021; Read et al., 2014). In design activities, the skills and knowledge needed to contribute successfully can be regarded as a core metric for a successful co-design methodology or process. Engagement, or how well a child participant can independently contribute, is a commonly used attribute to measure that success (Frauenberger et al., 2015). Montreuil et al. (2021) and Yip et al. (2013) and others have suggested solutions to reduce the "knowledge gap" and better empower children in co-design where a "knowledge gap" can be defined as a lack of knowledge expertise/understanding, or familiarity with a specific topic relevant to the study—which in our case would be calm technology. Reducing the "knowledge gap" through knowledge expertise has been proven to reduce children's limitations; Yip et al. (2013) found that children were able to contribute higher level functionality requirements for technologies if they had better knowledge of the "thing" they were designing and understood the relevance on their lived experience. Iversen et al. (2017) and Dindler et al. (2020) advocated for empowering children in digital literacy to allow for child involvement in earlier design phases. When children are provided with the necessary knowledge, co-design sessions can foster self-confidence, improve decision-making, increase motivation and engagement, and enhance problem-solving skills, leading to better research outcomes (Schepers et al., 2018a, 2018b).

When designing for children, resources such as the Developmentally Situated Design (DSD) cards from Bekker and Antle (2011) and well as design guidelines like the Head up Games guidelines from Soute et al. (2010), guidelines for design for special children from Pares et al. (2005) and for learning from Papavlasopoulou et al. (2019) all bring value. There have been several studies looking at personas to assist in design, including the use of child created personas (Sim et al., 2019) and the use of proxy personas for design for children with special needs (Metatla et al., 2020). Whilst involving children in design is widely regarded as valuable, there is discussion about how it should be done; from suggestions on how to engage periodically with children in design decisions—like Bluebells (Kelly et al., 2006) and to suggestions on how to describe children's involvement in design (Scaife and Rogers, 1999) the jury is still out on the effectiveness of prolonged child involvement. Many agree that the engagement of children is empowering (Frauenberger et al., 2011; Iversen and Smith, 2012; Iivari and Kinnula, 2018). There have been prior empirical investigations of children's involvement in design work, including studies on how to democratically investigate children's ideas (Read et al., 2016), to explore the effect of different materials on design outcomes (Read et al., 2013), and to explore how diverse or similar different designs end up being when large groups are involved (Read et al., 2014).

Researchers often describe carefully scaffolded design activities, using PowerPoint presentations and workbooks to guide children through a design process and ensure the designs align with study aims (Read et al., 2022). In Fitton and Read (2016) children were asked to write about their design ideas before putting pen to paper with the goal to deepen their thinking and help them self-explore the topic of interest; in an exploration of digital money children themselves explored money (Yip et al., 2023). When design sessions involve complex content and contexts, careful onboarding of the children is essential. For instance, in a large project in Finland, the authors took several steps before commencing design to help children understand bullying: encouraging them to empathize by writing letters and conducting interviews (Ventä-Olkkonen et al., 2021). Their design stages then began with an introduction to the mechanics of the chosen design method (design fiction) before the children embarked on ideation.

2.4 Scaffolding design

The term Scaffolding originated in the 1970s in reference to tailored support provided to a learner to help them achieve a goal, which would not be possible for the learner working independently (Wood et al., 1976), and more recently has been described as including fading (removal of scaffolding) over time as the learner takes increasing responsibility for their own performance (van de Pol et al., 2010). Design principles are commonly used as scaffolding aids across the design field, by both commercial brands and academic researchers. However, how design principles are curated and evaluated remains ambiguous. To address this, researchers have developed various approaches and techniques to assess the creation and application of design principles in different scenarios (Kali et al., 2009; Fu et al., 2016; Minh-Tam Dao-Kroeker et al., 2021). Although design principles alone are not necessarily enough—they should be considered as part of a wider design framework (Ren et al., 2017). Many sets of design principles exist (Ballou et al., 2021); examples from reviewed papers include Bonarini et al. (2020) who identified ten design guidelines for smart toys for children with disabilities, and Aker et al. (2017) who distilled 15 heuristics (guidelines) from 44 studies that could be used to design for play. In the context of smart toys, de Albuquerque et al. (2020) mapped 297 toys, and, in accounting for children's cognitive and physical limitations, curated five design principles for smart toy design. Kara and Cagiltay (2020) took the approach of gathering adult perspectives on children's technology while assessing a smart toy prototype, focusing on its features, functionality, and effectiveness in supporting curriculum-based objectives. Their study culminated in seven guidelines for integrating smart toys into preschool education. When using design principles, it is common to present them as a set of cards that designers can use in their entirety or as a selection tool. Design cards have been used to help children design in various design related tasks. Lomas et al. (2021), used design cards to help children build a game with complex game mechanics—using guessing as an interaction method as the focus of the cards. Arvanitakis et al. (2024), explored the use of design principles as design cards with children (10–12 years old) in robotics design as part of a wider STEAM design solution. These design cards were plentiful and helped children generate ideas by illustrating the various characteristics of robotic design. In summary, design cards are used to stimulate creative thinking, they provide a structure to the ideation session, they are used to scaffold creativity, thinking, discussion, and act as a visual aid to boost collaboration and engagement. Furthermore, design cards are versatile in that they can be used throughout the design process.

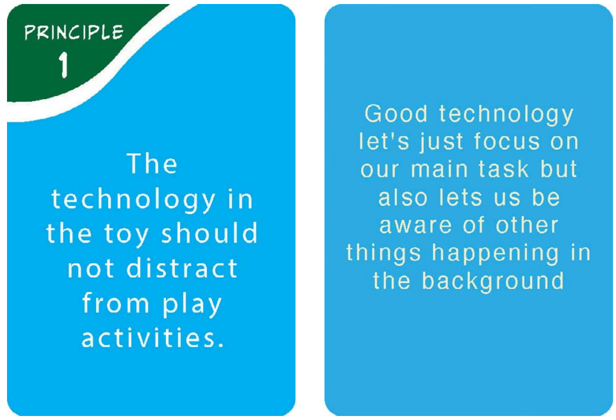
Priming, a similar concept to scaffolding, is also known to be effective in a design context (She et al., 2017). Priming delivers knowledge and design training upfront through informative and interactive sessions to influence thoughts and behaviors subtly through exposure, while scaffolding, as described earlier, relates to provision of tailored support. Fitton and Read (2016) note that when children encounter technologically driven design problems without prior context or experience, this can create barriers to early idea generation. To overcome these barriers (Fitton and Read, 2016) (developed the "Primed Design Activities" (PDA) technique, which scaffolds the design process by using a range of activities (designs, wireframing, questionnaires, and evaluations) which aim to inform, empower and engage participants. They tested the effectives of the PDA approach in two different design studies and found that the PDA approach did address help address the barriers they had identified initially. Inspired by the PDA technique, our current study developed two bespoke design booklets with priming activities for ideation, incorporating popular industry techniques like Crazy 8's and Brain Dump. Our work also draws inspiration from Amber Case's book on calm technology for nonintrusive design (Case, 2015), in which, she tasks readers to design a noninstructive alarm clock. We adopted this for children as a practice design task to prime them for designing for calm in the later workshop sessions; the novelty of our approach lies in applying this process within the context of calm (Figure 3B).

In summary, the work that follows will concentrate on the design of smart toys with children as a basis for understanding how calm design principles can be applied to the many facets that make up the design of such toys. The work will be explored through a scaffolding approach that consists of design cards, design principles, and industry practices combined with priming.

3 Method

To address RQ1, a set of eight *Calm Cards* were created (Table 1; Appendix A: Calm Cards and Technology Cards) to assist in designing smart toys (Thompson et al., 2024). The *Calm Cards*[1] represent eight core calm technology design principles and were designed to be accessible for children, using a variety of colors to represent each principle's uniqueness (70 × 100mm). Each card is comprised of a front and back component. The front of the card includes the principle number and design principle, the back presents a description of the principle to help participants understand the principle in context (Figure 1). The principles are based on Case's calm technology principles (Case, 2015). These were chosen as they are highly relevant to tangible products like toys, unlike principles that focus on screen interfaces or software (Kremer, 2018) and they embody key aspects of calm technology such as improved transparency and reduced distractions (Radesky and Christakis, 2016; Van Brummelen et al., 2023).

To address RQ2 we developed the *Design School* workshop format. The format was conceived through discussion with an industry UX practitioner and experts in child–computer interaction (CCI). *Design School* was chosen as the name of this as the first part of the workshop activities focused on teaching children about design and allowing them to practice different design techniques for divergent and convergent thinking, along with developing their ideas through varying levels of fidelity. In the *Design School*, we first primed the children with important knowledge, skills related to conducting design activities effectively, and an understanding specific to the follow-on design tasks (calm in the case of this work). Once this first part was completed the children then applied their new knowledge, skills, and understanding, to designing calm smart toys in the subsequent *design practice* part. Key aspects of this format were using design techniques, which



(a) (b)

Figure 1. Calm Cards presenting the front (A) and back (B) with title and description. Alt text: Front and back example of the Calm Card used to represent Calm technology design principle 1.

are recognizable to UX practitioners (Brain dumps, Crazy 8's, Empathy Mapping, Storyboarding). Child participants utilized a physical printed *Design Logbook* throughout all the design activities, which acted as a record of their work for both the child and the researchers. The *Design Logbooks* differed slightly according to whether the children were in the condition using the *Calm Cards* (Figure 3).

Collectively, the research team has over 50 years of experience working with children and are in regular communication with parents and teachers to ensure our approach is appropriate and effective. The authors' existing works with children focus on co-design (Read et al., 2014; Lochrie et al., 2016; Read et al., 2016; Fitton and Read, 2016; Metatla et al., 2020; Read et al., 2021; Thompson et al., 2024), methods to support design with children (Kelly et al., 2006; Fitton and Read, 2016; Read et al., 2022), children as evaluators (Read, 2008; Read et al., 2022), and children in the design process (Fitton and Read, 2016; Sim et al., 2019).

The study ran over four nonconsecutive days with child participants at Clayton-le Woods Primary School in Chorley in the Northwest of the U.K. Child participants were recruited as part of an on-going relationship between the University, the school, and the Year 6 teacher. At the start of each workshop, children were given a 15-minute recap of the previous day's activities, followed by instructions for the current day. To help child participants stay on task, an interactive whiteboard was used to present PowerPoint slides with instructions and examples. Two researchers were present in all sessions supporting children and answering any questions where appropriate. When the design of calm smart toys began, support was moderated to ensure that facilitators did not influence the design being developed.

3.1 Child participants

The child participants were Year 6 children aged 10 and 11. The school was a single-form entry Primary School, and so the workshop was designed to accommodate the whole class of 30 children. Out of the 30 children who participated in the study, 23 had given consent (via their parents) to have their data analyzed for the purpose of this research; the other seven took part in the activities but did not hand anything in (as per our ethical approach to not exclude children from taking part). Participants were assigned to groups A or B by the teacher who was asked

[1] Design assets including the *Calm and Technology Cards* used in this study https://bit.ly/design-cards

Table 1. A table presenting the content of the Calm Cards with design principles (titles and descriptions)

PID	Principle title	Principle description (Contextualization)
1	The technology in the toy should not distract from play activities.	Good technology let us just focus on our main task but also lets us be aware of other things happening in the background.
2	The toy should let you know that its technology is working properly.	Technology can make us feel calm by letting us know when everything is working okay and if something needs attention it will tell us.
3	The toy should be able to alert you without disturbing play activities.	If the technology is working well, we would not even notice it is there.
4	The technology in the toy should be well-hidden and child friendly.	Technology is best when it helps us be better at being human not when it takes over our lives.
5	The toy should use tones and subtle motions to communicate changes.	The toy should use tones and situations to communicate state changes.
6	The toy should still facilitate play when the technology fails.	Good designers plan for things going wrong and give us different ways to do important things if something is not working.
7	The technology within the toy should be justifiable in enhancing play.	Too much stuff on the screen can be confusing and distracting. Instead, designers can use symbols and sound that everyone can understand easily.
8	The toy should only include technology that has been socially accepted.	When we say technology is socially normal, we just mean it is something we think is okay to use.

to balance the groups as much as possible—one specific characteristic was applied based on consent (roughly equal numbers of consenting children in each group). This allowed for comparisons of task completion and increased confidence that any observed differences between the groups were due to the instructional (scaffolding) methods, rather than other variables.

The study involved collecting no personal data, and all notices of the workshop were sent home to parents and carers three weeks prior to the workshops. This notice contained the child participant information sheet, consent, and assent forms. A paper-based approach was used to obtain consent. To ensure anonymity, the teacher retained the consent/assent forms until the end of the workshop at which point, using an ID, the teacher would relinquish *Design Logbooks* to the researchers for those who gave consent and assent.

