Social Blooms

Materializing Screen Use During Family Time

Master Thesis

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Participant(s):
Thien Chan Le
Samir Memic

Supervisor(s):
Dimitrios Raptis

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Abstract:

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Resume af speciale

Brugen af mobiltelefoner og andre digitale enheder er blevet et allerstedsnærværende fænomen i det moderne hjem. Hvor hjemmet før var et sted for nærvær og fællesskab, er det nu præget af skærme, hvor både computere, fjernsyn, tablets, telefoner og smarte løsninger optager fællesområderne. Vi er alle digitalt forbundet til omverdenen, men det betyder også, at den fysiske kontakt og det nære samvær i familien kan blive svækket. Alt tyder på, at denne udvikling vil fortsætte, og det udfordrer vores måde at være sammen på i hverdagen. Det rejser spørgsmålet om, hvorvidt vi reelt er til stede, når vi har kvalitetstid med familien. Prioriterer vi de nære relationer, eller bliver opmærksomheden ofte rettet mod skærme og digitale indtryk i stedet for dem, vi er sammen med? I dette speciale undersøger vi gennem en Research through Design tilgang, hvordan fysiske artefakter placeret i familiers fællesområder kan gøre folk opmærksomme på deres brug af telefoner og dermed skabe refleksion over egne vaner, når man har kvalitetstid sammen. De to forskningsspørgsmål vi har formuleret til at undersøge dette lyder således:

- **RQ1:** *Hvordan kan husstande støttes i at reflektere over deres skærmbrug i fælles familiesammenhænge?*
- **RQ2:** *Hvordan reagerer husstandsmedlemmer på et fysisk artefakt, der materialiserer skærmbrug gennem plantebevægelser?*

Vi har indledningsvist foretaget en litteraturgennemgang af eksisterende løsninger, som viser, at traditionelle tiltag ofte fokuserer på at begrænse eller kontrollere skærmbrug gennem regler og restriktioner. Litteraturen peger samtidig på, at refleksive og materielle tilgange, hvor adfærden bliver synliggjort gennem fysiske objekter har potentiale til at skabe større bevidsthed og ansvarlighed i hverdagen. I vores gennemgang undersøgte vi ligeledes forskning om planteelementer og plantness, da tidligere studier i Human-Computer Interaction har vist, at planteinspirerede artefakter kan vække følelser af ansvar og engagement, og at planter er et genkendeligt og forståeligt symbol hos mennesker. På baggrund af litteraturgennemgangen gennemførte vi en idégenereringsfase, hvor vi udviklede og afprøvede flere forskellige koncepter. Det endelige valg faldt på en blomst som fysisk metafor for digital adfærd, fordi den både teknisk og symbolsk formidlede forskellen mellem nærvær og fravær. Vi udviklede og testede Social Blooms, som er en 3D-printet blomst koblet til en mobilapp, der reagerer fysisk på brugerens skærmaktivitet ved gradvist at visne eller blomstre. Prototypen blev testet i tre husstande over en uge, hvor hvert medlem af husstanden fik sin egen blomst der skulle repræsentere personligt skærmforbrug. Vi afsluttede testen med et semistruktureret interview for at indsamle deltagernes observationer og refleksioner om både deres skærmbrug og deres oplevelse af prototypen. Dataen blev herefter analyseret gennem en tematisk metode.

I vores analyse fandt vi frem til at:

- Synliggørelse af skærmbrug gennem blomsten skabte øjeblikkelig opmærksomhed, refleksion og nye samtaler om digitale vaner.
- Deltagerne oplevede både skyld, skam, sjov og glæde i mødet med blomsten.
- Prototypen fungerede som en katalysator for fælles dialog og ansvarlighed, snarere end som kontrol eller restriktion.
- Artefaktet gjorde det lettere at tage snakken om skærmbrug uden at det føltes moraliserende.
- Prototypen gjorde, at deltagerne begyndte at konkurrere med hinanden om, hvem der kunne bruge telefonen i mindst tid, hvilket ikke er ønskeligt på længere sigt.

Baseret på dette feltstudie diskuterer vi en række fordele og begrænsninger ved den nuværende prototype, herunder hvordan fremtidige designs kan udforske øget handlefrihed og direkte interaktioner med de materielle metaforer. Derudover udleder vi en række designimplikationer for materiale-centreret interaktionsdesign, hvor vi specifikt drøfter, hvordan fremtidige praktikere kan designe for refleksion gennem materielle metaforer på en måde, der holder brugere engageret og motiveret.

Social Blooms: Materializing Screen Use During Family Time

Thien Chan Le[1] (Student ID: 20195063) and Samir Memic[1] (Student ID: 20203186)

[1]Department of Computer Science, Aalborg University, Aalborg, Denmark

Abstract

The growing ubiquity of mobile technologies is reshaping everyday family life and challenging how we interact with one another. This study presents Social Blooms, a physical artifact developed using a Research Through Design approach grounded in the concept of materialization. The artifact is designed to make digital behavior tangible by using plant-like qualities. Individual screen use is visualized through the movement of a flower that wilts or blooms in response to mobile phone activity during family time. The prototype was deployed in three households over a week, and semi-structured interviews were conducted afterwards. Our findings show that making screen use visible through a tangible and plant-inspired artifact triggered immediate awareness, self-reflection, accountability, and a wide range of emotional responses, including guilt, shame, playful competition, and joy. The plantness of the artifact cultivated engagement and a sense of responsibility, although its artificiality sometimes limited emotional connection. Rather than restricting device use, the artifact acted as a social catalyst, prompting new conversations and negotiation of family norms. The study highlights the potential of material and plant-inspired interventions to surface hidden digital routines and support both individual and collective reflection on technology use within the home. Finally, we discuss design implications for future material-centered interaction design, including the importance of emotional engagement, the potential of more direct physical interaction with material metaphors, and the value of ambiguity to support nuanced reflection.

KEYWORDS
Screen use; materialization; plant-based interaction; households; mobile technologies; research through design; material-centered interaction design.

1 Introduction

Mobile technologies are now a constant presence in daily life, shaping how people communicate, work, and access information across nearly every context. As smartphones and tablets become more deeply embedded in daily routines, their influence extends into private and shared spaces, including the home. Within households, these devices increasingly shape how household members interact during family time. This often results in fragmented attention and a reduction in the quality of face-to-face engagement [23, 36, 44, 52, 57].

Family time refers to the quality moments spent together by family members, such as shared meals, recreational activities, or daily conversations [8, 11, 14, 26, 54]. Family time is important because it helps maintain strong family relationships, builds emotional bonds, creates a sense of belonging and supports both personal growth and the unity of the family as a whole [11, 26]. As digital devices become integral to everyday routines, families face new challenges as they balance physical presence with the pull of digital distraction at home. Screens now often accompany meals, conversations, bedtime routines, and other shared moments [23, 24, 37, 41, 44, 48, 52]. Over time, this constant digital presence can erode the depth of in-person interactions and change the ways families socialize [44, 57].

In response to these challenges, this paper adopts a Research through Design (RtD) approach and presents Social Blooms, a flower-shaped artifact designed to make everyday screen interactions visible and tangible [20, 60, 61, 62]. Rather than displaying data, Social Blooms embodies the social and emotional impact of screen use by visibly blooming and wilting in response to screen usage during family time. This physical artifact is not built to restrict access to technology. Instead, it aims to promote reflection on digital habits within the household.

This paper presents related work on screen use, materialization, and plantness in the context of human-computer interaction (HCI). We then describe our study method, introduce the Social Blooms prototype, and report findings on how the prototype supported reflection on screen use in a household setting. Finally, we discuss broader implications of the study for future interaction design. To guide this exploration, we ask the following research questions:

- **RQ1:** *How can households be supported in reflecting on their screen use in shared family settings?*
- **RQ2:** *How do household members respond to a physical artifact that materializes screen use through plant movement?*

2 Related work

2.1 The Impact of Mobile Devices in Households

The growing ubiquity of screens, especially smartphones, has become an integral part of modern life, fundamentally transforming how individuals interact, communicate, and engage with one another [1, 32, 43]. The modern home has increasingly become a space where tensions surrounding smartphone use emerge. These tensions often emerge from household members' differing expectations and negotiations regarding appropriate technology use [5, 17, 33, 37, 41]. For instance, parents may attempt to limit children's screen time while struggling to moderate their own use, or partners and roommates may disagree on acceptable phone use during meals, quality time, bed time or leisure time [23, 37, 41, 52]. These interactions reveal how dynamics, rule-setting, and mutual expectations shape how mobile devices integrate into household routines. As a result, seemingly mundane decisions, such as when to check a phone or answer work mails can influence relational dynamics and daily rituals [5, 44].

2.1.1 Defining households and family time

A household can be described as a fundamental social unit that consists of one or more individuals living in a single residence [9, 40]. The concept is multifaceted and includes not only nuclear families but also roommates, single individuals, cohabiting couples, and extended families [15, 55]. Households with multiple members, regardless of their specific composition, share a common feature: the daily interactions among their members that form the foundation of familial relationships [13, 15, 59]. These interactions within a household play a crucial role in emotional and social well-being of its members.

Family time, commonly understood as quality time spent together by household members during shared activities such as meals, recreation, or conversation [8, 14, 54], has long been recognized as essential to healthy relational development [11, 26]. However, as digital technologies become embedded in daily life, these of moment quality time are increasingly disrupted. Sherry Turkle in *Alone Together* [57], describes a paradox of modern household life, where individuals are physically present but mentally elsewhere because they are focused on their devices. She argues that this "flight from conversation" leads to fragmented and less emotionally resonant interactions [57]. As a result, family time in modern households is shaped not just by who is present, but by how present they are.

2.1.2 Tensions and social challenges of smartphone use in the home

Numerous studies within HCI have shown how screen use can impact social dynamics in households. Although mobile phones help families communicate and organize their shared routines, they can also cause tensions. These tensions are usually a result of differing expectations on appropriate screen use and often emerge when household members engage in non-urgent screen use during family time [17, 44]. This is especially common in parent-child relationships, where such tensions often lead to feelings of frustration, guilt, and distrust in children [5]. Other research on technology use in social settings suggests excessive screen use and its negative emotional consequences, such as guilt, are not exclusive to children and adolescents, but also extend to the adult population in different contexts [24, 29, 41, 52]. For example, Hiniker et al. [24] examined mobile phone use among 466 adult caregivers in a playground environment, a social context with implicit expectations for attentiveness to the children. Their findings indicate that while mobile phone use constituted a relatively small proportion of caregivers' time at the playground, it was identified as a notable source of guilt, as caregivers were aware of the potential negative impact of phone use on their children [24]. In other contexts, such as the bedroom, couples often use phones to relax together, but this can lead to frustration and feeling ignored when devices distract them from each other [52].

These emotional effects may, in part, stem from how people often use their phones subconsciously. Roffarello and De Russis [48] explored how users often interact with their phones out of habit rather than intention. They found that many phone unlocks are not tied to a specific need but are automatic responses to internal or external cues, such as negative emotions, boredom, or incoming notifications. Because these behaviors occur with little conscious awareness, they often go unnoticed and are difficult to change unless something actively interrupts the pattern [48].

Beyond social tensions, excessive screen use has also been linked to individual cognitive and psychological risks. The impacts of excessive screen use among multiple demographics groups including children, adolescents, adults include cognitive impairments, attention fragmentation, mental health challenges, and behavioral patterns similar to those observed in addictive disorders [36, 48, 50, 58]. These studies underscore the negative impacts of excessive screen use, ranging from cognitive and behavioral disruptions to serious psychological consequences.