3.2 Apparatus

The main aspect of the apparatus in this study was a *Design Logbook* consisting of 16 pages (as shown in Appendix B: Design Logbook). In the design logbook, three pages focused on a survey to measure understanding, three were intentionally blank pages (for notes and ideas), and ten were there to record the outputs of specific design activities. The Design Logbook (Appendix B: Design Logbook) was used to support all workshop activities, including both the Design School (learning activities) and Design Practice (calm technology design for smart toys):

- Brain dump—used in the *Design School* and *Design Practice*
- Crazy-8 s—used in the *Design School* and *Design Practice*
- Technology Cards—used in the *Design School* and *Design Practice* by both groups. A technology card consists of three elements: the name of a piece of technology in the form of an action i.e., “It takes a photo,” a visual element depicting the technology and the type of card “function.” For the purpose of this study, all technology cards were functions i.e., "It lights up," “It recognizes your face,” “It learns from itself,” etc. (Figure 2).
- Calm in the wild—activity for identifying calm design
- Calm alarm clock—activity to get participants thinking about how to apply calm technology design
- Sketching—with/without templating for use within *Design School* and *Design Practice*
- Calm technology design principles known as *Calm Cards* (Appendix A: Calm Cards) and rationale used only for Group A used within *Design Practice* (Figure 1). Participants would select which technologies their idea would include, the using the *Calm Cards* would note down how their design would follow a calm design approach for the technology chosen. This is achieved by evidencing the technology used and how the technology is used within the design. Followed by which calm principle was used and explaining what makes their technology calm (Figure 3A).
  - Similarly, Group B, logged their technology choices and rationale. However, rather than supplying a calm technology design principle, they grounded decisions based on their understanding of calm design (Figure 3B)
- Magazine (front cover for participants to embed their prototype and create a marketing campaign for their toy. Used within *Design Practice*)

The *Technology Cards* (Figure 2) were designed based on the technologies found in commercially available smart toys. The 20 cards included interactive robots (Nao Robot), educational companions (TONIES, Yoto), smart dolls (Barbie); remote controlled objects (Cosmo), programmable objects (Bee-Bot, Sphero), interactive playsets (LEGO Boost, littleBits) and connected musical instruments (Roli Lightpad block, Linkimals). In creating the cards, the toys were studied either in physical form (play-tested) or through a combination of online resources (walkthroughs, commercials, toy descriptions, manuals) where the technology and user interactions in the toys was later extracted and summarized on the cards: For example, the Sphero *responds to controller input*, the Nao robot *learns from itself,* the Roli Lightpad *lights up*, the Linkimals *connect to each other*, the Bee-bot *can be coded*. The *Technology Cards* are used in supporting participants in the design process to ideate future smart toys (capabilities and interactions). Similarly to the *Calm Cards*, the *Technology Cards* were of the same size (70 × 100mm) used a variety of colours to distinguish the different interaction modalities, feedback mechanisms and functionalities. Each card comprised of a flat designed icon, and an action “It takes a photo.” The *Technology Cards* were used with the *Calm Cards* (for Group A) to explore whether participants could design smart toys that follow

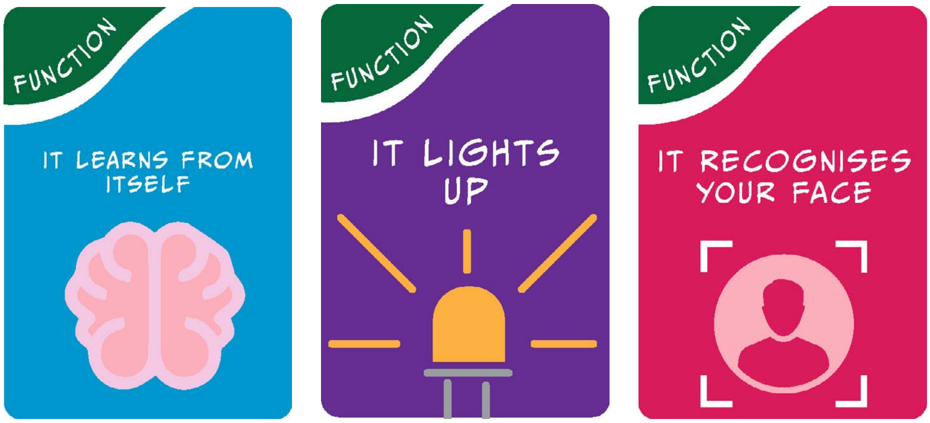


Figure 2. Technology Cards provided to both groups. Alt text: A line of three technology card examples; each card includes a title and icon. The titles read "It learns from itself," "It lights up," and "It recognizes your face, respectively."

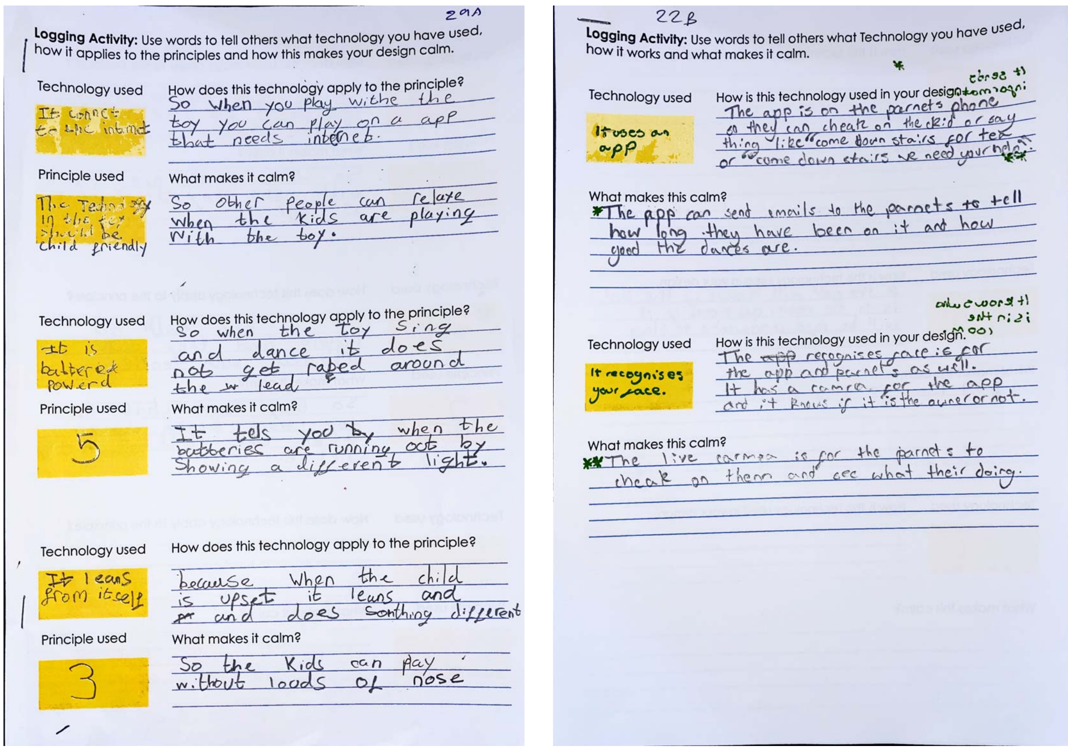


Figure 3. Explanations children had given as to why their technology design included aspects of calm: Group A (left) used Calm Cards; Group B (right) did not use Calm Cards. Alt text: Two scanned documents showing evidence of completed logging activity by both groups. Each scanned document showcases a child participant's handwritten response to the activity.

a calm design approach when implementing the technology. The purpose of these cards was to help ensure the child participants ground their ideas in technology aspects found in smart toys. These cards were used in both Group A and B primarily within the *Design School* to help decide what functions their toy would perform and help familiarize Group A with the use of cards in their design activities. As the main purpose of the *Technology Cards* was to familiarize all children with the notion of using cards within a design process their use was not studied.

Those in Group A used a pack of *Calm Cards* (Figure 1; Appendix A: Calm Cards) which consisted of eight cards with principles written on the front, and a contextualization of that principle on the back. These principles were inspired by the works of Mark Weiser, John Seely Brown (1995) and Amber Case (2015). The initial gathering of the principles adopted from Case were evaluated (Thompson et al., 2024) and later co-designed with teachers and play tested with children in a previous workshop. The explanations for each principle went through various iterations with HCI researchers questioning the purpose and schoolteachers informing the language and tone for comprehension. For instance, the calm technology Toy Principle, *"The toy should be able to alert you without disturbing play activities"* was inspired by Case's (2015) principle that *"Technology should require the smallest possible amount of attention"* In the context of play, this was interpreted as *"The technology in a toy should not seek so much attention from the player that it becomes distracting to their play."* The contextualized statements were pilot tested with a group of school children during enrichment activities. An example of the contextualized statement that aligns with the above principle is "*Good technology lets us focus on our main task but also lets us be aware of other things happening in the background.*" Alongside the *Technology Cards* and *Calm Cards* (for Group A), children were provided with pencils and pens, LEGO and plasticine depending on the activity.

4 Procedure

On day one, child participants were divided into two groups (as described earlier) and were distributed around tables in the room based on their grouping. Child participants stayed in the same table groups throughout the four days. This ensured that when support was needed, researchers were aware of which pathway (Group A or B) the participants were following and could assist accordingly. Children worked individually throughout all the activities across all the days. During the *Design School* (phase one), children were introduced to the study, the researchers' rationale, data collection plans, and the workshop's approach, activities, and materials. During these first two days, the *Design School* aimed to deliver activities in the following stages:

4.1 Design school (part 1):

1) ***Introduction:*** This introduced the workshop expectations, schedule, aims, objectives, and incorporated team building and ice-breaking exercises to help the children settle in. In the session, children were given *Design Logbooks*—a single source of information/reference for the participants throughout. The logbooks made the data collection at the end of the four days easier (Read et al., 2010).
2) ***Learning in Action*** : Day two focused on learning about design. Two topics (Appendix C: Workshop Outline) were introduced, one after the other via a PowerPoint presentation, followed by a workshop activity, which allowed the children to cement their learning by doing (practice) (Roussou, 2004). The topics were used to empower child participants with the knowledge and skills they needed to take part in the later workshop. Facilitators introduced core Design Thinking topics like Brain Dump, Crazy 8's, Empathy Mapping, and Storyboarding, followed by a similar introduction to calm technology design.

In the design activities, children were given the choice of two personas and tasked with "designing something to sit on." First, child participants were instructed to engage in a Brain dumping technique logging as many ideas as possible. Following this, ideas were brought to life through a Crazy 8's activity and narrowed down as other children voted on the idea they felt best met the needs of the persona. Finally, each child participant completed a storyboard depicting their design solution in a fictitious scenario. This activity aimed to empower child participants with the skills to design for others. The design thinking techniques chosen are well practiced in industry (Gennari et al., 2021) and encourage participants to think broadly (Brain dump) about their solutions before narrowing them down with the help of others' feedback (Crazy 8's). Finally, the storyboard activities allowed participants to envision their solution in a possible scenario.

To compliment the design process, subject and domain knowledge of design principles and calm technology design was provided to all child participants in design principles and calm technology design. This session again consisted of presentations followed by an interactive activity during which, the function cards were introduced as a means of exploring various technologies—to familiarize child participants with exploring content through various means. Next, child participants were encouraged to put into practice the new knowledge of calm technologies in a "Design a calm alarm clock" activity. During this time researchers went around the room to support the children and ensure they understood the activity. Child participants then applied this knowledge of calm technology to the *Technology Cards* they selected to iterate their designs for "something to sit on." This concluded the first phase of the workshop.

4.2 Design practice (part 2):

The final two days of the workshop focused on *Design Practice*. During this phase, *Design, Split and Scaffold,* and *Prototype and Present were the focal points* whereby child participants were given time to explore and ideate around the specific design problem of "smart toys for children." During this phase of the study, the children had graduated *Design School* and were considered informed about the various technologies that were common across smart toys, calm technology, and the design process.

On day three , child participants spent a full day (5 hours) following a studio-based Learning approach. Groups A and B followed a slightly different experience. This variation was intentionally designed to test the effectiveness of the *Calm Cards*. Both groups used the same *Technology Cards* to help them develop design ideas, but Group A also received the eight *Calm Cards*.

1) **Design Thinking Activities:** Child participants were introduced to the concept of a smart toy and the technologies and interactions that toy might afford. During this stage, participants were discovering the challenge and formulating an idea. Finally, a short presentation on Design Thinking (process) and calm was recapped.

Child participants were introduced to the main design challenge and given the same *Technology Cards* they had used during the *Design School* phase. After reviewing the function cards (as a recap) participants decided what functionality their smart toy should have. Participants were instructed to complete a logging activity in their *Design Logbook* stating which cards they chose and how these might affect or be used in their main design solution. Child participants were then introduced to a persona for their main design challenge. Those in group A received a physical deck of *Calm Cards* to link to their chosen technologies ensuring calm technology is designed into their smart toy. Group B, however, were instructed to think about how they would make their technology calm without the *Calm Cards*. This quasi-experimental approach sought to determine whether scaffolding cards could aid in the application of calm design principles during the ideation process. This activity helped to further narrow the design solution into a final idea. The main activities useful for data analysis focus on the Brain dump, Crazy-8 s, Sketch, prototype/magazine and presentation. All participants were instructed to complete a Brain dump and Crazy 8's activity to warm up their creative thinking skills.

During the Brain Dump activity, children sketched and annotated their existing knowledge of the chosen technology and calm design, focusing on ideas for a smart toy. Next, the Crazy-8 activity encouraged divergent thinking to generate eight distinct ideas based on the Brain Dump activity. The Crazy-8 s were then narrowed down using a convergent method of dot voting with other child participants. Once a design was decided on, child participants were instructed to annotate the design using words to describe what it does and where the scaffolding materials have been added. The use of design thinking techniques allowed the child participants to think broadly before narrowing down their design ideas. Child participants were asked to annotate their drawings to help communicate the design and mitigate ambiguity during analysis; for the participants, it helps them to remember their design decisions.

1) ***Prototype and Presentation***: On the final day, child participants made physical prototypes and presented their work. Before each physical prototype was created, the researchers wanted to be clear about what was evidenced in the *design logbook* before they moved to a more obscure representation. For this reason, participants were asked to reflect on their work by first briefly describing their final (paper) design and annotations to the researchers before being supplied with any tangible materials (LEGO or Plasticine) for prototyping. The prototypes were photographed and attached to a magazine template, which the children then used to create an advertisement for their design. The magazine design stencil restricted the volume of content that can be added to the final design "pitch" which was aimed to highlight the most valued aspects of the design (Figure 6). Finally, participants were offered the opportunity to present their concept and respond to questions.

At the end of the sessions all *Design Logbooks* were collected and stored in school. Only the logbooks where consent had been provided were collected at the end of the week and used in the analysis described in the following section. A full workshop outline can be found in Appendix C: Workshop Outline.

Table 2. Table to show matching of calm understanding towards the technologies chosen from Group A

Group A: With calm technology design principles (*n* = 12)	
Code	**Occurrences**
Match	20
Mismatch	2
Misunderstanding	11
Missing	7
Total	40

Table 3. Table to show matching of calm understanding towards the technologies chosen from Group B

Group B: Without calm technology design principles (*n* = 11)	
Code	**Occurrences**
Match	12
Mismatch	3
Misunderstanding	5
Missing	5
Total	25

5 Analysis

The first phase of analysis focused on children's explanations of how their technology designs incorporated aspects of calm. This aimed to provide insights into their understanding of calm and their ability to apply it. These explanations were provided by children in their *Design Logbooks* as part of the "calm technology design principle logging" activity for Group A and "calm logging" activity for Group B. For Group A, children listed the calm technology design principles that they had chosen for their designs along with why they thought that principle was being used (Figure 3A shows an example of the data). Children in Group B were asked an identical question but were not asked to identify specific calm technology design principles as this group did not have access to the *Calm Cards* (Figure 3B shows an example of the data).

Two coders (who are both authors of this article) began by familiarizing themselves with the data and collaboratively developed four apparent codes:

- **Match**: Where there was a match between the rationale for calm and the technology chosen i.e., calm was understood and applied. E.g., "It makes a small little beep noise when connected" for the calm design principle: *The toy should alert you without disturbing play.*
- **Mismatch**: Where there was a mismatch between the calm rationale and the technology chosen i.e., calm was understood but not applied in this example. E.g "It's so the toy says the right things and the parents know they can trust their child with the toy" for the calm design principle: *The technology in the toy should be well hidden and child friendly.*
- **Misunderstanding**: Where the children appeared to have misunderstood the task or misunderstood calm. E.g., "The technology within the toy should be justifiable in enhancing play" for the calm design principle: The technology within the toy should be justifiable in enhancing play (i.e. the child re-iterated the principle rather than explaining how they applied it).
- **Missing**: No data provided.

The coding was carried out collaboratively by both coders; only one code was applied to each response and there were no instances of disagreement. The results of this coding are shown in the following results section in Table 2 and Table 4 (for Group A) and Table 3 (for Group B). For more explanations of the codebook used see Appendix D: Codebook and Examples.

The second phase of the analysis involved coding design outputs from the *Design Logbooks*' *Design Practice* activities to identify evidence of calm. The coding was carried out by the same two coders who first familiarized themselves with the data and the *Calm Cards* and then proceeded individually to code each design in turn before reviewing each other's coding and discussing any disagreement (no disagreement occurred). As the coding focused on features evident within a design output multiple codes were allowed for each individual design. The data coded included outputs from the following design activities:

- Brain dump
- Crazy-8 s

5.1 Design

- Prototype
- Survey
- Presentation (observation notes made by facilitators)

Examples of this coding can be seen in Figures 4–6 by the depiction of the *Calm Cards* overlaid on the design or annotated Post-It notes to show what is calm and where it's been applied (Figure 7). The result of this coding can be seen Table 5.

Table 4. Further detail on phase 1 coding from Group A

PID	Calm technology design principles for smart toys (*Calm Cards*)	Frequency of use	Code totals	Matched success
4	The technology in the toy should be well hidden and child friendly	7	2 Matched 3 Misunderstanding 2 Missing	29%
2	The toy should let you know that its technology is working properly	6	5 Matched 1 Misunderstanding	83%
3	The toy should be able to alert you without disturbing play activities	5	4 Matched 1 Misunderstanding	80%
6	The toy should still facilitate play when the technology fails	5	2 Matched 1 Misunderstanding 1 Mismatch 1 Missing	40%
5	The toy should use tones and subtle motions to communication changes	5	4 Matched 1 Misunderstanding	80%
7	The technology within the toy should be justifiable in enhancing play	3	3 Misunderstanding	0%
1	The technology in the toy should not distract from play activities	2	2 Matched	100%
8	The toy should only include technology that has been socially accepted	2	1 Matched 1 Misunderstanding	50%

6 Results

The results of the first phase of analysis are shown in Table 2 and Table 3 (coding of explanations children had given as to why their design included aspects of Calm). While the groups were similarly sized (Group A, n = 12; Group B, n = 11), Group A provided more detailed explanations of technology aspects related to calm, resulting in 40 coded instances compared to Group B's 25. The most frequent code in both groups was "Match," indicating understanding and application of calm in the technology designs: 50% in Group A and 48% in Group B. Mismatch, misunderstanding (and missing) occurred in similar proportions across both groups, the misunderstanding code included issues around both calm and the logging task.

In Table 4, we break down the results of phase 1 further to identify which *calm* children in Group A aligned their explanations with (this was not possible for Group B as they did not have the *Calm Cards* to refer to). The most popular *Calm Cards* chosen were for principles 4 and 2 (with n = 7 and n = 6 respectively) whereas the least popular chosen were for principles 1 and 8 (both with n = 2); the mapping between principles numbers and can be seen below in Table 4 and in more detail in Table 1. In Table 4, we also show the breakdown of coding for each *Calm Card* and the proportion of successful "Matches" (in relation to the total number of codes for that *Calm Card*). Although the data sample is small, the findings suggest that children found it most difficult to successfully apply the calm principles from cards 7 and 4 (with 0% and 29% "Match" rates, respectively), while cards 1 and 2 were the easiest to apply successfully (100% and 83% "Match" rates, respectively).

The second phase of analysis involved coding all design outputs for evidence of calm (as described in the previous section), the results of which can be seen Table 5. As we can see from Table 5 shows that more children in Group A (67%) demonstrated calm technology in their design process compared to Group B (36%). In Group A the Brain dump, sketch and presentation activities generated the most evidence of calm technology in the designs. Although coding was less frequent for Group B, the data revealed an understanding and application of calm in their designs, despite not having *Calm Cards*. For example, one participant wrote, *"When she's being depressed the technology robot gives advice and gently nudges her*," which was coded as calm because the toy recognises emotions and offers subtle support.

The results of the second phases of analysis also allowed us to look closer at the individual frequency of calm appearing in the outputs of each of the different design activities for both groups. Overall, we found 63 instances of calm technology design principles across the five design outputs (Table 5); principles were often coded multiple times within one design output as the design might demonstrate the principle in multiple ways (Figures 4 and 5). The Brain dump and sketch activities generated the most evidence of calm technology design principles, whereas the Crazy-8 s and Prototype and Magazine produced the least; (Table 5) Appendix E: Design Outputs provides examples of these.

In total 8 out of 12 (66.6%) child participants from Group A evidenced calm within their logbook design activities. Totaling 63 instances of calm across all design activities. Whereas, in Group B, only 13 instances of calm were identified in all of the 4 out of 11 (36.3%) child participants design outputs. In all cases there was a spread of evidence of calm across all design logbooks (i.e., in no case did all the evidence come from a single logbook).

7 Discussion

One of the key contributions of this work was the success of the *Calm Cards* as a tool to scaffold children in operationalizing unfamiliar design principles (RQ1). Where *Calm Cards* were used (Group A) 66.6% (8 out of 12) of the *design logbooks* showed evidence of calm in the designs, while in Group B, where *the Calm Cards* were not used, just 36.3% (4 out of 11) *design logbooks* showed evidence of calm (Table 5). This suggests that the *Calm Cards* significantly helped children design for calm more effectively. Conversely, the *Calm Cards* were not a pre-requisite for designing for calm within our *Design Workshop* format. Calm was still evident in four design logbooks from Group B, which we attribute to our priming approach (discussed later). Nor were the *Calm Cards* able to support every child in Group A to include calm in their *design logbooks* where four logbooks showed no evidence of calm at all.

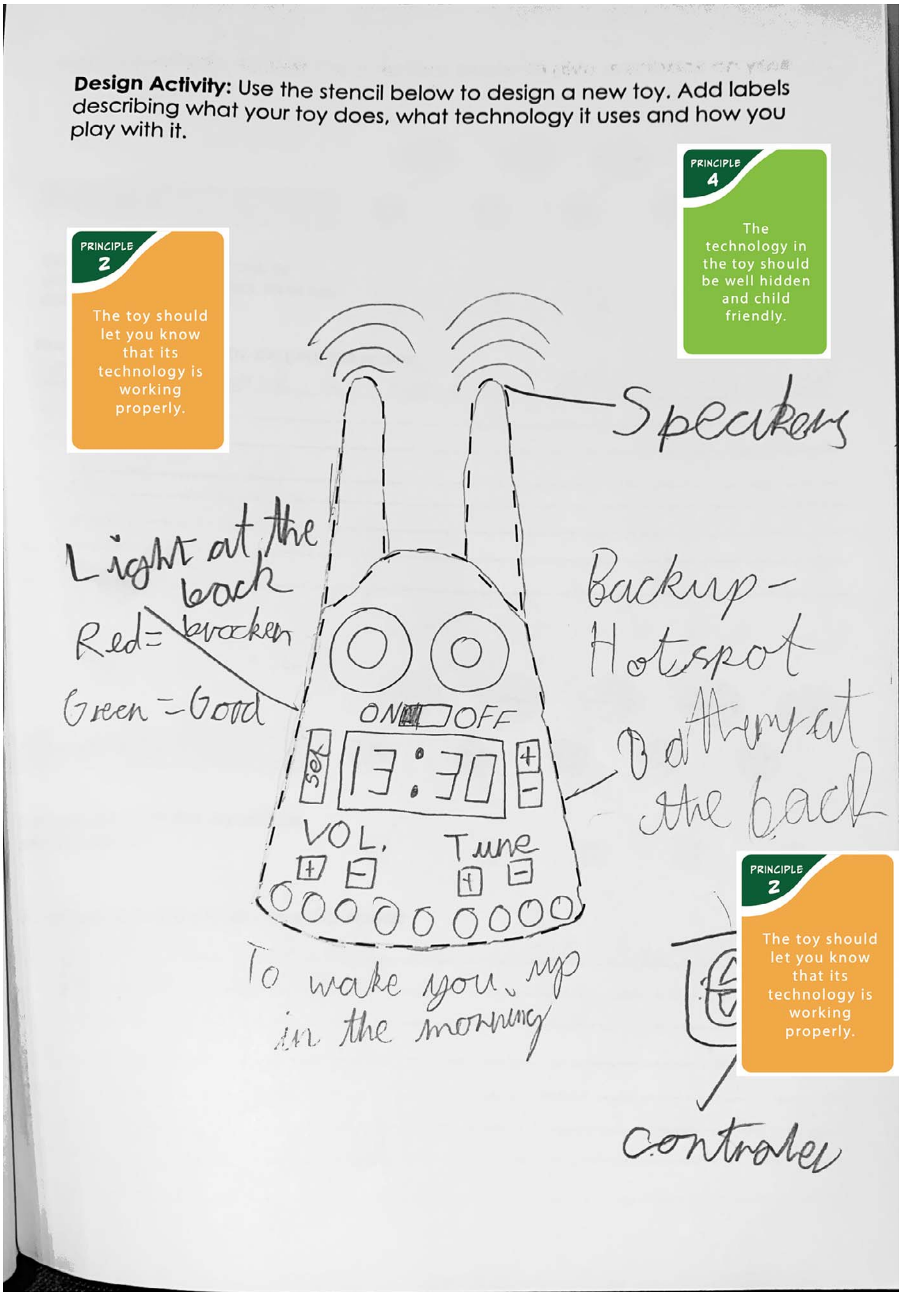


Figure 4. A sketch design output marked up with evidence of calm technology design principles taken from Group A. Alt text: a sketch from a participant from group A where evidence of calm technology design principles have been overlaid to demonstrate understanding and application.