2.1.3 Restrictive vs reflective interventions in HCI

To address the growing concerns around screen use and its negative effects on individuals and households, researchers within HCI have explored various restrictive interventions that actively reduce screen time by introducing friction into daily technology use. By constraining when and how screens are accessed, these approaches seek to curb device overuse and encourage individuals to re-engage with their social environments. For instance, Bruun et al. designed the *Pup-lock* provocative prototype to challenge screen habits at home by having family members trigger a lockdown on any connected smartphone devices. The findings reported that the participants became more attentive during family time and felt relief from digital interruptions during the lockdown. Additionally household members reflected more deeply on their smartphone habits [8]. Similarly Ko, et al. presented *Lock n' Lol* that allowed groups to temporarily lock their phones synchronously, using peer pressure as a leverage to encourage non-use of smartphones [34]. In another study, Ko et al. developed *FamiLync* for participatory parental mediation of adolescents' smartphone use, treating use-limiting as a family activity, which promoted a virtual public space for social awareness and improving self-regulation and reduced the overall screen use in the family [33].

While the aforementioned studies explored direct methods of limiting screen use through interruptions or rule enforcement, other researchers have investigated more indirect approaches aimed at creating awareness and accountability on smartphone use. Jensen et al. explored smartphone accountability in family home settings through the design and deployment of provocative prototypes [29]. Instead of restricting use, these prototypes aimed at provoking reflection on the ubiquity of smartphone usage and encourage a sense of shared responsibility of this issue [29].

Across these interventions, a recurring theme emerges: the fostering of collective responsibility within social environments when it comes to managing screen use and emphasizing that addressing this issue benefits from shared accountability rather than individual action alone [8, 29, 33]. However, most of these solutions still rely on a prescriptive model, centered on limiting or controlling access to technology. While the research supports that prescriptive interventions have proven effective in the short term, they may fall short in proving that they can promote sustainable behavioral change or encouraging users to develop intrinsic motivation for long-term self-regulation [8, 29, 46]. Recognizing these limitations, researchers in HCI have increasingly turned to alternative strategies that support reflection and self-awareness over restrictive control. Mikael Wiberg's work on designing for reflection through physical artifacts and material-centered interaction provides a theoretical framework for this shift [20, 61]. Wiberg argues that interactive artifacts help tackle problems that require behavioral change by encouraging reflection through their physical form. These artifacts act as a mediator between users and their actions by making interactions more tangible [20, 61].

2.1.4 Using materialization to reflect on screen use habits

Several studies showcase how materialization through physical artifacts helps surface otherwise invisible patterns of digital behavior, making them easier to notice, discuss, and reflect on collectively [20, 29, 60, 61]. For example, Sathya and Nakagaki, used printed receipts to summarize YouTube content usage, finding that the familiar and tangible format of the receipts encouraged users to reflect more deeply on their media habits [53]. Similarly, *Crank That Feed* required users to manually power their Twitter feed using a hand crank [56]. While the device was not designed to reduce screen time, the physical effort involved led to a significant drop in Twitter usage, as users often turned to other social media platforms instead. However, some participants reported that the experience prompted them to reflect on the role Twitter played in their lives and the kind of content they wanted to spend time consuming. Interestingly the physical aspect of the device introduced a new social dynamic, as friends often cranked while participants scrolled, turning a typically individual activity into a shared experience [56]. These early interventions illustrate how materialization of screen use could be further explored to support shared awareness and reflection in domestic environments.

2.2 Plants in HCI

Many researchers within HCI frame plants as more than static decor by positioning them as interactive and responsive entities, arguing that incorporation of plants in design challenges conventional anthropocentric approaches [10, 39]. Many studies have explored plants as interfaces for data visualization [6, 10, 25, 35, 51] and as mediators of social interaction [3, 16, 39, 42]. Furthermore, we have seen an emergence of several distinct design principles that transfer the unique traits of plants into technological contexts. One such principle is *BioMedia*, where information such as personal data is communicated through changes in the health, form, pigmentation, and bioluminescence of living plants [51]. Similarly, the concept of *plantness* has been introduced in spec-

ulative design to explore how interactive systems can be created to embody plant-like qualities [27, 39].

2.2.1 Living vs. artificial plants for data visualization

The existing literature in the HCI field distinguishes between approaches that use living and artificial plants, each providing different benefits and challenges for data visualization [10, 12, 25, 35, 39]. Living plants can provide long-term feedback through gradual organic changes such as growth and color variation, which can be useful for displaying cumulative data [6, 10, 12, 51]. For example, Botros et al. [6] explored how a living plant, watered in proportion to its owner's step count, could engage people in tracking and reflecting on their fitness. Their findings showed that this living visualization of personal data possessed qualities that digital visualizations do not, such as emotional engagement and a feeling of responsibility towards the health of their plant. This emotional engagement also proved to be a crucial factor in increasing participants' physical activity levels [6]. Similarly, designs like *PlantDisplay* demonstrate how plants can be used in ambient displays to serve as an alternative to digital screens for visualizing data, highlighting that plant growth can be used to convey digital information in a more emotionally engaging manner [35]. However, the slow and unpredictable development of living plants makes it difficult to ensure timely and unambiguous representation, which limits their effectiveness in visualizing dynamic and immediate data [12, 25, 51]. In contrast, artificial plants and plant-like artifacts provide designers with greater control over both the type of data and the methods of display, which can be particularly useful to deliver immediate and dynamic feedback [25, 39]. An example of that is the *Botanical Printer*, an artifact that visualizes environmental data by mimicking plant-like responses. It represents the intensity of CO2 and the strength of Wi-Fi in a household through printouts and LED indicators. Rather than displaying data numerically, it encourages users to reflect on their home environments as they would when observing a plant [27]. One drawback of using artificial plants, however, is their limited ability to elicit emotional engagement from humans and maintain their interest over extended periods [25].

Considering these factors, the choice between living and artificial plants should depend on the intended application and interaction goals. In any case, a significant amount of research demonstrates that plants and plant-like artifacts can serve as effective displays of personal or environmental data [6, 10, 12, 25, 35]. To the best of our knowledge, there is a lack of literature that specifically explores the use of plant-based designs in visualizing data on screen use. This provides an opportunity to explore approaches that mimic the affective and ambient qualities of plants to promote individual and collective reflection on screen use in households.

2.2.2 Use of plants to foster social cohesion

Several studies have also explored how plants can improve social cohesion through different levels of interaction. To promote community cohesion, the *Common Roots* study utilized a network-based system for shared plant watering between households in an apartment block to encourage social interactions in a communal garden [42]. The system connected potted plants via the internet, allowing socializing in the communal area to trigger watering in both the communal garden and private homes, resulting in an increase of community cohesion in the neighborhood [42]. Another system, *FamilyFlower*, used an artificial flower integrated with a real plant to signal everyday activities between related but remote households. The system detected human presence, movement, sound levels, and touch, transmitting this data to a paired unit in another home through visual, motion, and scent-based cues, thereby fostering a sense of closeness and prompting additional communication via other media [16]. Some studies have exemplified how plant-based ambient displays can specifically mediate interpersonal interactions. One such ambient display is *LaughingLily*, an artificial lily that mediates group dynamics in meetings by subtly reflecting the overall mood and conversational tone through changes in its state. Its petals droop during loud discussions or when there is little conversation, and bloom during conversations with moderate volume [3]. These approaches indicate that plant-based designs can enhance both interpersonal relationships and broader community cohesion. Therefore, we see an opportunity to use plant-based systems as a way to explore the impact of screen use on social interactions in households.

3 Ideation

Our ideation process combined structured sketching sessions and an ideation workshop to explore how physical, plant-inspired designs could reflect screen use in shared household settings. We began by generating concepts that visualized both individual and collective screen behavior, gradually narrowing our focus to plant-like artifacts due to their symbolic and interactive potential. Drawing on plant traits such as heliotropism and wilting, we considered how these

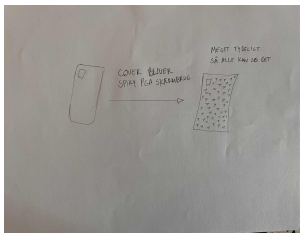
metaphors might prompt reflection on digital habits. The workshop introduced new perspectives, including concerns about visibility, symbolism, and user awareness, which helped refine our direction. These activities ultimately led to the development of two distinct design concepts.

3.1 Initial Ideation

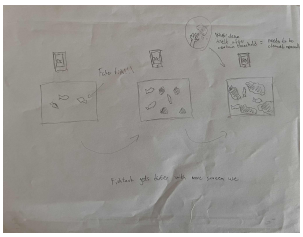
Our ideation process began with two separate 30-minute sketching sessions, each with a distinct focus. The first session explored how material designs could encourage household members to reflect on their screen use, while the second centered specifically on using plants and plant-like artifacts to visualize screen time within the household.

3.1.1 First sketching session

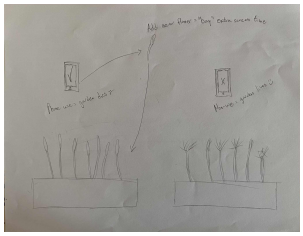
In the first session, we ideated on material designs that could not only depict the screen use of individual household members but also illustrate its broader impact on the household as a whole. This approach stemmed from our understanding that excessive screen use can lead to individuals' disengagement from family activities, creating frustration among household members [44]. Guided by this perspective, we ideated several concepts



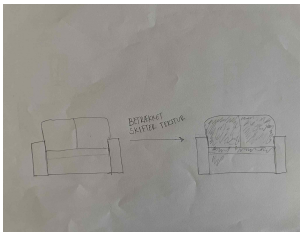
(a) Phone cover



(b) Fish tank



(c) Kinetic data garden



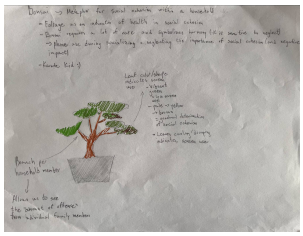
(d) Couch

Figure 1: Ideas from first sketching session: (a) A phone cover that will change form when screen use increases. (b): a fish tank that gets dirtier as screen use increases and requires manual cleaning. (c): A garden of artificial flowers that can be nurtured both manually and by adjusting screen use. (d): A couch whose cover changes texture according to screen use

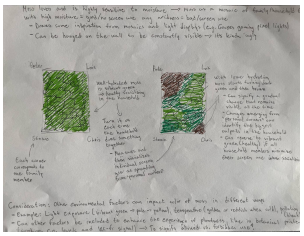
Among these ideas, we were particularly drawn to the kinetic data gardens (Figure 1c), for two reasons: (1) it was rooted in the concept of data sculptures, an established niche within data physicalization research [28, 46] and (2) it provided an opportunity to explore Human-Plant Interaction (HPI) and plantness [27] in the context of excessive screen use. Thus, in the subsequent phases of our ideation process, we decided to focus specifically on how plant-like qualities could be utilized in our prototype to visualize screen use and promote reflection.

3.1.2 Second sketching session

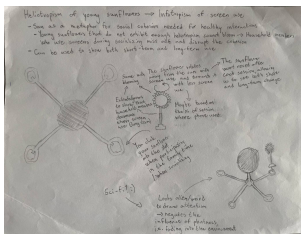
Our goal with the second sketching session was to ideate on how different traits of plants can be translated into material metaphors for good and bad behavior to reflect the impact of screen use during family time. Prior to sketching, we conducted a review of botanical literature and online articles to identify plant traits, such as wilting, blooming, and color change, that could metaphorically represent social cohesion and the distinction between "good" and "bad" behavior. We also explored how plant symbolism in various cultures could be used in this context, e.g. heliotropism of sunflowers as a symbol of loyalty and devotion in European cultures [22]. Additionally, we examined fictional portrayals of abnormal or malicious plants in sci-fi, such as human-plant hybrids in the movie *Annihilation* [2], to gain a broader perspective on how plant-like entities could represent human behavior. To deepen our understanding, we conducted a structured review of Human-Plant Interaction literature, investigating how plants and plant-like designs have been used in the HCI field to visualize data and foster social cohesion. Using these insights, we generated several ideas involving both real and artificial plants (see Figure 2).