In Table 2 and Table 3, we present the details of the coding approach used when ascertaining if children understood calm design. This was the foundation of the children's comprehension that led to the above results and from these we can see that in Group A there were 11 instances of "Misunderstanding" (of principles) vs. only five in Group B (the scores for "Mismatch" and "Missing" were very similar between groups). This shows that the cards have the potential to assist in ideation even when the calm technology design principles have not been fully understood. The above highlights the challenges inherent in working with children in a participatory context with concepts that are unfamiliar, e.g. how can we ensure all children understand calm sufficiently to be able to include it in their designs? In addition, there is a trade-off between supporting flexibility and choice within ideation (where including calm is encouraged through priming and scaffolding) and constraining ideation (where calm is mandated in the activity); e.g., how do we ensure designs include calm without reducing child agency? While our work provides a range of valuable insights, these two questions (adapted as appropriate) are valuable for all working with children in a design context to reflect upon.

To gain an understanding of how different design activities afforded expression of calm in design ideas, we asked children to describe where their chosen *Calm Cards* were used within their designs (Figure 3A). Our aim was to elicit evidence of their interpretation of the principle to understand if it had been applied in a way that attributed calm to an existing technology and therefore combined the use of the *Technology Cards* with the *Calm Cards*

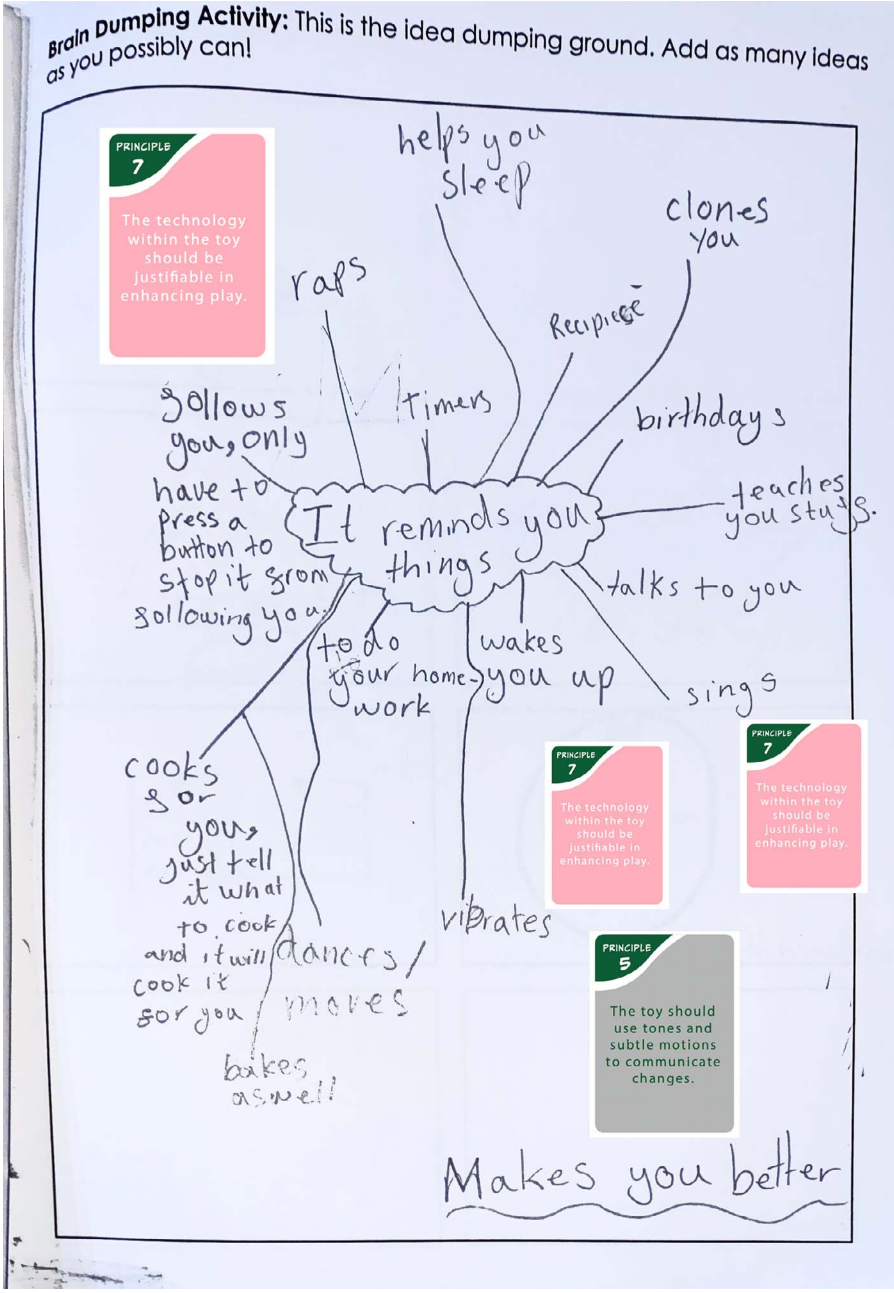


Figure 5. A Brain dump design output marked up with evidence of calm technology design principles, taken from Group A. alt text: A brain dump activity from a participant from group A where evidence of calm technology design principles have been overlaid to demonstrate understanding and application.

to contribute to the design of a calm smart toy. However, when describing where a principle would be used, children were also asked to explain what made it calm. This resulted in instances where the design decision was considered as aligning with calm by coders but the rationale for what made it calm was a "mismatch" with the design (see Table 2 for explanation of these codes with examples). The frequency with which a principle was used did not necessarily indicate whether it was understood. The results displayed in Table 4 help us understand which principles were the most popular and aligned to the chosen technology. The principle that was coded as "match" the most for use was *The technology in the toy should not distract from play activities,* although it is worth noting the low frequency of use of this principle. A principle with a high level of frequency and relatively high *Matches* was principle 2: *The toy should let you know that its technology is working properly*. One principle with no examples of "match," was *The technology within the toy should be justifiable in enhancing play.* Overall, seven principles had "match" responses indicating that they were generally applicable within the children's design ideas.

The *Design School* workshop format proved effective in enabling children to engage in design activities. This was facilitated over four school days, contrasting with prior work with children, which may only involve a single session (Read et al., 2022). We began by introducing children to the motivations for the research, included ice-breaker activities, introduced the notion of calm and calm technology, presented the design process and then enabled participants to explore the process using an instruction

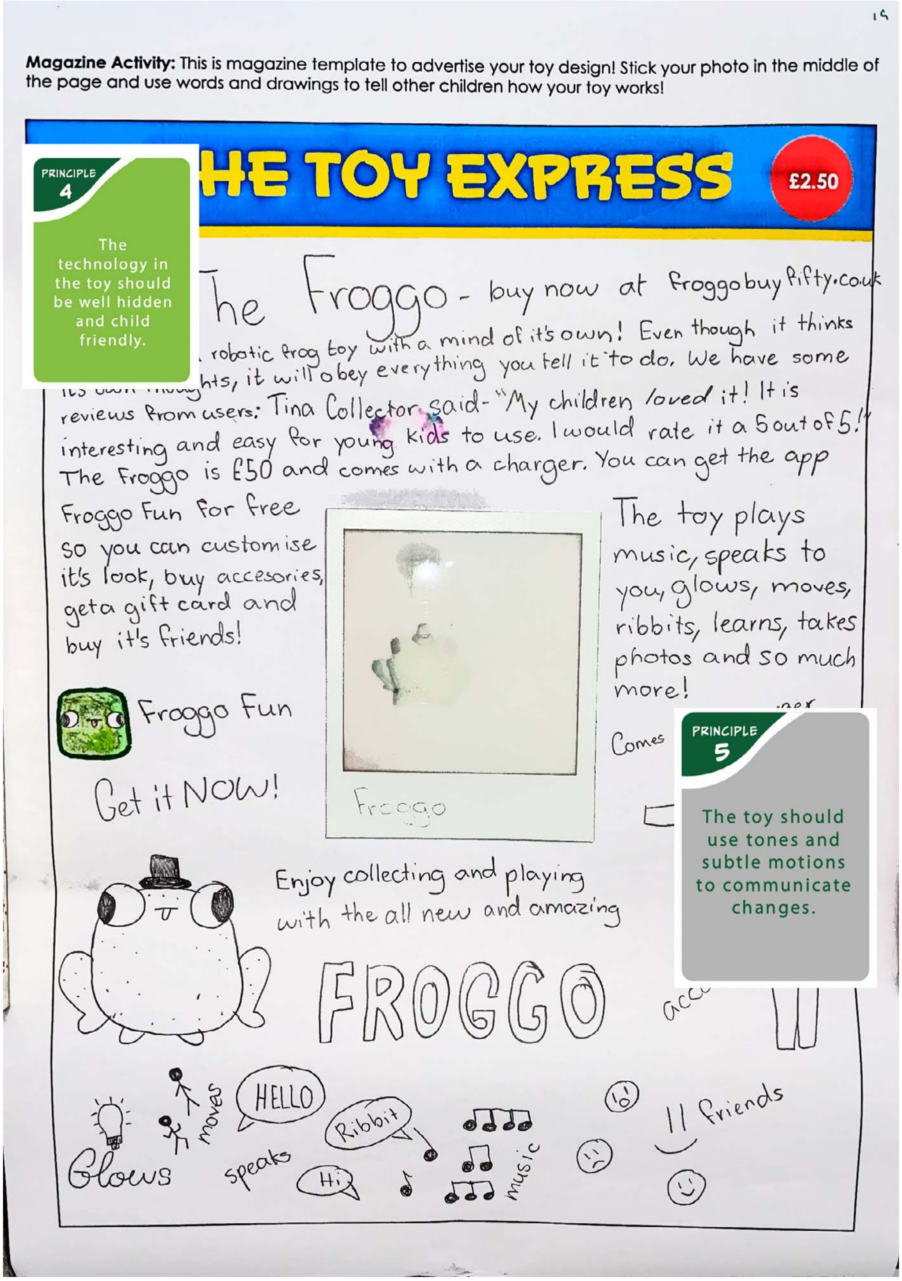


Figure 6. A front cover sketch advertising a calm smart toy, marked up with evidence of calm technology design principles taken from Group A. Alt text: Scanned evidence of a child participants completed Magazine activity with hand drawn toy designs and a handwritten description of the toy's functions and features. A screenshot of a Calm Card referencing Principle 4 is placed next to handwritten description.

and activity-based approach in a design "sandbox" where children were encouraged to ask questions and experiment. Our goal was to prime the children (Fitton and Read, 2016) with knowledge and experience of design activities and calm technologies. What followed was what we called "*Design Practice*" where the design activities were carried out in the two groups (Group A scaffolded via *Calm Cards*, and Group B without) which generated the designs we present in this paper. We believe that priming and scaffolding are essential when co-designing for complex topics with children (Golembewski and Selby, 2010; Bekker and Antle, 2011). In Group B we see the results of the priming and in Group A we see the results of both priming and scaffolding. Even Group B, without the additional scaffolding, had some ability to recall information on calm technology from the priming activity (as discussed earlier).

From this we draw two key findings, which respond to our initial research questions:

- Priming child participants as part of our *Design School* experience provided children with subject and domain knowledge, which enabled them to participate effectively in the design activities (RQ1; RQ2).
- Priming combined with scaffolding (*Calm Cards*) was most effective in enabling children to design calm smart toys (RQ1).

Within the *Design School* format, we sought to follow a design process that included techniques that would be familiar to a UX design practitioner; we also wished to understand which techniques would best support the inclusion of calm in child designs (RQ1). The results of this analysis are shown in Table 5. While

Table 5. A table to show the number of child participants that had evidence and instances of calm understanding and application in their design

	Group A		Group B	
Design outputs	**Evidence (no. logbooks)**	**Instances**	**Evidence (no. logbooks)**	**Instances**
Brain dump	7	18	1	1
Crazy-8 s	2	2	1	2
Sketch	8	17	4	6
Prototype and magazine	4	12	3	3
Presentation	7	14	1	1

the small sample size precludes statistical analysis, we can see that Brain dump, Sketch and Presentation were the most effective techniques for allowing children in Group A to show calm in their ideas (7, 8, and 7 participants with evidence of calm within the designs for each technique respectively). For Group B the techniques Brain dump, Crazy-8 s, and Presentation performed jointly worst (all with 1). The Prototype and Magazine performed similarly across both Group A and Group B (4 and 3 respectively), and within Group A Crazy-8 s performed the worst. Our work is unique in both attempting to recreate a UX process using a range of design techniques with children and in reporting the analysis of the outputs from each stage. While these findings are situated both with a multi-step design process and the context of calm, they are highly interesting findings that others may wish to consider; primarily that in both groups Sketching performed the most successfully and Crazy-8 s performed the least. Sketching (or drawing) is likely to be the activity that the children were most familiar with and therefore allowed the children to be able to concentrate on their designs fully. While Crazy 8's also includes sketching, children are unlikely to have much experience of the very rapid ideation and rough drawing that is central to this technique—although primed through the *Design School*, Crazy 8's still was a challenge for children (RQ2).

8 Limitations and future work

Although this study involved working closely with a group of children over four days, the relatively small number of participants, all from a single age group in one school in the Northwest of England, limits the generalizability of any findings. In future work, we plan to carry out similar studies with larger and more diverse groups of children to generate stronger findings regarding children's use of design cards and other UX methods.

Another limitation of this study is that adults analyzed the children's designs in the logbooks, which, despite being common practice in the HCI community, could potentially lead to misunderstandings or misinterpretations. Involving children in analyzing the designs would involve many challenges, but this is a potentially valuable direction for future work. For example, we could involve children directly in the coding process or train them sufficiently to carry out coding themselves and potentially compare the outputs of child coders with adult coders.

As shown in Table 5, there was variability in the application and understanding of the calm principles within the design logbooks. Future research should focus on understanding why this occurred, in the context of applying calm principles and design principles more generally. From this study we speculate there are a range of contributing factors, which include; the complexity of the principle and its explanation (i.e. how easily can the child understand it), the ability of the child to apply the principle in their ideas (i.e. is the child able to apply it), the applicability of the principle to the child's ideas (i.e. is it appropriate to apply it), and the prior experience of the child (i.e. examples of toys and associated play experiences to use in their thinking). Future studies would be needed to understand to what extent these factors (and others) influenced the designs of the children and how to address any emergent issues.

9 Conclusion

The overarching goal of this work was to explore the creation of calm smart toys as we see calm as a valuable but underexplored aspect of smart and Internet-connected toys. Our work took a participatory approach, working directly with children to observe how calm technologies can be designed into smart toy products. This is a novel and underexplored area, which brings many challenges in ensuring children understand what we mean by "calm" and how they can include it within their ideas. Within this work we developed the *Design School* approach to explore our research questions: (a) How can scaffolding support children in understanding calm when designing smart toys? (b) To what extent can children contribute to the design of calm smart toys? *Design School* this is a multi-day workshop format informed by UX practice and CCI research. Children were trained and onboarded in order to ensure familiarity with a range of design activities relevant to the study. Whilst taking a more longitudinal approach to co-design workshops is not novel, our workshop format of structured priming and scaffolding for complex design activities such as calm design, has a range of novel aspects, which we feel others in design research and practice could gain value from adopting.

The first key contribution this paper makes is the success of the *Calm Cards* as a tool to scaffold children in operationalizing unfamiliar design principles in co-design activities when designing calm smart toys. The use of the cards effectively doubled the number of designs that showed evidence of the calm within our study. Given the relative ease of creating and printing such cards, we would encourage others to use this approach where there is a requirement for children to utilize unfamiliar concepts such as design principles. The second key contribution from this work is an understanding of how different design activities afforded the expression of calm in design ideas. For example, it was evident that rapid ideation techniques such as Crazy-8 s are of less value if there is a requirement for children to express unfamiliar aspects within their designs, while in our work more detailed annotated sketches proved most useful. These contributions form the basis for answering the question, how can scaffolding support children in understanding calm and designing calm-smart toys? Additionally, our *Design School* format proved valuable in enabling

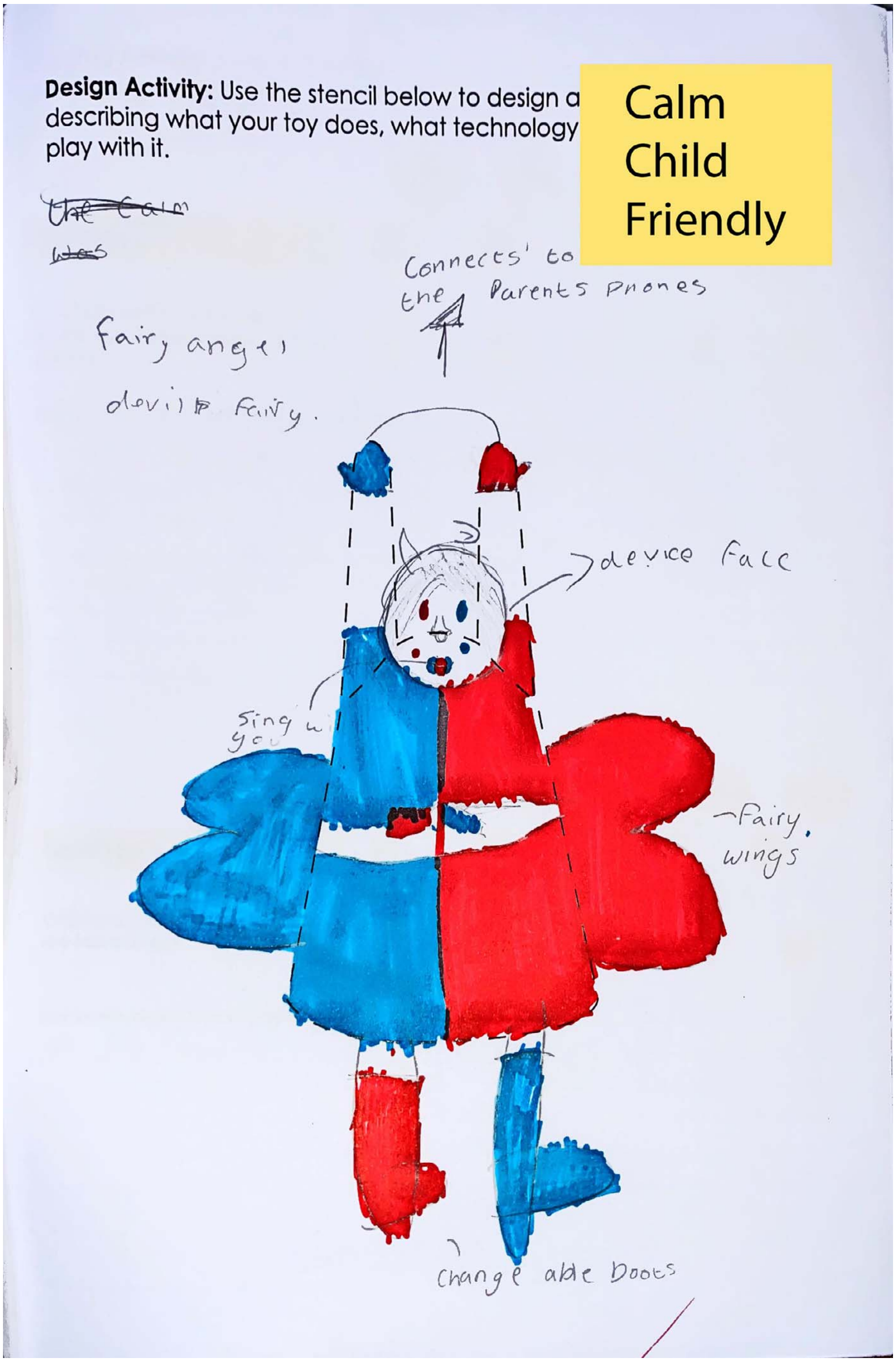


Figure 7. A sketch design output marked up with evidence of calm understanding, taken from Group B. Alt text: Scanned evidence of a child participants toy design with handwritten annotations. A post-it note reading "Calm Child Friendly" is placed next to handwritten annotations.

children to engage in a range of design activities for us to explore our research questions.

- Overall, we hope our findings will be valuable to toy designers, HCI and CCI researchers, and UX practitioners and will inspire others to consider the value of calm technology within technologies and interactions used by children.

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Data availability

The data underlying this article cannot be shared publicly due to the fact that this permission for this was not sought in the parental/participants consent form.

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Appendix A: Calm Cards and Technology Cards

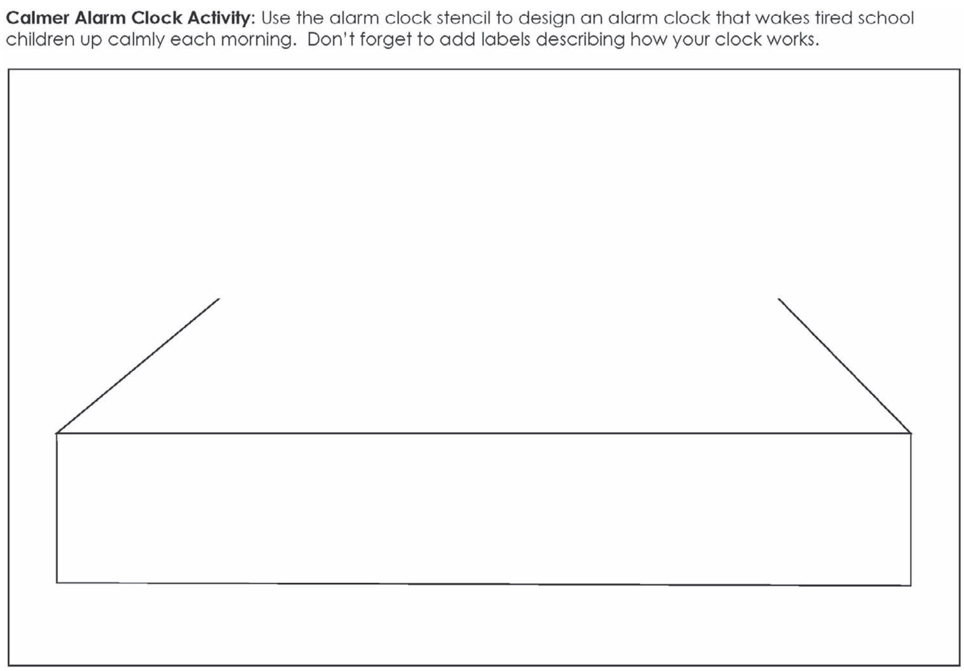
Calm Cards. Alt text: Image of all eight calm cards used in the study. Each card is placed in a row of two, depicting the front, where the principle is written, and the back, where the principle's contextualization/description is written. The eight principles are in numerical order.

Technology Cards. Alt text: Image of all twenty technology cards used in the study. Each card is placed in a row of four, depicting the technology and an accompanying relevant icon. The technology cards are listed as follows. It takes a photo, it plays a sound, it lights up, it responds to voice input, it plays games, it makes small vibrations when pressed, it connects to the internet, it sends information, it uses an app, it recognises your face, it can be coded, it is powered by solar, it is powered by batteries, it is powered by a wired connection, it responds to a controller input, it connect to other internet objects, its knows who is in the room, it learns from itself, it connects people together, and you can personalize it with new applications.

Appendix B: Design Logbook

Calm In The Wild Activity: Tick the images you think are real examples of Calm Technology.