(a) Bonzai tree sculpture



(b) Moss decor



(c) Heliotropic flowers

Figure 2: Ideas from second sketching session. (a): A bonsai tree where each branch tracks screen time of a family member, changing color as phone use rises. (b): Screen use controls how much water each person's moss area receives. (c): Drawing on heliotropism; a sunflower rotates based on individual screen use.

We decided to pursue a heliotropism inspired idea (see Figure 2.c): an installation with a central sun-like sphere surrounded by slots where household members could insert their sunflowers whenever they engaged in family time. Initially, the sunflowers would face the sun, but as their owners spent more time on their phones, the flowers would gradually turn away, symbolizing their disengagement. Since the sunflowers would have to be inserted into the installation at the start of a social activity, it would create an opportunity to explore how physical interaction with our prototype could carry symbolic significance [60, 61]. Furthermore, we were interested in exploring how heliotropism could translate as a metaphor for social cohesion in the household. Another factor that influenced this decision was our understanding that an artificial plant would be more fitting for the purpose of our study. As our literature review suggests, real plants offer authenticity and long-term organic responses but lack the fast responsiveness needed to represent dynamic behaviors like screen use. Artificial plants, by contrast, allow precise control over timing and form while preserving the symbolic qualities of plant life [10, 12, 25, 35, 39]. We also had reservations about the idea, particularly due to concerns that it might need to be large and occupy significant space in the room. This prompted reflection on how the size of the installation could compromise the subtlety of the prototype, an essential aspect of its plantness [27], and raised practical concerns about deployment. We wanted to refine the idea further and explore how heliotropism might be materially manifested in other ways in our prototype, which led us to conduct an ideation workshop to gather additional insights.

3.2 Ideation Workshop

The workshop consisted of a sketching session, where participants generated their own ideas for material-centered designs representing individual screen time and its impact on the household, followed by a How Might We (HMW) session to discuss how heliotropism could be represented as a physical metaphor for screen use [49].

We recruited five participants from our personal network. All participants were majoring in the human-computer interaction field and were recruited through convenience sampling. At the start of the sketching session, we introduced participants to the effects of screen use in households and the concept of materiality and material-centered design. We then set two guidelines for ideation: (1) participants had to design a physical representation of individual screen use, which could be static or dynamic, and (2) their ideas had to encourage reflection on how individual screen use affects the household as a whole. Our goal was to generate discussions on materiality in this context and uncover insights we may not have considered in the earlier ideation phases. To avoid influencing their thought process, we did not introduce them to plantness or our own idea. Participants were given 20 minutes to sketch as many ideas as possible, which they then presented and discussed with the group (see Figure 3 and Figure 4).

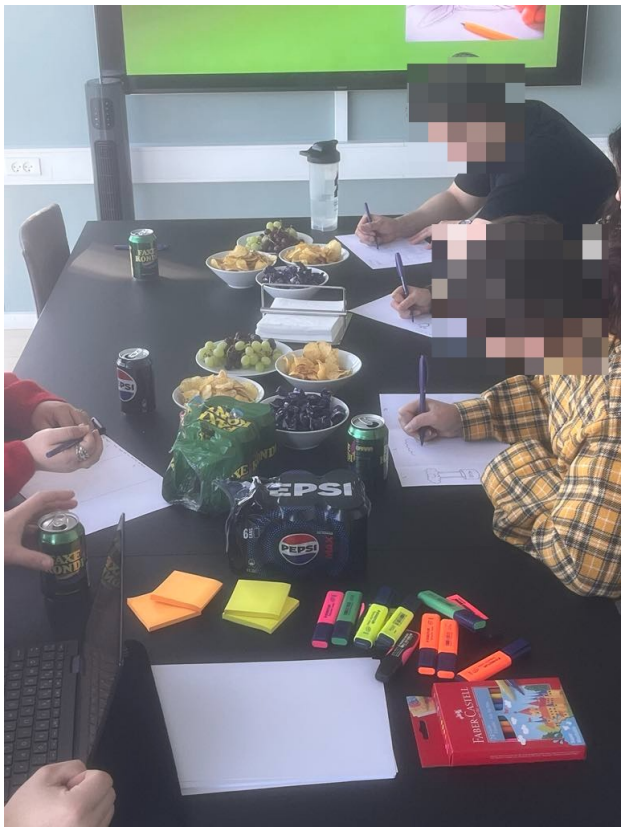


Figure 3: Ideation workshop

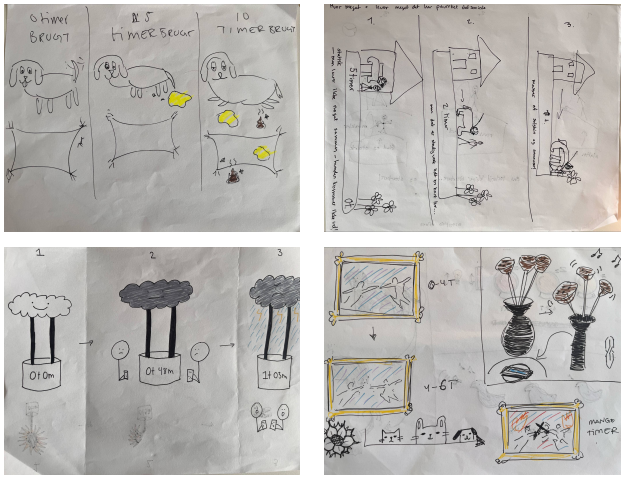
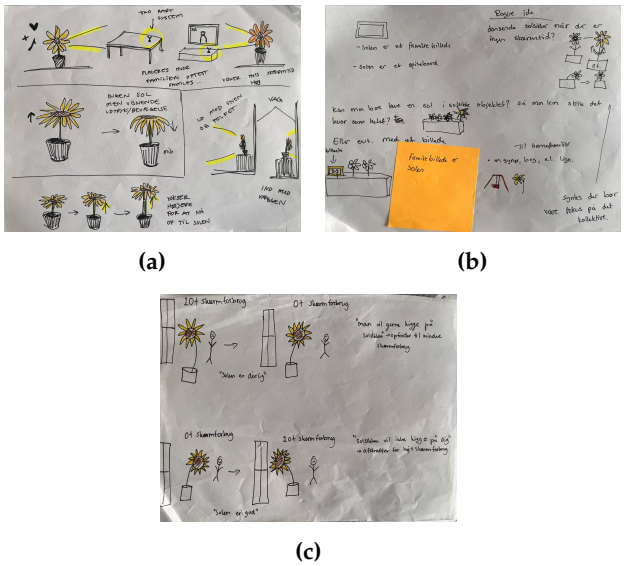


Figure 4: Ideas sketched by the workshop participants

Following the sketching phase, we introduced the concept of Human-Plant Interaction and presented our heliotropism-based idea to initiate the HMW-session [49], where participants were given 15 minutes to generate ideas for ideas for physical prototypes based on heliotropism. To encourage free thinking and reduce pressure, participants were asked to suggest both feasible solutions and deliberately impractical or absurd. They were also allowed to both write their ideas on post-it notes and sketch them out. Each idea was then discussed in plenary.



(a) **(b)**

(c)

Figure 5: (a): Sunflower turns towards and from a portable sun (b): Sunflower turns towards and from a portable family photo (c): Sunflower faces its owner when screen use is acceptable; will shy away if excessive

3.2.1 Insights

The ideation workshop yielded several interesting insights:

1. A discussion emerged on whether materializing screen use on an individual level might make household members overly self-conscious about their screen use. Some participants argued that this approach could make people avoid using their phones entirely during family time, making it a restrictive rather than a reflective intervention. However, other participants argued that screen use is so habitual that even with heightened self-awareness, people would likely still use their phones, which could lead to reflections on just how subconscious their screen use is.
2. The participants' ideas on how heliotropism could be translated into a material metaphor for screen use mainly revolved around what the 'sun' should be (Figure 5). Their ideas ranged from sunflowers turning toward the phone with the least screen time, to using the Wi-Fi router or the loudest source of sound in the home as the "sun". One idea that was suggested by several participants was that the sun could be a movable object placed at the center of shared activities (Figure: 5a, 5b) such as the dinner table, to give it a more symbolic role by representing the focal point of family time. We found the idea compelling because it opened up the possibil-

ity of exploring how the deliberate placement of the sun and its symbolism could frame and influence reflections on screen use during family time

3. Most participants were unfamiliar with heliotropism before the workshop, leading us to question whether it would serve as an effective metaphor in our design. The participants recommended adding features to the sunflowers that mimic more familiar plant qualities, such as growth, blooming and wilting to make the metaphor more relatable. Based on this, we decided to also consider an alternative design direction alongside the heliotropism, which resulted in two design concepts (Subsection 3.3) that we explored in our prototyping activities.

3.3 Concepts

The insights and ideas we gained through our ideation process ultimately resulted in two concepts:

- **Concept A - Sociotropism**: A prototype consisting of multiple sunflowers, each belonging to a household member, and a portable sun. When the household wants to begin family time, they will place the sun at the center of their interaction, e.g., the dining table, and physically interact with it to activate it. This will symbolize the start of their family time and cause all the sunflowers to turn toward the sun. At the same time, the system will begin tracking screen use. The more screen time a person accumulates, the more their sunflower will turn away from the sun. After a certain period of non-use, the sunflower will gradually turn back towards it.

- **Concept B - Social Blooms**: A prototype consisting of flowers directly connected to each household member's phone. When they want to start family time, they will activate their flower-either through an app or by physically interacting with it. This will symbolize the beginning of family time and initiate screen time tracking. As screen time accumulates, the flower will gradually show signs of wilting, such as drooping or bending. After a certain period of non-use, the flower will begin to revive.

We chose to let the decision between these two concepts be guided by our following prototyping process. Given the limited time we had to develop our prototype, we also saw prototyping as a way to asses which concept would be more feasible within our time frame.

4 Prototyping

After identifying our design concepts A and B (subsection 3.3), we transitioned into physical prototyping to explore potential forms, movements, and interactions, as these elements were central to how screen use would be represented and interpreted by users. This process was driven not only by practical concerns, such as assessing the feasibility of each concept within our time frame, but also by a methodological emphasis on generating knowledge through making [4, 62]. Drawing on Lim et al. [38], we understood prototypes as both filters and manifestations: tools for selectively exploring design questions and for giving material form to abstract concepts. Guided by this understanding, we structured our prototyping into two distinct phases. In the first phase, we used cardboard models to intentionally isolate and explore spatial, metaphorical, and interactional qualities without committing to technical implementation. In the second phase, we shifted toward prototyping with 3D-printed models to iteratively test and refine the movement, structure, and material composition of the prototype, allowing us to evaluate both metaphorical expression and technical feasibility in parallel.

4.1 Cardboard prototyping

At this point in the process, we were still deciding between two design concepts (Subsection 3.3). Thus, our goal in this phase was to consider how these two concepts could function within a household and ultimately decide which one would be most technically feasible within our limited time frame.

Figure 6: Cardboard models

We created simple cardboard models of two flowers and a portable "sun" (see Figure 6) that we used

to simulate movements, interactions, and placements of the prototype during our discussions. One aspect we explored in this process was the prototype's spatial arrangements within the household. Using our cardboard models, we replicated different scenarios of use by placing the cardboard prototypes in various locations in our design studio (see Figure 7). This led us to consider whether our prototype should consist of multiple flowers arranged together in a shared container or whether each flower should be placed in its own separate pot. Additionally, we reflected on how such arrangements could affect the prototype's visibility in the home and households' interactions with it.

Figure 7: Simulation of prototype placement in the household

Another aspect we explored during this phase were movement metaphors. For example, we simulated blooming using foldable cardboard flowers in Figure 8, while other movements that were difficult to simulate physically due to cardboard's rigidity, such as bending and drooping, were sketched or discussed. Our intention to use movement as a metaphor for screen use guided these discussions. We considered both how different movements could be technically achieved and how they might be combined or sequenced to express varying lengths of screen use, ranging from short glances to extended periods of disengagement.

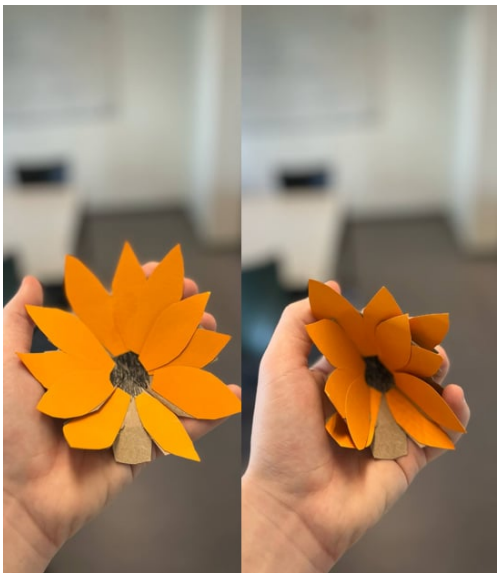


Figure 8: Simulation of blooming with a foldable cardboard flower

4.1.1 Understandings and design choices

Through cardboard prototyping, we arrived at the following understandings:

1. Each flower should be designed as a standalone artifact placed in a separate pot to offer households greater flexibility in how they arrange the flowers. This decision understanding was informed by a compositional approach to material interaction design, where the spatial arrangement of elements contributes to both function and meaning [60]. Allowing each flower to be positioned independently would enable us to explore how the spatial configuration affects the perception of our prototype within households.
2. Concept A required a considerably high level of technical complexity and more advanced hardware configurations to enable the flowers to localize the portable sun. This raised concerns about its technical feasibility within our limited time frame. Furthermore, insights from the ideation workshop indicated that heliotropism is not a widely understood phenomenon, which led us to question whether it would serve as an effective and easily understood metaphor.
3. For Concept B, the wilting could be simulated with a simple bending movement to reflect the duration of screen use. This decision was based on two considerations. First, the movement supports the subtlety we consider essential to the prototype, as it reflects core qualities of plantness [27]. Rather than demanding attention, the slow bending motion would express change in

an ambient way to promote reflection without confrontation. Second, it represents the technically simplest solution, as it can be achieved using a single servo and a string mechanism that pulls and releases the stem to create the bending motion.

Ultimately, we decided to discard Concept A regarding *Sociotropism*, as we had multiple technical reservations towards the feasibility of this idea. Furthermore, our ideation phase uncovered that using heliotropism metaphor for screen use is an abstract concept with multiple interpretations, which might be difficult to grasp among users, if they do not understand the plant traits of a sunflower. For these reasons, we decided to discard the concept for this iteration and pivot to our Concept B with the wilting flower.

4.2 3D Prototyping

Building on our understandings from the cardboard prototyping, we moved on to 3D prototyping to develop our Concept B with the wilting flower using 3D-printed models. In this phase, our goal was to explore material properties that could help us achieve the desired functionality, particularly regarding the stem and the integration of hardware.

We used AUTODESK Tinkercad to model individual parts of the prototype, such as the stem and pot, which we printed using various filaments. Each printed part was evaluated for its functionality, and based on these evaluations, we printed new, refined iterations until the desired form and function were achieved. A central aspect we explored in this process was bendability, and we developed and tested various stem designs capable of bending and straightening. One concept featured a modular stem made of interlocking cylinders printed in solid PLA and connected internally by a string. Another stem design was a single-piece model made of flexible TPU filament, where the string was externally attached to the top of the stem. We modeled and printed several iterations of these stem designs (see Figure 9) to test how different shapes, dimensions, and printing settings would affect their bendability and structural integrity.

Figure 9: Picture on the left shows the modular stem, picture on the right shows the evolution of the bendable TPU stem

We also explored the overall structure of the prototype, specifically, which parts were necessary to achieve the desired functionality and how they should be integrated. The pot was particularly important in this regard. Initially, we modeled and printed a simple square container, which served as a starting point for considering details such as dimensions and hardware placement. Our main goal here was to design an internal structure that would minimize interference with the string. These considerations informed later iterations, allowing us to refine the pot and other parts of the prototype.

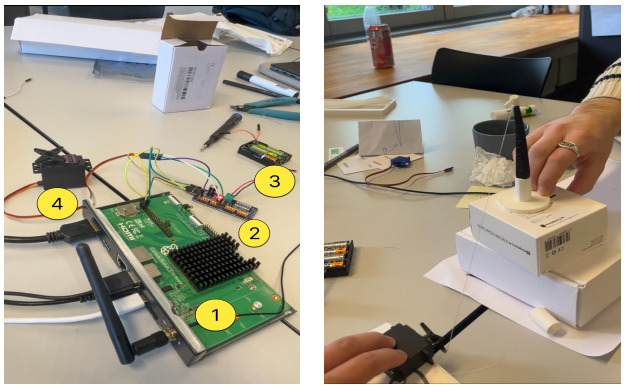
4.2.1 Synchronizing physical design with technical components

Throughout the prototyping process, it was pivotal to ensure that the physical design of each 3D printed part worked consistently with the technical components. This meant not only testing the fit and function of individual parts, but also considering how the hardware such as the servo motor, Raspberry Pi, and wiring would work in the complete system.

A key focus was on the stem design and how it would interact with the string mechanism controlled by the servo. Each new stem design was evaluated by connecting it to the servo and running test scripts, checking if the stem could bend smoothly without excessive resistance and recover back to its upright state (see Figure 10b). This iterative approach made it possible to adjust dimensions and printing settings until the physical motion matched the technical requirements.

Choosing the right technical components was also part of the synchronization process. After experiencing erratic servo jitter with direct Raspberry Pi control, we switched to a PCA9685 servo driver board and an external battery pack, ensuring the servo motor would receive stable power and reliable signals (see Figure 10a).

In summary, our approach was to constantly test and adapt the physical and technical elements together, making sure that the mechanics, electronics, and wiring all worked as a coherent system.



(a) Hardware setup **(b) Test of stem flexibility**

Figure 10: Image on the left: 1) Raspberry Pi device 2) PCA9685 servo motor driver 3) Battery pack 4) Servo motor. Image on the right: Testing the flexibility of an early stage prototype of our stem. A string is tied to the servo and the top of the stem

4.2.2 3D prototyping understandings and design choices

Our 3D prototyping led to the following understandings:

1. The stem should be a single-piece cylinder made of flexible TPU that can be bent by pulling a string attached externally to it. The cylindrical shape proved to be more bendable and durable than other shapes we tested, such as elongated cones and pyramids. The solid modular stem design proved unreliable, as its segments frequently detached and we were unable to achieve a consistent bending motion.
2. The internal structure of the pot should consist of two levels: the upper level for the servo and the lower level for the rest of the hardware. This configuration ensures that other hardware components do not interfere with the servo-string mechanism and disrupt the flower's movement. This setup also requires a modular design to accommodate the internal structure while separating it from the outer, visible layer of the prototype.
3. Our choices regarding the prototype's aesthetics were limited by both functional needs and time constraints. This was an important limitation to consider, as the aesthetic qualities are one of the main mediums for establishing familiarity with users' mental images of real-world plants, which in turn significantly affects both how the prototype resonates with users and how it blends into their living space [27, 39, 51]. For this reason, the aesthetic expression of the prototype should be improved through post-processing of the printed parts, with the most feasible approach being the addition of color.

The 3D prototyping phase translated our conceptual direction into functional form. It helped us understand how material properties, structure, and mechanical configurations could work together to support our intended interaction. Ultimately, the 3D prototyping was the way our wilting flower concept manifested into its final physical form, as we opted for using the latest iterations of printed components for our final prototype.

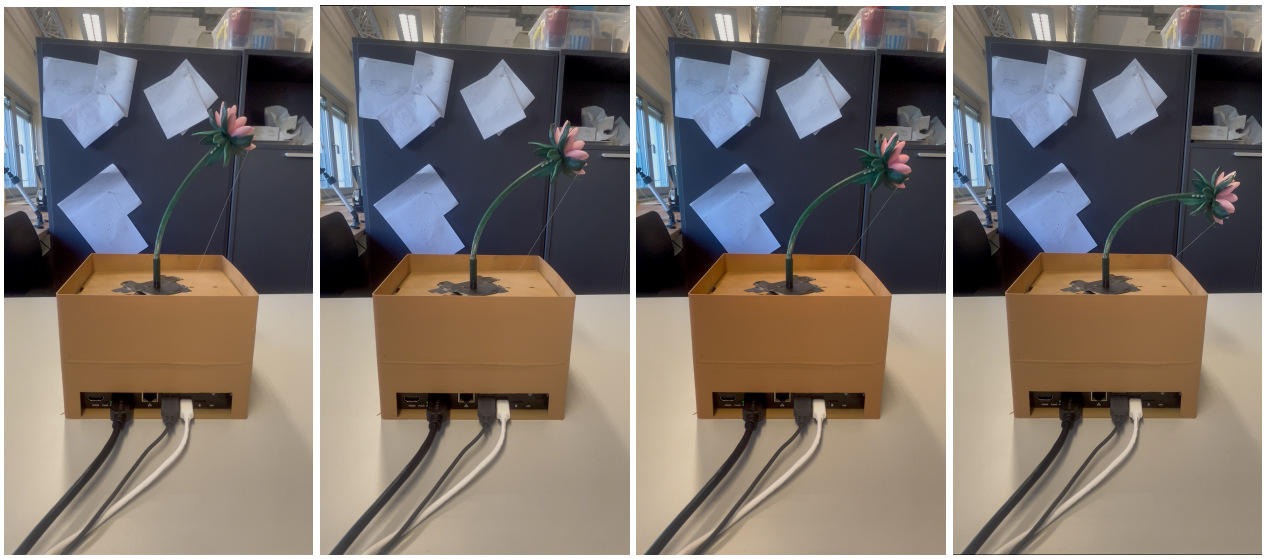
5 Social Blooms Prototype

The system consisted of two parts: a physical component and an Android mobile application. The physical prototype consisted of a flower embedded in an individual pot. The mobile application supported real-time tracking of screen use, enabling the flower to move based on screen usage. The vision was that each household member would have their own flower to materialize their personal screen use during periods of family time in the household.

5.1 The Physical Prototype

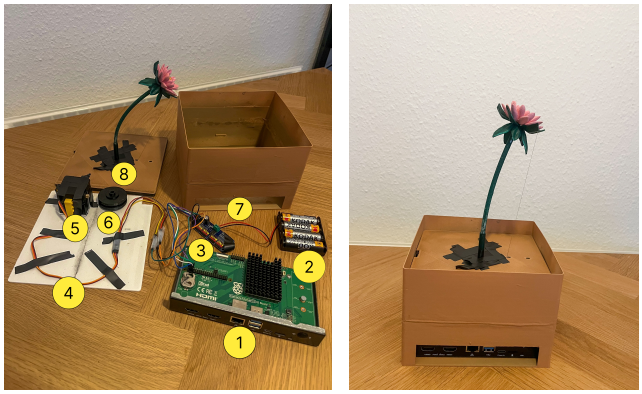
Based on the understandings we gained during prototyping in section 4, all visible parts of the prototype were 3D printed using polylactic acid (PLA). However, the flower stem was printed in thermoplastic polyurethane (TPU). As seen in Figure 12a point 8 the stem is flexible and durable, which allow the stem to bend repeatedly during actuation without breaking. Each part of the physical prototype was designed with modularity in mind, allowing for easy assembly and disassembly. Components were 3D printed with a press-fit design, which eliminated the need for tools during setup or adjustment.

To simulate the blooming and wilting effect, we designed a simple string mechanism. A string is tied to the flower head and runs down into the pot, where it is attached to a servo motor. As the servo rotates, it pulls the string, applying downward force that causes the flower to wilt (see sequence in Figure 11). Releasing the string allows the flower to return to its upright position.