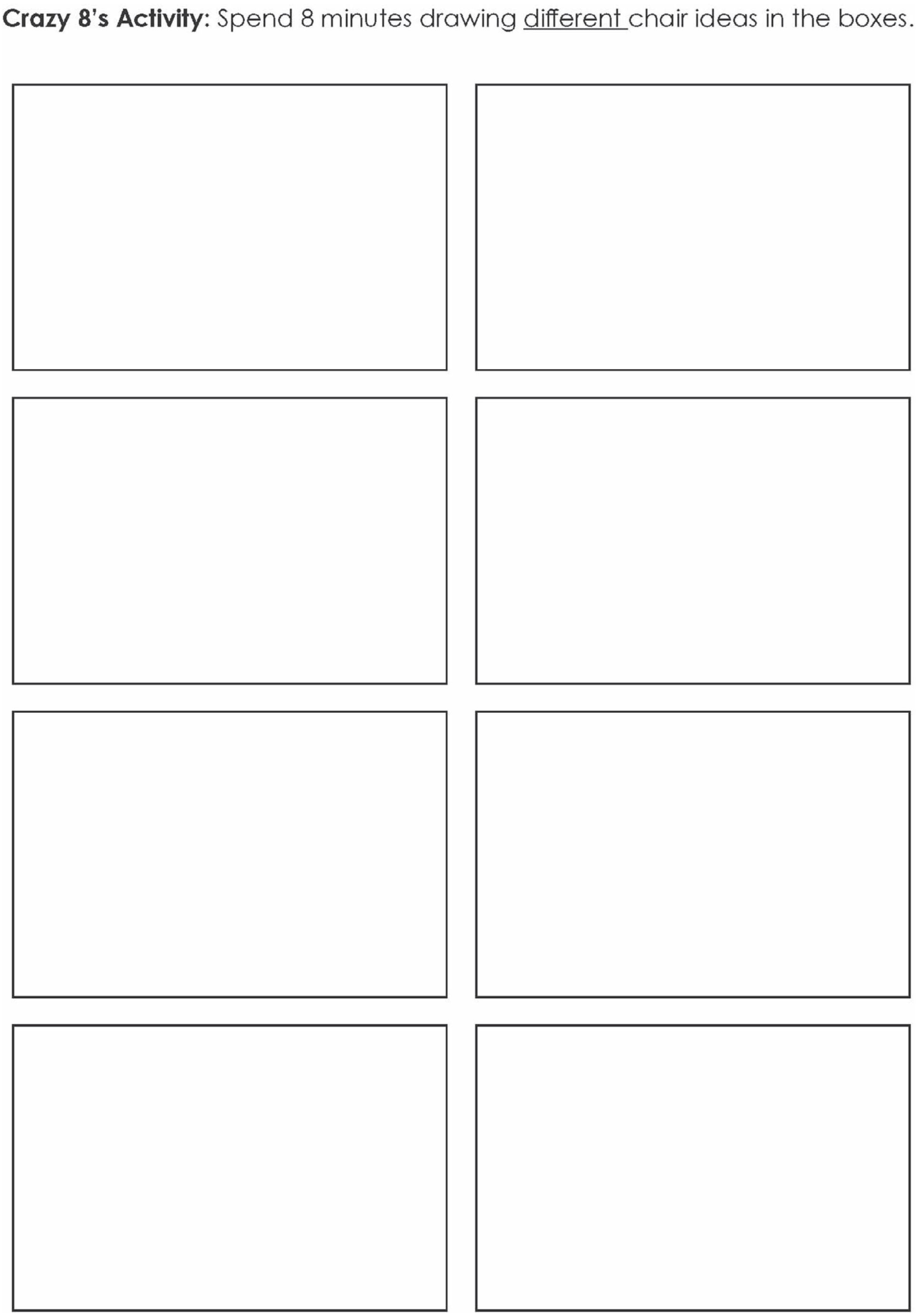
Calm in the wild activity. Alt text: Scanned example of the calm in the wild activity and written activity instructions. The example depicts nine images of technologies in rows of 3. The technologies include a smart kettle, a robotic hoover, a smart phone, a WIFI router, a television remote controller, an inner office glass window, an aeroplane lavatory sign, an Identification badge with a barcode, and a smart tap. To the left of each image is a yellow square indicating where the child participant should "Tick" as part of the activity.



Calmer alarm clock activity. Alt text: Scanned example of the calmer alarm clock activity and written activity instructions. The example depicts a partly drawn template representing a traditional digital alarm clock.

Brain Dumping Activity: This is the idea dumping ground. Add as many ideas as you possibly can!

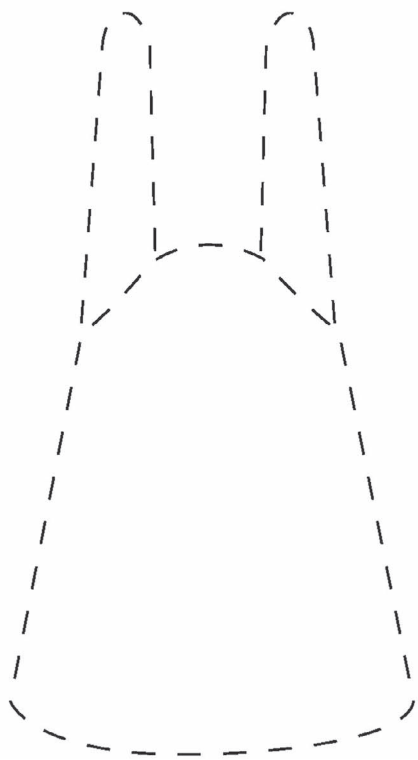
Brain dumping activity. Alt text: Scanned example of the brain-dumping activity and written activity instructions.



Crazy 8's Activity: Spend 8 minutes drawing different chair ideas in the boxes.

Crazy 8's activity. Alt text: Scanned example of the crazy 8's activity and written activity instructions. The example depicts 8 square boxes in rows of two.

Design Activity: Use the stencil below to design a new toy. Add labels describing what your toy does, what technology it uses and how you play with it.



Design activity. Alt text: Scanned example of the design activity and written activity instructions. The example depicts a template of a Nebtag robot.

Logging Activity: Use words to tell others what Technology you have used, how it works and what makes it calm.

Technology used

How is this technology used in your design.

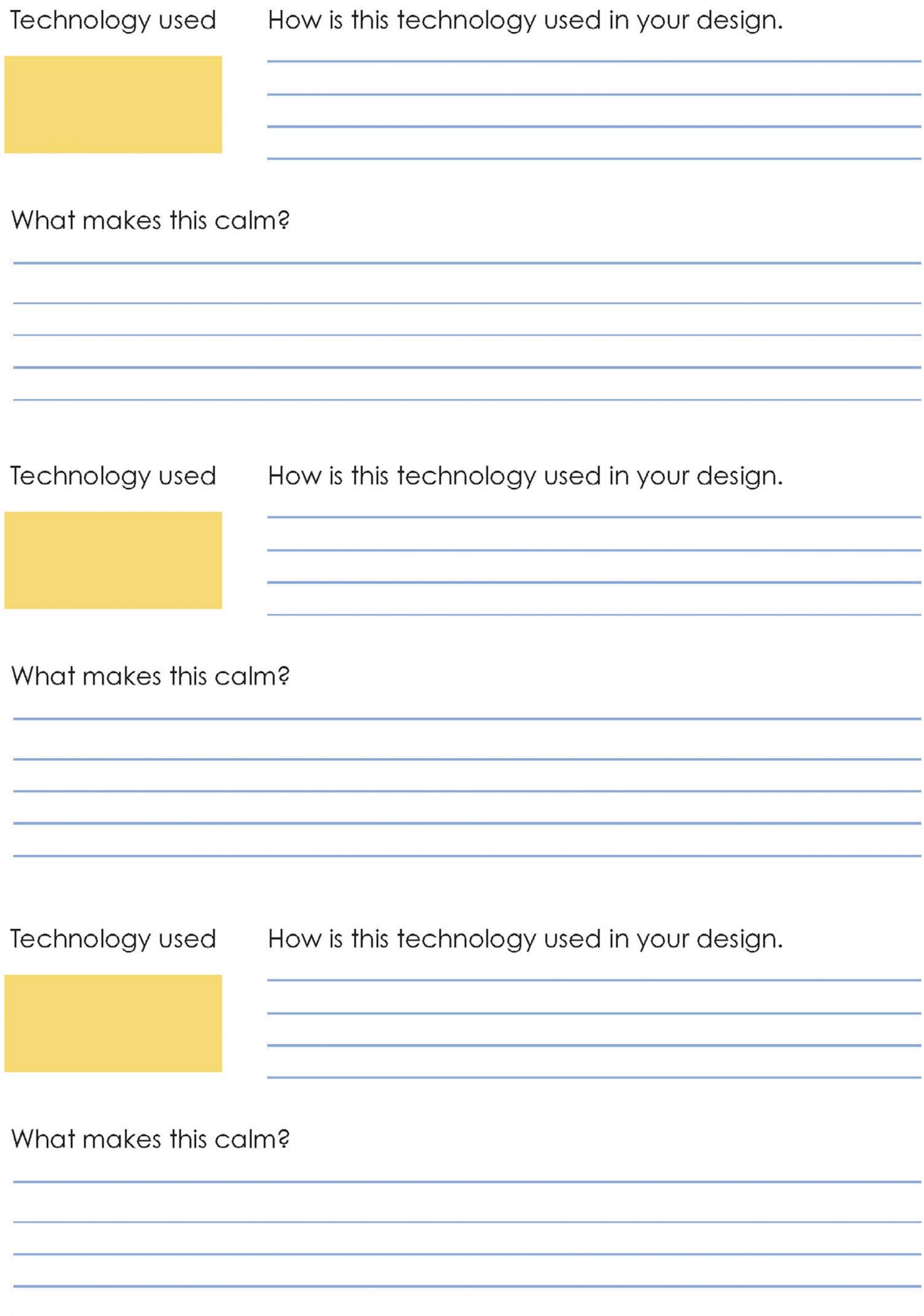
What makes this calm?

Technology used

How is this technology used in your design.

What makes this calm?

Group A principle logging activity. Alt text: Scanned example of group A's principle logging activity and written activity instructions. The example depicts two columns. In column one, there are two yellow boxes for child participants to note their chosen technology and principle, respectively. In column two, there are two questions: "How does this technology apply to the principle?" and "What makes it calm?" Under each question are lines singling where the child participant should write their answers. This is repeated across three rows.

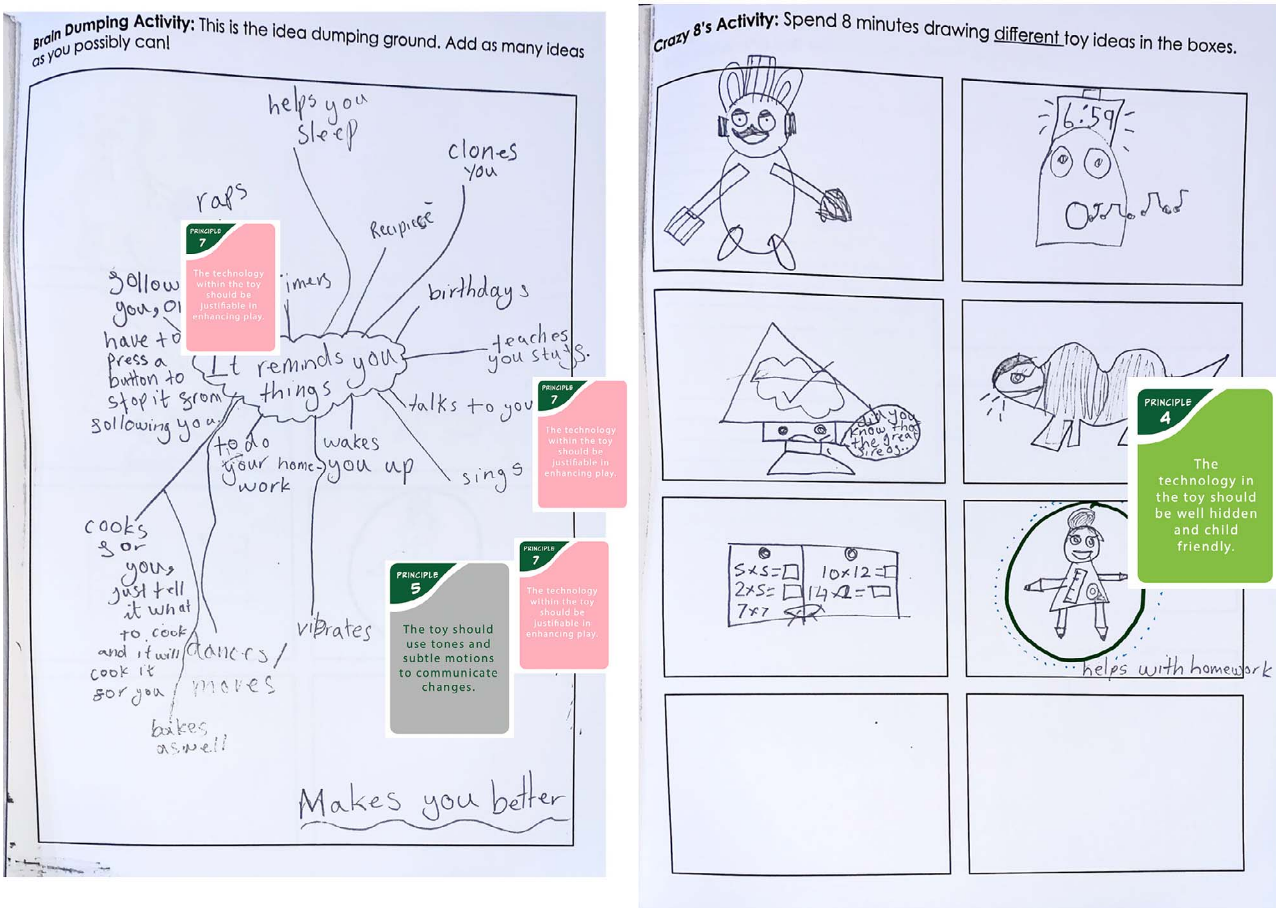


Group B technology logging activity. Alt text: Scanned example of group B's technology logging activity and written activity instructions. The example depicts two columns. In column one, there is a yellow box for child participants to note their chosen technology. In column two there are two questions: "How does is this technology used in your design?" and "What makes this calm?", Under each question are lines singling where the child participant should write their answers. This is repeated across three rows.