(a) Blooming state **(b) Starting to wilt** **(c) Wilting** **(d) Wilted state**

Figure 11: Sequence showing the flower from blooming to wilting.



(a) Deconstructed flowerpot prototype **(b) Assembled flowerpot prototype**

Figure 12: Picture on the left includes all hardware:
1) Raspberry Pi device
2) Battery pack for the servo
3) PCA9685 servo motor driver
4) Middle-level plate that fits inside the pot
5) MG996R 180° servo motor
6) Custom 3D-printed spool that attaches to the servo. A string is tied to the spool, which runs up to the head of the flower to create the pull effect
7) Flowerpot to fit electronics
8) Lid for the pot with a holder that fits the 3D-printed bendable TPU flower stem

Each Raspberry Pi device acted as the central controller of one Social Blooms flower, by hosting a Flask server that received data on screen use from the mobile application, which triggered physical movements based on our predefined behavioral logic (see Table 1).

Condition	Flower Response
Users starts socializing	Reset flower to neutral position (0°)
Phone is unlocked	Rotate downwards by 2° (simulate wilting)
30 seconds of continuous screen use	Rotate downwards by 5° (simulate wilting)
3 minutes of no screen use	Rotate upwards by 5° (simulate blooming)

Table 1: Behavioral logic linking screen activity to flower movement. A servo motor pulls or releases a string to simulate wilting or blooming, based on screen use data received from the mobile app.

5.2 The Social Blooms Mobile Application

The Social Blooms mobile application enables the physical prototype's movement by delivering real-time screen activity data from the user's phone to the connected flower. When users open the application, they are presented with a minimal interface that includes a "Start Socializing" button and a simple indicator showing the connection status with the flower (see Figure 13). Once activated, the app runs in the background, detecting each phone unlock and tracking the duration the screen remains active while the screen is unlocked. While socializing is activated in the app, users can see the total duration of the ongoing session, but the time they have spent on their phone remains hidden until the session ends

(see Figure 13). To minimize distraction and maintain focus on the physical prototype, the interface was deliberately kept simple, using a basic layout and neutral color scheme. This design approach was selected to ensure that the digital elements remained unobtrusive and did not compete with the physical feedback provided by the Social Blooms flower.

To enable the wilting and blooming functionality of the physical prototype, the app continuously sends screen activity data to a Flask server hosted on a Raspberry Pi device that is connected to each flower. The data is transmitted over the local network every 10 seconds and includes metrics on each participant's screen use for the 10 second interval. When the server receives the data, it will process the information in real time and trigger an appropriate physical response in the respective flower such as wilting, blooming, or remaining unchanged based on our predefined behavioral logic (see Table 1). Additionally, every time a user unlocks their phone, a separate event is sent to the Flask server, prompting the flower to gradually wilt as an immediate response to represent the user's disconnection from family time. Beyond its technical role, the mobile application also served a symbolic and social role. It acted as a starting point for family time among household members. When participants chose to activate the prototype by tapping "Start socializing" in the app (see Figure 13), they did so collectively, marking the beginning family time.

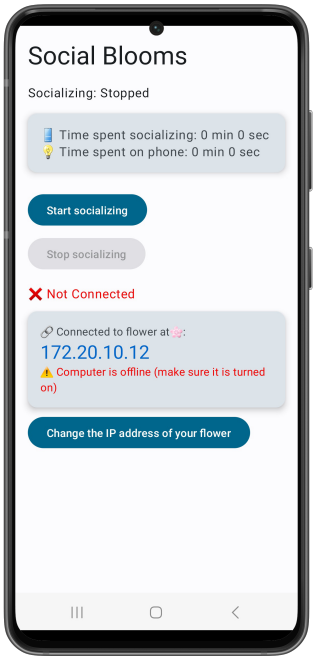


Figure 13: The main screen of the Social Blooms application.

6 Field Study

To evaluate our Social Blooms prototype, we conducted a field study with the intent to answer our research questions:

- **RQ1:** *How can households be supported in reflecting on their screen use in shared family settings?*
- **RQ2:** *How do household members respond to a physical artifact that materializes screen use through plant movement?*

6.1 Participants

Participants were selected based on three predefined criteria: (1) participants needed to reside in the proximity to the local research area, as we needed to facilitate transportation and on-site setup of the prototypes; (2) households were required to have between two and four members, thus excluding individuals living alone or households exceeding four members; (3) all household members were required to own an Android-based mobile device, as the Social Blooms digital application was exclusively compatible with this operating system.

Participants and their associated household were recruited through social media outreach, primarily via LinkedIn and Meta. On Meta, posts were made in several local community groups focused on mutual support and neighborhood initiatives. These posts served as the primary method of recruitment and included an image of the physical prototype alongside the Android application. The posts provided a brief introduction to the research area and specified the desired participant demographic. This strategy generated a positive response, with several individuals expressing interest in participating. Some respondents indicated that they were personally concerned about their own screen use and were therefore motivated to take part in the study. A number of potential participants, however, noted that they were unable to join due to not owning an Android device.

In total, three households participated, comprising 7 participants aged between 12 and 48 years. The participating households consisted of two couples and one family with a child. Participants varied in terms of gender and occupation. We had 3 male participants and 4 females participants. An overview of the participating household, their anonymised names, age and occupation is presented in Table 2.

Household	Anonymised names	Gender	Age	Occupation
1	Harry	Male	27	Salesman
	Hilda	Female	26	Student
2	Martin	Male	28	Deputy judge
	Maria	Female	26	Lawyer
3	Eric	Male	48	Software engineer
	Elisabeth	Female	45	Physiotherapist
	Eve	Female	12	High school

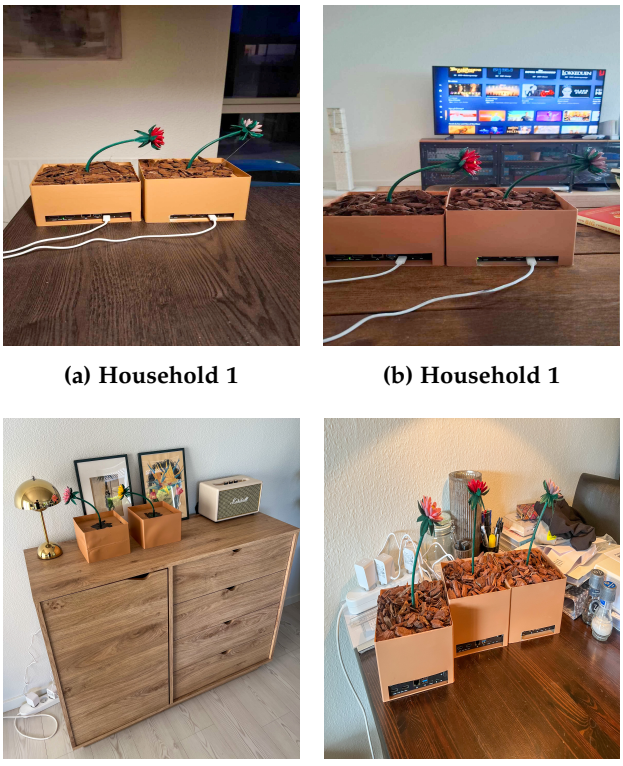
Table 2: Overview of participating households

Across households, participants expressed a variety of motivations for engaging in the study. Some were curious because they had no prior experience with similar research prototypes and found the idea exciting and intriguing. Others were interested in understanding their own screen habits, were attracted to the technological aspect of the prototype, or aimed to gain deeper insights into their household's social interactions. Some participants reported a combination of these motivations.

6.1.1 Procedure

Before beginning the field study, each participant signed a consent form agreeing to the collection of specific data during the evaluation and acknowledging that participation was entirely voluntary. They were also explicitly informed that they could withdraw from the study at any time without consequence. To address potential privacy concerns, the consent form clearly stated that the prototype did not track specific phone activities, such as app usage, browsing behavior, or location data. It only detected whether the screen was on or off. To support ongoing communication and engagement, we created a group chat for each participating household. This served as a space where participants could ask questions, share photos, and record reflections or observations throughout the deployment week.

Each household lived with the Social Blooms prototype for seven days. To maximize attention and engagement during the test period, participants were encouraged to place the prototype in areas where they naturally had frequent daily interactions. These included common living spaces such as the kitchen, dining table, coffee table, and sideboard in the living room. However, participants were given the flexibility to move the prototype if their social interactions shifted to a different area of the home. For instance, if it was initially placed in the kitchen but most social activity occurred in the living room, they could relocate it accordingly. The different placements of the Social Blooms prototype are illustrated in Figure 14.



(a) Household 1 **(b) Household 1**

(c) Household 2 **(d) Household 3**

Figure 14: Placement of Social Blooms prototypes in each household. Top left image: Household 1 dinner table. Top right image: Household 1 moved to the coffee table. Bottom left image: Household 2 sideboard. Bottom right image: Household 3 dinner table

6.2 Data Collection and Analysis

To gather insights from participants, we used two main methods. First, during the test week, participants were encouraged to write down any reflections or observations they had and share them in a group chat. This allowed us to capture their immediate thoughts as they interacted with the prototype in their homes. We would then ask about these reflections in the post test interview.

Second, after the deployment period, we conducted a semi-structured interview with each household. All household members were present for the interview. The interview was divided into three parts: we first discussed the social impact of the prototype, then moved on to its physical and material qualities, and finally talked about the plant-like aspect of the design.

All interviews were audio recorded. Transcriptions were generated using Whisper AI on a local machine, and later edited to remove filler words and improve clarity [45]. We analyzed the data using thematic analysis [7], first by identifying semantic and latent codes in participants' statements, and then

categorizing broader themes. Subsequently, we reviewed the themes to ensure that there was sufficient evidence to support them. To provide a clearer structure, each theme was divided into sub themes [7]. As a result, we were able to identify patterns across the interviews that informed the insights presented in the Findings section.

7 Findings

Informed by the thematic analysis we derived three overarching themes. (1) Regards the materialization of screen use and how the participants responded to the visibility of the prototype, what feelings it invoked and lastly how the prototype created awareness and realizations of accountability during family time. (2) How the prototype impacted the social dynamics and created new interactions, reflections and discussions between participants. (3) Last theme highlights how the prototype´s material design, its aesthetics, placement, and ambient qualities shaped participants engagement with it.

7.1 Theme 1: The Visibility of Digital Behavior

The first theme concerns the physicality of the prototype. Our findings show that the presence of the Social Blooms prototype during family time made previously unnoticed screen habits visible. Participants described the flower's movement as fun and engaging, and noted that it brought a new tangibility to their phone use, something they had not experienced before. The flower's real-time response to screen use gave them a clearer understanding of digital behaviors within the household. This visibility triggered a range of emotional responses, including discomfort, guilt, satisfaction. In addition, several participants began to reflect more deeply on their accountability during family time.

7.1.1 Material feedback and awareness

The most direct and immediate impact of the Social Blooms prototype was its ability to provide physical feedback on screen usage. Participants reported that they noticed the flower's movement following a habitual action like unlocking the phone or if they had been using the phone for a while.

Household 1 and 2 (H1, H2, H3 from here) both noted that the flower would begin to wilt the moment they unlocked their phone and this awareness was triggered by both the sound and the visual movement of the flower, as Hilda and Harry described:

> *"I felt like the longer I had my phone unlocked, the faster it wilted. [...] But still, every time I unlocked it..."*(Hilda, H1)

> *"I thought it was funny. You could hear it when it moved, and that made me aware that she was using her phone."*(Harry, H1)

Similarly Martin explicitly linked his phone use to the flower's physical response:

> *"It happens right when you turn on your phone actually, and then if you keep using it, it moves more over time."* (Martin, H2)

This immediate feedback, often accompanied by the audible "servo sound", prevented screen use from remaining an unacknowledged or subconscious habit. Harry highlighted this, noting that when he had used his phone for a while, the flower would make him aware of his usage:

> *"In the beginning, it really felt like I'd used my phone a bit, just scrolled a little, and then I'd think: 'God, is my flower wilting?' Then I wanted to throw my phone away."* (Harry, H1)

This suggests that the continuous ambient presence of the prototype served as a reminder to directly interrupt habitual and often unconscious phone behaviors, which Hilda described at a point as "muscle memory." However, the physical presence provided a level of tangibility that traditional mobile applications can not provide, which Hilda elaborated on:

> *"It's like you're being confronted, because it's in your face, and it's something you constantly have to deal with. It's not just a notification you can swipe away and forget about."* (Hilda, H1)

Hilda's statement helps us understand how physical feedback can create a deeper engagement and emotional response. A notification on your phone can be ignored or swiped away, but the flower is spatially embedded and continually visible in the shared space.

This persistence was also shared by Harry, who reflected on the inescapable nature of the prototype's presence:

> *"It's not like you can just pick up the flower and hide it and say, 'look, I didn't use my phone today.'"* (Harry, H1)

The flower's presence did not only affect individuals. Its physical form also introduced a subtle shared awareness, where screen use became something visible and open to comparison. Elisabeth noted how this made it easier to engage with each other's behavior:

> *"It's always fun when it becomes physical and more tangible, as it gives you something to talk about and lets you keep an eye on each other."* (Elisabeth, H3)

Martin added that the flower's presence demanded attention and reflection, just for the fact that is was there and visible to everyone present:

> *"But when it's physically manifested in the room, you can't avoid seeing it and relating to it. Especially when others can see it too."* (Martin, H2)

Ultimately, the flower's constant physical presence and immediate feedback made hidden phone habits obvious and unavoidable in their shared living space, leading to more self-awareness and new ways for people to interact about screen time.

7.1.2 Emotional responses and personal reflection on digital habits

As the participants began to connect the wilting and blooming of the flower to their own screen use, it led to moments of realization and self-reflection. This triggered a range of emotional responses, from negative feelings such as guilt, shame, and feeling exposed, to positive reactions like joy and satisfaction.

> *"I became much more aware of when I turned on my phone, especially on the first day we got the flower."* (Maria, H2)

Even though she was aware of her phone use, she recounted her initial struggles:

> *"I kept telling myself, 'No, I shouldn't use my phone when we're together.' But I still caught myself doing it and had to put it away again."* (Maria, H2)

Similarly, Martin described how excessive phone use left him with a negative feeling, affecting both his mood and how he viewed the flower's wilting as a visible sign of negative digital behavior during family time:

> *"I actually think you feel mentally worse after spending too long on your phone. It just feels like wasted time and puts you in a bad mood. [...] it represents something that is a little bit bad."* (Martin, H2)

Participants across households echoed these mixed emotions. For some, the flower acted as a raised finger and a public reminder of behavior that was hard to ignore. For Maria, the flower's movement was actually helpful:

> *"I realized I was doing something that was not great, so I thought maybe I should do something differently. It's like a reminder that there's something bad going on."* (Maria, H2)

Others felt the social impact of the flower's movement more strongly. As Hilda said:

> *"it was kind of like the flowers became a form of shaming. Because then it would be like, 'your flower is really drooping right now, isn't it?' 'Maybe you should put your phone away.'"* (Hilda, H1)

Harry also echoed this feeling of social pressure that the prototype created:

> *"every time you picked up your phone, you'd glance over at the flower and think, no, I'll just put it away again."* (Harry, H1)

The participants from H3 expressed their feelings of exposure and social feedback in a somewhat less direct way than H1 and H2. Eric described their household's general approach to screen use during family time:

> *"We try to have some basic rules, like when we are together, we don't sit and look at our phones, we try to be face to face."* (Eric, H3)

Elisabeth reinforced that they did not consider their screen use to be problematic, emphasizing their intention to be present with each other. However, she admitted that distractions do occur, during meals for example:

> *"But I also think we do it a bit too much. But it's true that when we eat, we eat. But sometimes, during the meal, you might check something or look something up."* (Elisabeth, H3)

Furthermore, she also reflected on her own use, acknowledging a common rationalization and ambivalence:

> *"I think I use it less than others on average. And sometimes that's my excuse. I can definitely feel that I use it a bit too much, but I also think that I actually enjoy it quite often. It's really cozy. It's good entertainment, you can get inspired, so it's more that screen time shouldn't go much lower."* (Elisabeth, H3)

Although Elisabeth claims that they are below average in terms of screen use, she is often the main culprit when it comes to using her phone during family time. However, her attitude is notably free from shame or guilt. Instead, she openly acknowledges

both sides: while she recognizes that she sometimes uses her phone too much, she also values the enjoyment, inspiration, and comfort it brings her. For Elisabeth, screen use is not simply a bad habit to be curbed, but a part of everyday life that also serves a positive function.

Conversely, from Eve's perspective, her mother's phone use during shared activities, such as watching TV, can be disruptive, which was illuminated through the flower cause it made the interaction visible and tangible:

> *"You can hear vibrations and things like that. It's a bit annoying. You could also see the flower move when she (Elisabeth) used her phone."* (Eve, H3)

These findings highlight, even in households with a tradition of minimizing screen use during family time, lapses still occur and are noticed. The physical feedback of the flower makes such moments explicit, serving both as a reminder and a source of mild irritation or self-reflection. H3 demonstrates how shared physical feedback can reinforce intentions for phoneless presence, while also surfacing those small slips that might otherwise go unacknowledged.

Looking across all households, making screen use visible through the flower triggered a variety of emotional responses, not just guilt or shame. Some participants felt mildly exposed or judged when their flower wilted, while others regarded phone use as a normal and enjoyable part of everyday life and were less affected by the feedback. In H1 and H2, seeing the flower droop was often linked to negative emotions like guilt or shame. In contrast, H3 viewed the flower more as a gentle reminder to be present with each other, reinforcing habits they already valued. For them, the flower did not carry the same emotional weight but simply supported their existing approach to family time.

7.1.3 Shared visibility creates accountability

Another notable pattern was that participants began to reflect on both their individual and shared accountability during family time. Especially in H1 and H2, participants became aware of how often they habitually unlocked their phones, as the flower's immediate movement made this behavior visible each time. They started to consider how these small actions could affect the rest of the household and the overall social dynamic. Our findings indicate that the flower's instant feedback prompted them to pause and question their own behavior in the moment. Hilda, for example, reflected that:

> *"I was thinking, it's just that thing where you're together with others, and then you just check your phone, just to see what time it is. You do that pretty often, and in some way, it kind of shows laziness or [...] maybe it's more like disengagement? [...] It made me reflect that it's actually a bad habit and something I should probably get better at not doing"* (Hilda, H1)

While Hilda interpreted the act as a form of disengagement during social interactions, Martin reflected deeper on the repetitive gesture itself as disruptive:

> *"There's screen time and then there's the habit of quickly unlocking your phone, checking it, and putting it away again. That act starts to feel negative. If you're constantly interrupted by it, it can feel worse than using the phone for ten minutes straight. Unlocking it ten times in a few minutes might be more disruptive, even if the screen isn't on for long."* (Martin, H2)

Similarly, having the Social Blooms prototype made Harry aware of how often he reached for his phone during moments that were meant for social interaction, especially when they were sitting in their couch:

> *"I found it a bit unsettling to see how much I actually use my phone, often during moments where I could easily be doing something else. It becomes second nature to check Facebook for the 28th time in half an hour. The flower made me more conscious of that, because normally it's automatic, you just pull out your phone because you're in the spot on the couch where you usually do it. Then I would think, okay, maybe I should just put it away and do something else."* (Harry, H1)

Hilda agreed, noting how these routines can slip by unnoticed until the feedback of the flower made them visible:

> *"It's like you just have these bad habits of pulling it out, just because it's there and you're used to it. You start thinking that it's a bad habit you might need to get better at avoiding."* (Hilda, H1)

Participants described moments of hesitation or reflection, questioning their motivation for picking up their phone, especially knowing the prototype would respond immediately. This awareness often arose when they realized there was no clear reason for using the phone. In a family time setting, this hesitation carried more weight because it could disrupt shared moments, like watching a movie or spending time together.

The findings through this theme show that making screen use visible and tangible did more than just

highlight individual habits. The flower prompted participants to pause and reflect on their behavior, sometimes for the first time, and made them aware of the small, often unconscious actions that could disrupt family time. Materializing these actions also brought up a range of emotional responses, from guilt and shame to self-awareness, and for some, even joy and satisfaction. By drawing attention to these routines in a shared space, the prototype encouraged both self-awareness and a sense of responsibility toward others. For many, this led to a greater appreciation for the impact their screen use could have on the social atmosphere at home, reinforcing the value of being present with one another.

7.2 Theme 2: The Prototype as a Social Catalyst

This theme concerns our prototype's impact on social dynamics within participating households. Our findings indicate that the prototype transcended it's role as a reflective intervention and actively framed family time. It prompted negotiations of household norms, and, at times, led to new understandings and adjustments in habits. The prototype also became a medium for social play and competition, creating new ways for household members to interact with each other.

7.2.1 Shaping family time and norms

Participants in H3 noted how pressing the "start socializing"-button in the app created a deliberate starting point for their family time. Eric described how this function helped concretize their social interactions:

> *"I actually thought it was interesting, because starting the timer in some way sets a kind of framework for: "now we begin, now we sit down and do something." So it makes the social interaction a bit more concrete [. . .] That thing about having a starting point, where everyone presses at the same time, gave something extra."* (Eric, H3)

Elisabeth reinforced this, comparing the button to to taking a seat at the dinner table.

> *"Well, there's that thing about something starting and it kind of being official. For example, when you're about to sit down and eat, it's not like one person starts eating way before everyone else. You wait until everyone is ready to sit down."* (Elisabeth, H3)

The prototype served as a reminder and a social agreement for H3 to be present during the family time. Pressing the start socializing button reinforced these expectations by making them more aware of their togetherness.

> *"It's of course something that suddenly makes you much more aware that now we're actually together, and it's not just something that happens fluidly. It's something that has a concrete starting point."* (Eric, H3)

A similar sentiment was expressed by H2. For example, Martin explained how activating the prototype created an immediate expectation for social engagement:

> *"Yes, I'd say so. You definitely do. Also because when you turn it on, I think you become more aligned on: "Okay, now that we're being social, we're not using our phones."* (Martin, H2)

These insights suggest that the prototype actively shaped the environment and expectations for family time during the study, and possibly also in a more general sense. For example, in H1, the prototype triggered conversations about screen use and family time that never occurred before in their household:

> *"No, not really. We've never actually talked about what 'being together' means before this."* (Hilda, H1)

Furthermore, it also shed light on assumptions that had previously gone unquestioned, which even lead to tensions surrounding the definition of family time and acceptable screen use. Hilda described how they initially disagreed about what counts as family time, but that she eventually shifted her perspective:

> *"And then we also started having discussions about when it is, exactly, that we're actually spending time together. Like, what does being together mean for us? You (Harry) said it was whenever we were in the same room. And I was like, I don't really feel like that counts. But after I said that, it kind of shifted, like, now we are together. I just kind of started agreeing with you."* (Hilda, H1)

Thus, the prototype did not just make them aware of their screen use, but it also became a prompt for negotiating the definitions and norms regarding family time. In addition to these conversations, the prototype also prompted H1 to make concrete adjustments to their routines around screen use in shared spaces. These adjustments were not directly guided by the prototype itself, but emerged from the participants' reflections on their screen use. For example, Hilda described how they started moving away from their sofa to minimize screen use:

> *"I think we definitely became more aware, like, "okay, we actually use our phones a lot when we're spending time together." So we actually tried to get better at not doing that, and there were times when we tried to suggest ways we could get off the couch and do something else instead [...] It was kind of about physically moving to a different location away from the place we usually associate with screen time and hanging out together. That helped a bit, like, "okay, now we're doing a new activity, and we're doing it somewhere else too."* (Hilda, H1)

The prototype enabled H1 to reflect how screen use was tied to specific places and routines, such as lounging together on their couch, influencing them to rethink how and where they spent time together. In contrast to H1, defining and negotiating screen use during family time was already an established practice in H3. Thus, for them, the prototype functioned as a reminder that reinforced existing norms and understandings rather than introducing new ones. As a result, any adjustments in normal habits regarding screen use in H3 seem to have been temporary and isolated to their participation in our study. An example of this is Eve bringing her phone to the dinner table.