Appendix C: Workshop Outline

Appendix D: Codebook and Examples

Appendix E: Design Outputs



Brain dumping and crazy 8 s activity output. Alt text: Scanned evidence of a child participant’s handwritten brain dumping and corresponding crazy 8 s activity. The image depicts the child participants’ handwritten annotations and hand-drawn toy design ideas.

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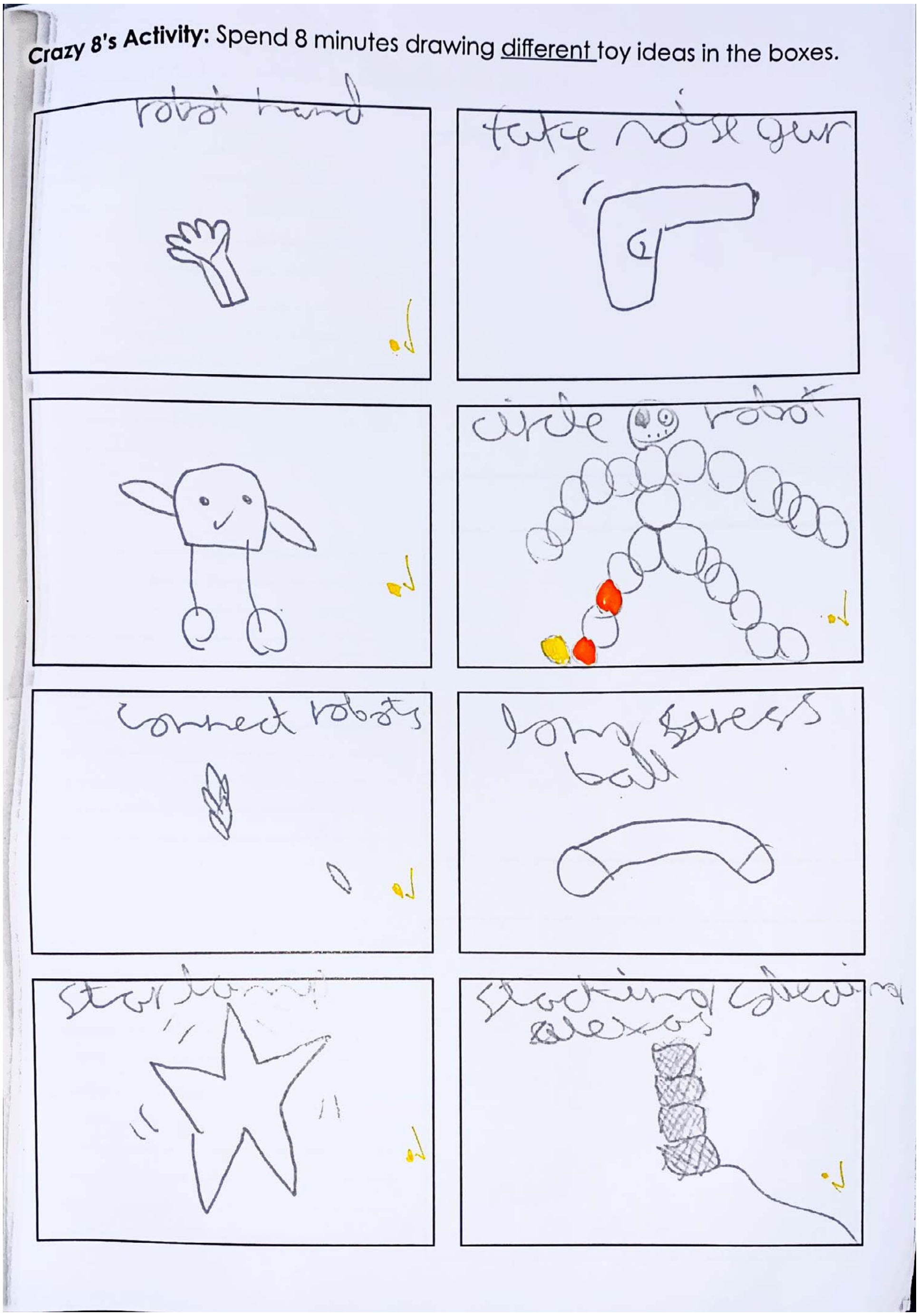
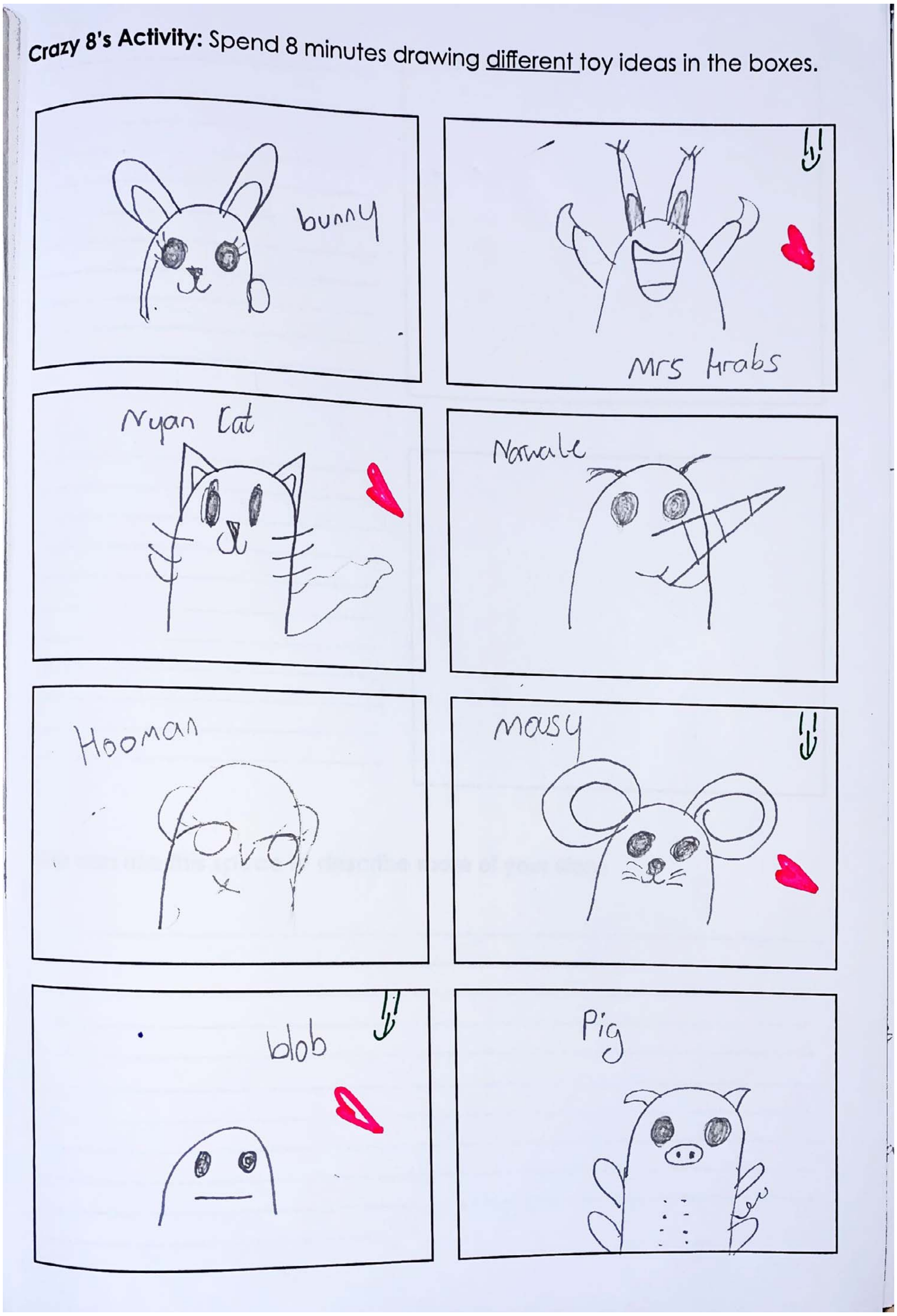
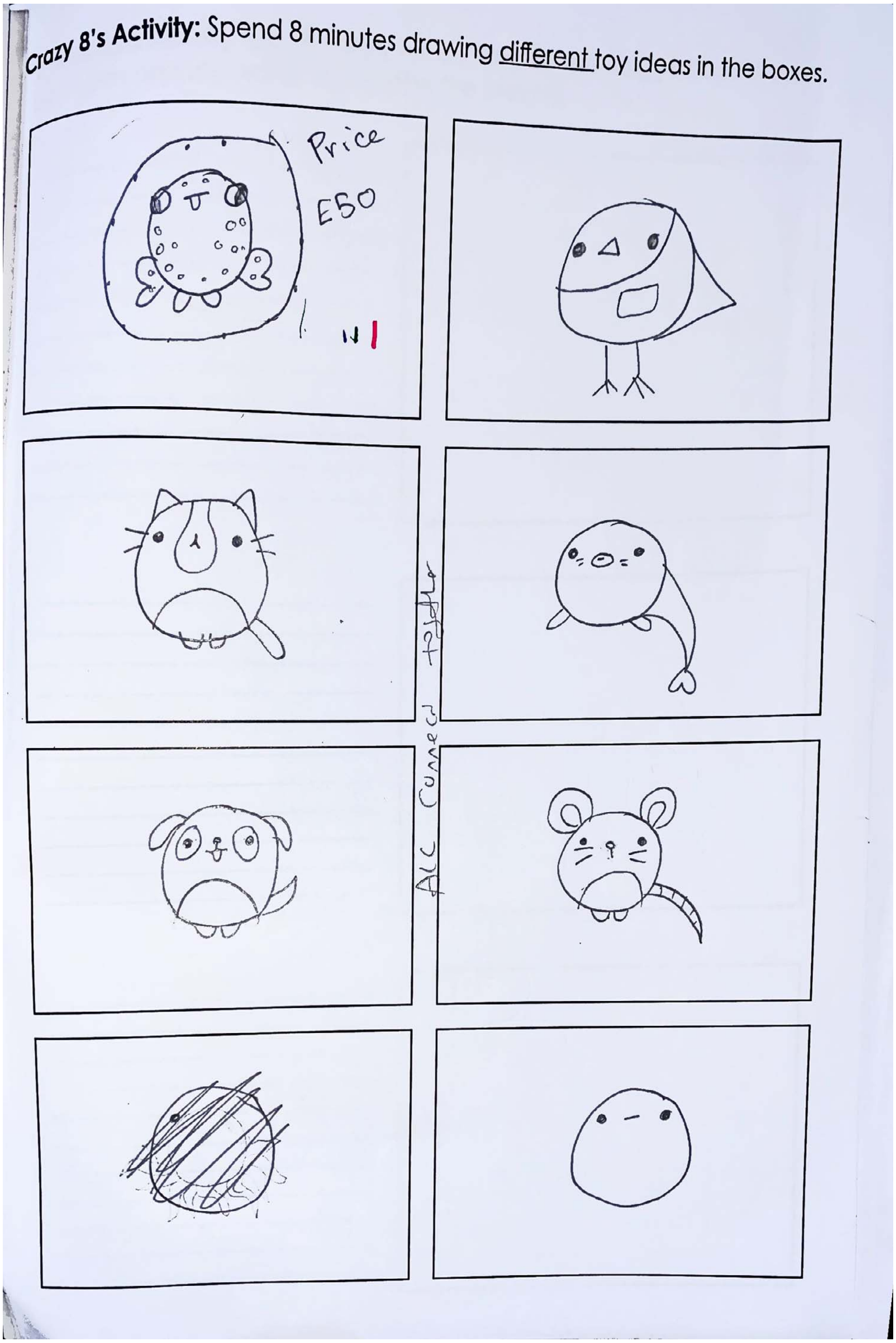