> *"[...] You've really used your phone very, very little when it's been connected."* (Eric, H3)
>
> *"Well, it's also only because of all this. I pretty much never use it when we eat. It's never even there."* (Eve, H3)
>
> *"Yeah, exactly. It probably felt really unnatural for you to sit at the table with your phone."* (Eric, H3)

Eve's deliberate deviation from her habits stemmed from H3's desire to provide realistic results during the study. This was also explicitly pointed out by Elisabeth at the beginning of the interview:

> *"Actually, we also thought that we should give you a natural picture of it. So we've kind of tried to act the way we normally do. I mean, it could've been tempting to just not use our phones at all, but then it wouldn't have shown much. So we made sure to not just avoid our phones."* (Elisabeth, H3)

This suggests that while the prototype did not fundamentally change their routines or lead to negotiations about screen use, it did make H3 more aware of their existing norms and habits.

Our findings in this theme suggest that the prototype helped family family time by introducing a shared starting point through the "start socializing" button. This small action made participants more aware of being together and created a sense of shared commitment to spending time together. In some households, it led to new conversations about what family time means and prompted changes in daily routines, like moving away from areas linked to screen use. In other households, where screen use norms were already in place, the prototype mainly served as a reminder of shared norms and routines.

7.2.2 Facilitating play and competition

In all three households, the prototype became a medium for social play. Participants found strategies to use the flowers to provoke reactions and create shared moments of fun. Because the flower visually represented screen use, it gave them a concrete target for teasing. In H2, Martin explained how he would turn on Maria's phone behind her back just to make Maria's flower wilt a little more:

> "*I'd secretly turn on your (Maria's) phone, just to watch your flower go down a bit without you noticing*." (Martin, H2)

Eric from H3 described a similar kind of play where they would try to trick each other into using their phones just to see the flower react:

> *"[...] just for fun, we'd ask the other person to check something on their phone, like the weather, to see their flower bend."* (Eric, H3)

Using the prototype added a new layer to their family time and introduced a type of interaction that was not just about using the prototype together but also playing with it. This has seemingly led to a sense of competition in terms of who had the most screen time. Participants started comparing the state of their flowers and using it as a basis for rivalry, as Harry from H1 puts it:

> *"[...] because then I could see that mine was completely drooping, and hers was standing up and fluttering just fine. So of course, I was like, "Oh come on! Go back up already."* (Harry, H1)

Martin from H2 described how this rivalry became a central part of how they interacted with their phones and each other around the prototype. It even led to a form of "cheating" through self-restriction.

> "*You'd end up purposely not using your phone just so the other person would lose*." (Martin, H2)

These competitive strategies reinforced the playful dynamics during family time, making the prototype feel more socially embedded.

Findings in this theme show that our prototype became a medium for social play. Participants used the flowers to tease each other and spark playful interactions. Because the flowers showed each person's screen use, they became an easy target for jokes and light competition. Some would secretly turn on each other's phones or try to trick someone into using theirs just to see the flower react. This playful use added a new kind of interaction to family time and led to a sense of rivalry around who had the most screen time. Participants began comparing their flowers and even tried to "win" by limiting their phone use.

7.3 Theme 3: Design and Plantness of the Prototype

This theme concerns how the physical design of the prototype influenced participants' interactions and overall experience with it. Our findings show that the prototype's placement, appearance, and sensory feedback played a crucial role in its effectiveness and how it garnered attention. Additionally, the plant-like qualities of the prototype had a paradoxical effect on participant's perception of it. It's perceived plantness led to a heightened sense of engagement and responsibility among participants, while its inherent artificiality inhibited its emotional resonance.

7.3.1 Aesthetics, placement, and sensory cues

Participants described how the look and materials of the prototype influenced their interactions with it. Small aesthetic details helped the prototype fit naturally into their homes as an ordinary household object rather than a piece of technology. Hilda from H1 had a particularly positive reaction to the prototype's appearance, highlighting the design elements that amplified it plant-like aesthetic:

> *"I love the terracotta color [...] Also the thing with the dry bark, which adds to the feeling that it's a real flower."* (Hilda, H1)

Participants also mentioned that the appearance of the prototype made it easy to place in visible, central spaces, such as the dining table or living room, which strengthened its visual feedback.

> *"They're quite pretty, so they would also work well as decoration and could be incorporated into the interior."* (Hilda, H1)

> *"We haven't moved them. But that's also because the sideboard is in the middle of the room and the flowers fit in really well, so we'd often notice them when we're moving around here in the kitchen-living area."* (Maria, H2)

Besides its aesthetic qualities, participants emphasized the sound made by the servo, which was not intended as a part of our design. Participants from H1 described this quiet mechanical sound as an effective way to bring their attention away from their phones.

> *"That's also what keeps the effect from becoming invisible. When you're looking down at your phone, [...] as soon as you hear that sound, you become a bit more aware."* (Harry, H1)

> *"It was very subtle [...] but it was nice how it kind of pulls you out of your doomscrolling."* (Hilda, H1)

Even though many participants liked the aesthetic and ambient qualities of the prototype, they also pointed out some clear limits in how it worked physically, especially when it came to how it looked, where it was placed, and how it gave feedback. One issue was the placement of the flower in the home. H1 noted they initially placed the prototype near the dining table, but had to move it in order to make it more noticeable.

> *"We chose to place the flower mainly by the dining table at first [. . .] but we couldn't really hear them when they moved. It was only you (Hilda) who could see and hear them."* (Harry, H1).

This indicates that the prototypes reliance on visual and audio cues limited its spatial arrangements. Similarly, the flowers' placement relative to each other was also an important factor in this regard. Martin from H2 pointed out that the prototype only had an effect when the flowers were placed next to each other:

> *"There should preferably be a flower next to another one, so you can kind of compare their positions. [. . .] if it were just standing alone, you wouldn't really think about it."* (Martin, H2)

For him, placement was crucial because the state of his flower only became meaningful and engaging when it could be compared to Maria's, which indicates that this particular spatial arrangement was crucial for the prototype's ability to promote reflection and interaction. Finally, there were issues with how the prototype gave positive feedback. Participants noticed when the flower wilted, but many said they did not really see when it started to go back up again.

> *"I rarely noticed when it went back up again."* (Harry, H1)

> *"I don't really think we noticed it moving upwards at any point. At least not while the flowers were running, but they would of course move upwards when you reset them."* (Eric, H3)

This might have made the "success" moments too subtle, potentially skewing participants perception of their screen use. Overall, these findings highlight our prototypes dependence on visual and auditory cues to support reflection. Interestingly, several participants noted that they desired more physical interaction with the prototype. For instance, H3 expressed that they would have preferred a physical button on the flowers or the table as an alternative to using the app.

> *"Yes, maybe, if you could just press a button on the flower, then maybe it would have been even easier."* (Eric, H3)

> *"Maybe the button could be made more visible? Like a big a big red button on the table that we had to press instead. So it's very much about the visibility of it."* (Elisabeth, H3)

These ideas seem to come from their perception that physical interaction with the prototype would increase its usability. Similar suggestion was made by Maria from H2:

> *"Yeah, it would be cool if you didn't have to open the app at all, like if it could somehow just start measuring automatically. I actually think it would be even cooler if you could do something with the flowers instead of using the app. Like, water them or something. But that would probably be dangerous with all the electronics inside."* (Maria, H2)

While she also makes a point for improving usability, her idea of physical interaction, and specifically watering, seemingly stems from a desire for more engaging interactions with the prototype.

Overall, the findings in this theme indicate that the aesthetic form of the prototype helped it fit naturally into participants homes, making it feel more like a decorative object than a piece of technology. Its design made it easy to place in central areas, which made it more noticable. Some also appreciated the quiet servo sound, which acted as a subtle reminder to look up from their phones. However, the prototype's feedback was sometimes too subtle, especially the upward movement, which often went unnoticed. Placement was also key, as participants felt the flowers were more meaningful when placed together, allowing for comparison. Finally, some wished for more direct physical interaction with the prototype, like pressing a button or even watering the flowers, rather than using the app, suggesting that such interactions would make the prototype more engaging.

7.3.2 Plantness of the prototype

Even though they knew that the flower was artificial, participants often described it in emotional and relational terms.

> *"I didn't want it to hang too much, like, okay, now I need to treat it a bit better."* (Martin, H2)

The metaphor of a wilting flower created a sense of responsibility, which indicates that the plant-like qualities of the prototype had a direct impact on how engaging it felt for the participants. Further insights from our interviews suggest that this is likely a result of the symbolism embedded in the prototype. This was explicitly stated by Eric from H3:

> *"The fact that it's a flower, if it had just been some ball moving up and down in a glass or something, I think this has felt a bit more personal. Precisely because it's a flower, it makes it fun, because the idea that it can wither, I think that's really interesting and symbolic in a way."* (Eric, H3)

For him, the plant-like form and symbolism enhanced the personal resonance of the prototype. Some participants viewed the artificiality of the flower as a strength rather than a weakness. They explained that an artificial flower provided clear and predictable feedback about their screen use. A real plant, in comparison, might have felt too fragile or unpredictable.

> *"It would probably be hard to watch it just die, because you know it can't really come back again."* (Maria, H2)

However, the flower's artificiality also created a certain distance. Because the flower was not alive, the perceived seriousness of its feedback was reduced.

> *"I really only saw it as just a gimmick. To be honest, it was kind of hard to take it seriously."* (Maria, H2)

Similarly, some participants pointed out that a real flower would likely create a more emotional resonance. With a real flower, their screen use would have irreversible consequences for another living being, which would have deepened their sense of responsibility.

> *"Yeah, I think you'd have a more personal connection to it if it were alive and your actions had consequences. Then you'd know the flower wouldn't come back to life. Because essentially, you're killing the flower."* (Harry, H1)

> *"It could also have been cool with a real flower. Maybe you'd end up feeling a bit more guilty when using your phone."* (Elisabeth, H3)

Overall, our findings indicate that the plant-like qualities of the prototype had a significant impact on its effect in the households. The perceived plantness of the prototype reinforced participants' engagement with it, but the obvious artificiality of the flowers weakened its emotional resonance.

The findings in this theme suggest that the plant-like features of the prototype had a considerable impact on participants' experience with it. The wilting metaphor induced a vague feeling of responsibility, which increased engagement. Some felt the flower's plant-like form made the prototype more relatable and meaningful. Furthermore, while the artificial nature gave clear and predictable feedback, it also reduced the emotional impact for some, who saw it as less serious or even gimmicky. Some participants noted real flower could have made the experience feel more personal, since screen use would then have real, irreversible consequences. In general, the plant-like qualities helped participants connect with the prototype in different ways, but its artificiality limited its emotional resonance.

8 Discussion

8.1 Reflections on Lack of Physical Interactions with the Prototype

The interaction model of Social Blooms predominantly depended on visual and sensory cues, coupled with activation through the app. Consequently, participants perceived the prototype mainly as a representational artifact instead of a physically interactive object. This is consistent with conventional HCI practices, which typically prioritize functionality and informational representation over direct physical interaction [30]. From a material-centered perspective, the limited physical interaction provided by our prototype can be considered a missed opportunity. Wiberg [60] characterizes the "material turn" in HCI as a shift from metaphor-driven designs to direct interaction with physical materials. This perspective suggests that the limited options for physical interaction with Social Blooms reduced its compositional depth and undermined the sense of shared agency between the user and the prototype [60].

However, this design decision was intentional. We prioritized designing for a familiar and easily understandable plant metaphor to enable intuitive associations for participants regarding their screen use. Practical constraints, such as technical feasibility and time limitations further decreased our priority for direct physical interaction. Ultimately, this resulted in a minimal user agency, as the participants' engagement with prototype became contingent on their screen use. This meant that participants could intentionally influence the prototype solely by using their phones, something they generally wanted to avoid, or through deliberate non-use. The interaction model provided users with restricted opportunities for direct engagement with the prototype, which likely accounts for the desire among several participants for more physical interaction.

Yet, this critique does not invalidate our design. Recent HCI perspectives increasingly acknowledge minimalist, ambient, or even "faceless" interactions, where engagement occurs subtly and technology blends smoothly into everyday life [60]. Social Blooms' subtle movement, servo sounds, and visual presence successfully prompted reflection and conversation. These results align well with the "expressive" and "meaning" perspectives of form from the literature, where artifacts are integrated into personal and social life even without direct manipulation [30].

Moreover, compositionality in material-centered design does not necessarily require direct physical touch; rather, it refers to how diverse physical and digital materials are meaningfully integrated [60]. Seen in this broader sense, the combination of our prototype's physical form, its movements, servo sound effects, and app-based activation together creates a meaningful materiality of interaction. This highlights how interactive systems can effectively combine physical, computational, and experiential elements without needing direct tactile engagement [30, 60]. Nevertheless, participants did indicate that the option to physically interact with the prototype, especially as an alternative to using the app, could have made the experience both more engaging and easier to use.

Looking ahead, we see potential in expanding embodied interactions such as gestures, direct touch, or physical co-assembly. This could deepen users' engagement and enrich the compositional experience. At the same time, it remains important to acknowledge that meaningful material interactions exist along a spectrum, ranging from direct physical manipulation to subtle ambient engagement.

8.2 The Prescriptive Metaphor of a Wilting Flower

Although our intention was to merely promote reflection on screen use, Social Blooms effectively became a prescriptive intervention by framing all screen use as inherently negative. Our findings suggest that this framing nudged participants toward a normative view of screen use that, even in absence of any explicit rules, resulted in self-regulation strategies, such as restricting phone usage or changing normal routines. This outcome reflects a broader pattern in Research through Design (RtD) studies in which

reflective interventions inadvertently take on a prescriptive role. For example, findings of *Attention Receipts* [53] show that the metaphor of a receipt as proof of cost led participants to curate the right receipt and discard undesired ones, feeling pressured to perform acceptable digital behavior because the metaphor implicitly communicated what kind of attention was "too expensive" [53]. Such tensions between reflection and prescription in RtD research are largely acknowledged as inherent. Designing always reflects the intent and values of the designer, which inevitably leads to 'ontological politics' [18], where the design defines what is considered desirable or undesirable. Thus, prototypes that are only intended to promote reflection still contribute to the construction of meaning and value, which can, in turn, prescribe new behavior [18, 63]. In our case, participants' interpretation of Social Blooms was constrained by the wilting flower metaphor that implicitly framed all screen use as unacceptable. This is an important limitation to consider, as reflections on how purpose of screen use influences its acceptability could have added more depth to our findings. Namely, research shows that tensions in households often stem from differing expectations around what counts as acceptable screen use during family time. For example, screen use related to work or education is typically seen as more acceptable than use of social media [5, 37, 44]. This sentiment was also shared by some of our participants during the interviews, but our findings indicate that did not sufficiently support nuanced reflection on how such norms apply in their households. For example, our prototype prompted H1 to define and negotiate what family time meant without accounting for what they view as acceptable screen use. They subsequently began restricting all phone usage during interactions that fell under their newly defined concept of family time. However, this response seems inconsistent with their usual acceptability thresholds, as they explicitly mentioned that some forms of screen use during family time, e.g. work-related, typically did not bother them.

Given these effects, we can consider whether another approach to metaphorically representing screen use would be more appropriate. Our choice of the wilting flower as a metaphor was heavily based on our understanding that its familiarity would make it more relatable and understandable for the participants. However, it is very likely that this familiarity was reinforced the prescriptive effect, as Jung et al. [31] note that "too familiar metaphors or formal patterns may disengage a user from fully experiencing interactions by imposing the image of something else" [31]. This raises the question of whether a more ambiguous metaphor might have suited the purpose of our study better. Well designed ambiguity encourages diverse and improvised interactions that emerge between the design and its context [19, 31]. Social Blooms, however, leaned toward specificity over ambiguity. As a result, our study participants did not fully engage in exploratory interpretation, but instead interpreted the prototype as a behavioral directive. Moreover, the impact of this metaphorical specificity also affected social dynamics in the households. As seen in our findings, participants responded to each other's flower states with teasing, correction, and comparison. Even though these interactions made the prototype more socially embedded, they also intensified its normative tone. Ultimately, these insights highlight a common challenge of designing for reflection. Overly prescriptive metaphors can reduce the ambiguity needed for personal interpretation, risking prescription and reinforcement of norms rather than reflective inquiry. To avoid these outcomes, future designs should embrace strategies that allow for ambiguity and multiplicity. Ambiguous designs allow for multiple interpretations, thereby encouraging users to actively make meaning rather than passively receive it. As such, they could provide a bigger potential for disrupting easy understanding and prompting users to make sense of the situation themselves [19]. In the context of screen use or households, this could mean experimenting with metaphors that are less emotionally loaded, or forms that resist binary distinctions between "good" and "bad" behavior.

8.3 Implications of Playfulness and its Impact on Intrinsic Motivation

In this study, we set out to provide an alternative to the restrictive interventions that have previously dominated HCI research on excessive screen use. While our related work shows that limiting access to technology can effectively reduce screen time in the short term, the long term impact of such interventions is still not well understood.

Instead of simply treating the symptoms of digital distraction during shared family activities by enforcing restrictions, we aimed to promote a more reflective approach, encouraging entire households to engage in shared reflection and dialogue about their everyday habits. By focusing on reflection rather than control, the Social Blooms prototype made digital presence visible specifically during family time, prompting both individual and collective considerations of how screens affect these moments. Our findings support that this material approach, much like Jensen et al. [29], successfully triggered self-reflection and new conversations about screen use in a shared domestic context, as the feedback was

immediate, physical, and visible to all household members [31, 48, 61]. However, in contrast to some of the more prescriptive based interventions uncovered in our related works section [8, 34], the artificial nature of our artifact led some participants to view it as a playful gimmick rather than a serious prompt for change. While the participants acknowledged the prototype as a novel idea and the playfulness boosted engagement and even sparked innocent competition, it also risked undermining the seriousness of the intervention, echoing concerns in prior work about the limits of artificial feedback over time [21, 31, 47].

Ultimately, although Social Blooms created awareness and motivated some participants to reconsider their habits during family time to some degree, its long term effect on intrinsic motivation for healthier digital habits in a domestic context remains uncertain. This highlights the need for further research into how future interventions can sustain user engagement around shared family activities over time without relying on competition or novelty, but instead by creating more natural and integrated forms of reflection and self-regulation within everyday routines. At the same time, our findings indicate that the collective context of the household played a noteworthy role in how the intervention was received and discussed. When feedback was experienced together, it sometimes sparked group conversations and mutual awareness that may not have occurred with individually targeted approaches. These results suggest that for future designs, it will be essential to strike a balance between playful engagement and meaningful reflection if interventions like this are to support real and lasting change in digital habits during family time.

8.4 Reflection on Process

Reflecting on our design process, we explored a design space influenced by three areas: material-centered interaction design, screen use as a social phenomenon, and plantness. Each area offered major expressive and conceptual possibilities, but combining them into a single coherent concept eventually resulted in a process influenced more by technical feasibility than theoretical considerations.

This was notably evident in three parts of our design process. Firstly, our focus on material manifestation of screen use meant that plantness remained only conceptual [27], expressed primarily via the wilting metaphor and the prototype's visual look. Secondly, and inversely, our focus on plant metaphors reintroduced representational thinking, which material-centered design aims to challenge [60]. Third, the need for simple and more familiar metaphors expressed by participants in our ideation workshop, along with our transition from ideation to functional prototyping, led us to choose the wilting flower concept due to both the familiarity of its metaphor and its technical feasibility. As noted in Section 8.2, this approach inadvertently framed screen use negatively, reducing our prototype's interpretative openness and ambiguity in how the prototype could be perceived and interacted with.

Despite these challenges, the design process itself became a valuable source of knowledge for us. These conflicts indicated that interpretation might be limited rather than increased when design choices favor feasibility or obvious metaphorical meaning. We also learned that starting with symbolic framing rather than interactional features or material behaviors limited both our understanding of plantness as a situated and interactive feature [27]. Similarly, our approach to material-centered design was mostly conceptual, since we did not prioritize interaction-first thinking or explore the expressive potential of materials [60].

In hindsight, we could have included households in our early exploration of metaphors and through collaborative material investigation. Hands-on material exploration with participants could have allowed them to influence both the meaning and form of interactions. Material-centered design stresses materiality as relational experiences influenced by how things are used and perceived [60]. Inviting participants to investigate qualities such as texture, movement, responsiveness, and temporal behavior may have revealed insights that are difficult to access through conceptual ideation alone, thereby increasing our understanding of both the interaction and the material composition.

Additionally, engaging households early on in discussions about their experiences with screen use and their associations with plant metaphors, particularly regarding how they relate plant traits to presence or distraction could have been beneficial. As Jung and Stolterman note, interactive artifacts, whether metaphor-driven or material-centered, "communicate, symbolize, and in other ways are associated with particular ways of interpreting the design" [30]. Co-developing metaphors might have fostered a shared language for interpretation, enabling more situated and culturally specific expressions of plantness to emerge.

9 Conclusion

In this thesis, we explored how a physical artifact can support reflections on screen use during family time. To guide this process, we initially defined two research questions:

- **RQ1:** *How can households be supported in reflecting on their screen use in shared family settings?*
- **RQ2:** *How do household members respond to a physical artifact that materializes screen use through plant movement?*

We addressed these questions using a Research through Design approach. In answering the research questions, we began by reviewing existing literature on screen use interventions and plantness. The literature revealed a gap in the HCI field regarding the combination of materialization and plant-like qualities as a means to support reflection on screen use within households.

To bridge theory and practice, we carried out a structured ideation process in which we generated and discussed various ways to make screen use visible in the home. We prototyped different approaches to representing a plant figure that could materialize screen use.

The final design was *Social Blooms*, a flower-shaped physical artifact that responds to screen use by wilting and blooming. The deployment in three households revealed that making screen use visible in a shared space during family time prompted awareness, new social interactions among participants and various emotional response ranging from shame, guilt, feeling exposed to joy and satisfaction.

Our findings suggest that while the Social Blooms prototype managed to foster reflection and a feeling of accountability among some participants, it also carried normative implications. The wilting metaphor, despite its simplicity and familiarity, implicitly framed all screen use as undesirable, which led some participants to engage in self-censorship or rigid interpretations of acceptable behavior. This highlights a broader challenge in designing for reflection, being the risk that reflective tools may unintentionally become prescriptive.

We argue that future designers should carefully consider how metaphors, material form, and interactivity shape users' interpretations and responses. Further research is needed in this area to explore how alternative metaphors, material forms, and interaction can support more diverse forms of reflection and agency. Long-term deployments and studies across different household cultures could also reveal additional challenges and opportunities that we did not account for.

In sum, this thesis contributes to the growing field of material-centered interaction design by showing how ambient, tangible interventions can surface invisible digital behaviors in a family setting. It also raises critical questions about the fine line between reflection and prescription, calling for nuanced design strategies that allow users to interpret and negotiate meaning within their own specific social context.

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