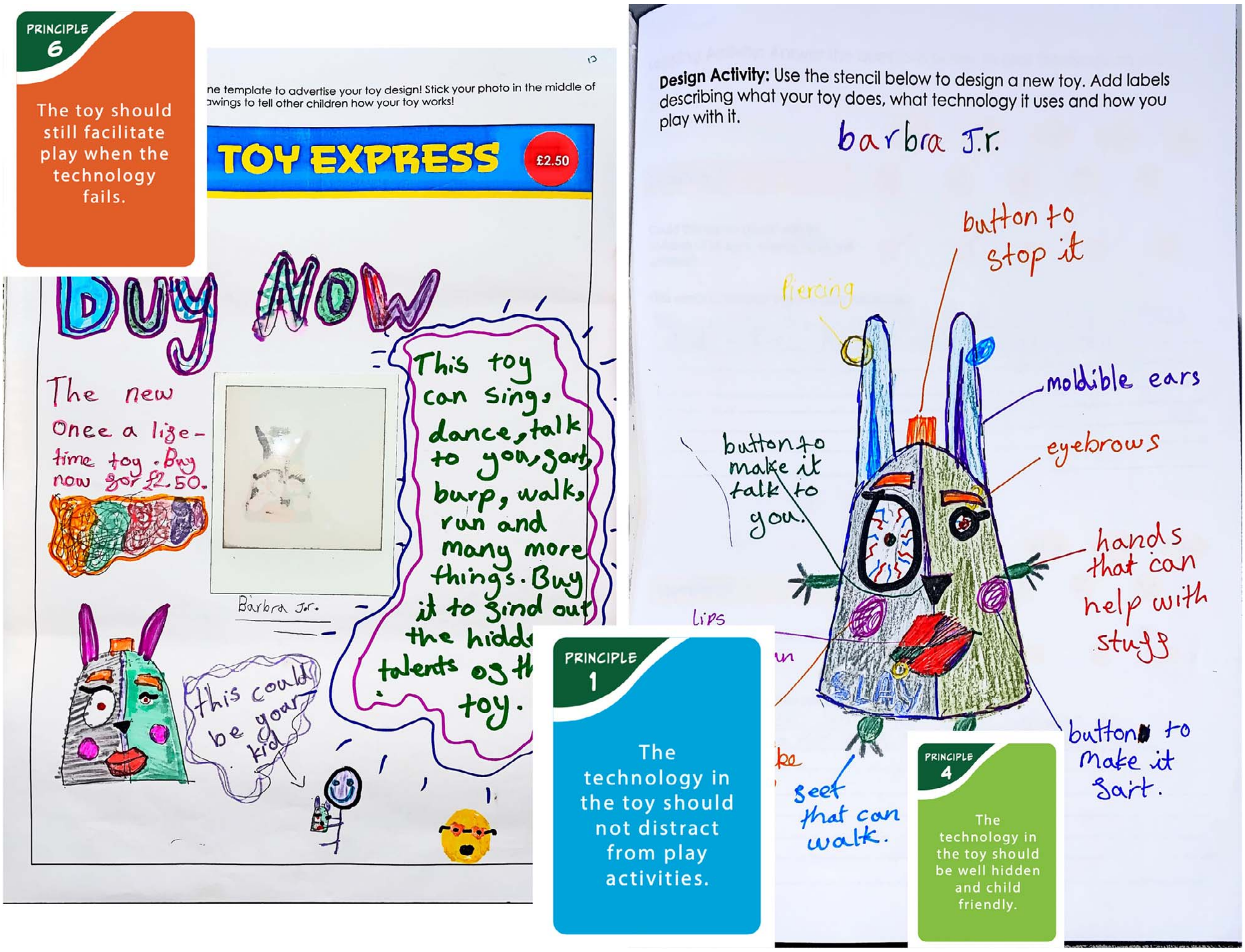
Crazy 8's activity output. Alt text: Scanned evidence of child participants hand drawn crazy 8's activity.



Crazy 8’s activity output. Alt text: Scanned evidence of child participants hand drawn crazy 8’s activity.

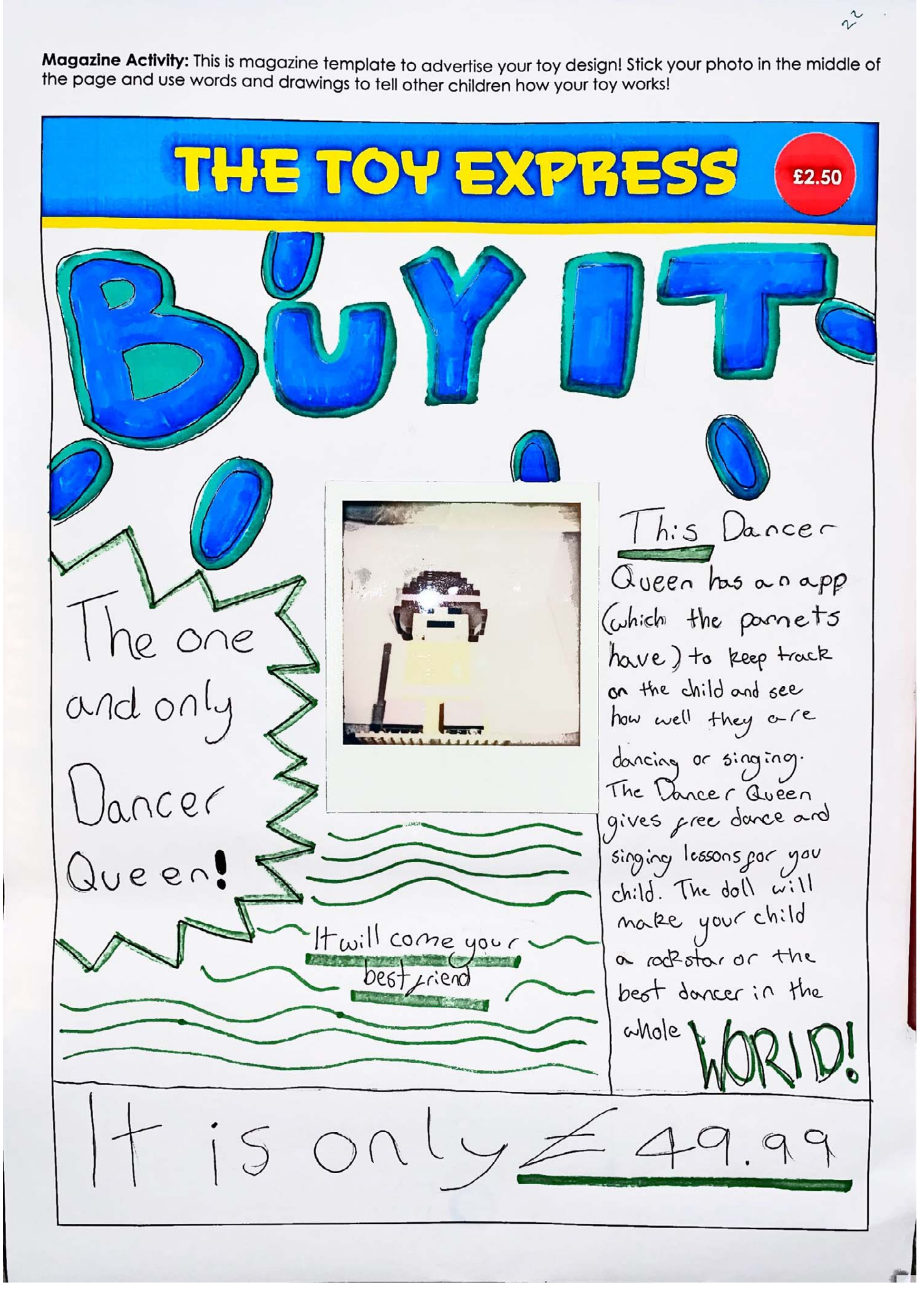


Crazy 8's activity output. Alt text: Scanned evidence of child participants hand drawn crazy 8's activity.

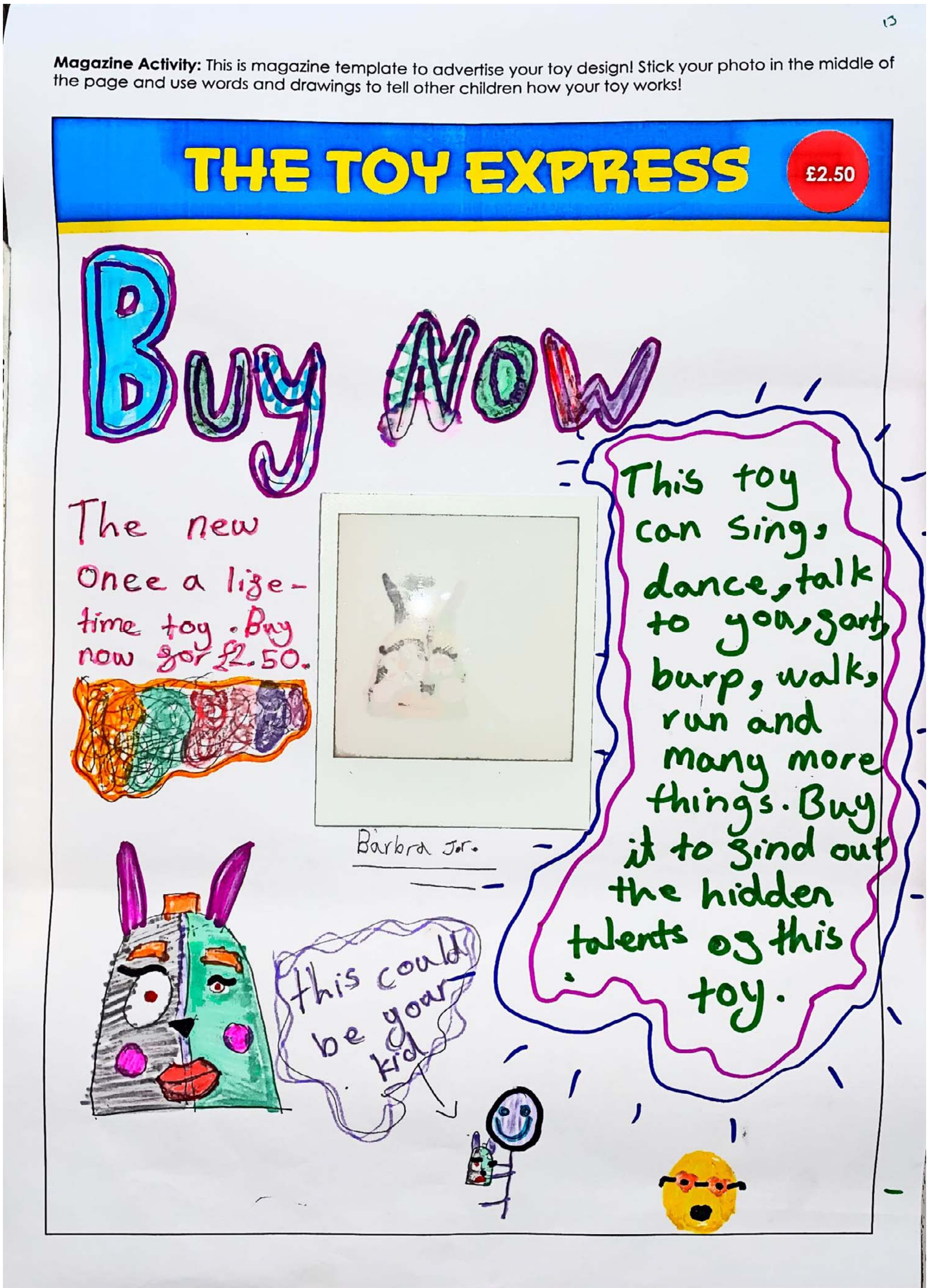


Design and magazine activity output. Alt text: Scanned evidence of child participants' hand-drawn toy design with handwritten annotations.

Magazine activity output. Alt text: Scanned evidence of four child participants hand-drawn toy designs with handwritten descriptions of the toys' intended functions and features.



Magazine activity output. Alt text: Scanned evidence of four child participants hand-drawn toy designs with handwritten descriptions of the toys' intended functions and features.



Magazine activity output. Alt text: Scanned evidence of four child participants hand-drawn toy designs with handwritten descriptions of the toys' intended functions and features.

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