

Putting the Self in Self-Tracking: The Value of a Co-Designed ‘How Might You’ Self-Tracking Guide for Teenagers

A ‘How Might You’ Self-Tracking Guide for Teenagers

ANONYMOUS AUTHOR(S)

Although teenagers engage with Personal Informatics tools to track their health and fitness, many do so without adequate guidance, and they express concerns regarding the potential for these practices to bring harm. Further research is needed to understand how we might leverage resources beyond these tools to support young self-trackers. We worked with 44 teenagers (aged 13-18 years) in the United Kingdom in two series of online workshops to co-design a reimagined ‘how might you’ guide to promote lifelong, healthy behaviors with self-tracking tools. Our findings emphasize the importance of flexible resources that can support teens’ self-tracking practices. For example, guidance on asking critical questions can be particularly valuable in the preparation and reflection stages of self-tracking. To better design teens’ interactions with health technologies, particularly Personal Informatics tools, we must think critically about how we design the broader information ecosystems within which these tools reside.

CCS CONCEPTS **Human-centered computing ~ Ubiquitous and mobile computing ~ Ubiquitous and mobile computing design and evaluation methods • Human-centered computing ~ Human computer interaction (HCI) ~ HCI design and evaluation methods • Applied computing ~ Life and medical sciences ~ Health informatics**

Additional Keywords and Phrases: Self-tracking, personal informatics, co-design workshops, youth, education

ACM Reference Format:

First Author’s Name, Initials, and Last Name, Second Author’s Name, Initials, and Last Name, and Third Author’s Name, Initials, and Last Name. 2018. The Title of the Paper: ACM Conference Proceedings Manuscript Submission Template: This is the subtitle of the paper, this document both explains and embodies the submission format for authors using Word. In Woodstock ’18: ACM Symposium on Neural Gaze Detection, June 03–05, 2018, Woodstock, NY. ACM, New York, NY, USA, 10 pages. NOTE: This block will be automatically generated when manuscripts are processed after acceptance.

1 INTRODUCTION

Personal Informatics (PI) systems, such as commercial self-tracking devices and apps, allow users to gather and reflect on personal data. For example, these tools can track health data such as daily step counts and calories burned [42]. This is commonly referred to as ‘self-tracking’¹. The proliferation of these tools has been accelerated by the COVID-19 pandemic and, according to the United Kingdom (UK) mobile network EE (2020) [11], tracking apps such as *MapMyRun* and *Strava* saw two- and three-fold increases in data usage respectively during the first UK lockdown (a legally-enforced Stay at Home order) compared with pre-lockdown usage figures in February 2020.

We know that teenagers are an important user group for these tools [9,18,72]. In 2020, an academic report in the UK found that over half of teenagers reported using self-tracking tools, often doing so without a clear understanding of what their self-tracked data means [61]. As young people grow up with these technologies, we as a Human-Computer Interaction (HCI) community are faced with important questions around how we can work *alongside* teens to develop resources which might best support young users of these PI tools.

The teenage years are a critical developmental period for life-long health behaviors [35,53]; however, more work is needed to empower teen users to engage with PI tools to track their health and fitness in ways most relevant to them, their personal motivations, and their needs. Previous work has recognized that teenagers’ engagement with PI tools might look different to adults’ [18,57,59]. Yet, studies of teenagers’ use of self-tracking tools are still relatively limited outside of intervention settings, where researchers prescribe the uses and intended outcomes of PI tools [45,57]. These interventions often deny users autonomy in deciding their own self-tracking practices [64], and many teens express uncertainty about how to best harness the affordances of digital health technologies for their individual circumstances [61]. We need a better understanding of how teens might re-imagine the design of educational resources around these tools to fit their purposes and to identify new opportunities and interactions that such a resource might foster. Now, more than ever, it is critical to involve young people in this research.

In this study, we attempted to address this gap by working with teenagers (aged 13-18 years) in two series of online workshops to co-design a reimagined resource to promote lifelong, healthy behaviors with self-tracking tools. We started by understanding the different experiences teens have when engaging with PI tools as teens reflected on their own PI experiences and those of their friends, family, and classmates. We then explored the types of information they wished they knew more about and how to design a guide that could provide these resources. Finally, drawing teens’ recommendations together, we worked alongside our young collaborators to co-design a series of posts intended to be a ‘how might you’ guide for teenagers interested in self-tracking. We then collaborated with a graphic designer to produce an example of what such a resource could look like on *Instagram*.

The contributions of this work are: (1) designing remote co-design workshops with teenagers to gather insights on their needs and questions around interacting with PI tools, (2) identifying design opportunities for educational resources to support self-tracking practices, and (3) demonstrating the value of flexible resources to support teens’ decision making in all stages of their self-tracking journeys. We argue that to better design teens’ interactions with health technologies, particularly PI tools, we must think critically about how we design the broader information ecosystems within which these tools reside.

¹ The terms ‘personal informatics’ and ‘self-tracking’ are often used interchangeably in the HCI literature. Our teenage collaborators were more familiar with ‘self-tracking’ so both terms can be considered equivalent in this paper; however, we only used the phrase ‘self-tracking’ in the workshops with our collaborators.

1.1 Related Work

PI has been the focus of considerable work in the field of HCI. The related work in this section touches on: the conceptual foundations of PI, teens' engagement with PI tools, and educational resources around teenagers' engagement with PI tools. We also describe previous efforts to engage teens in co-design work around PI tools.

1.1.1 Conceptual Foundations of Personal Informatics

The Quantified Self community and their interest in generating “self-knowledge through numbers” is often associated with PI [26,34,42,67,73,74]. The demographic of the Quantified Self movement has been historically most represented by white males aged 20-40 [38] and, although some work has been done to extend the Quantified Self practices to youth populations [39], to date this has been limited. Recent work has emphasized the need to look beyond these highly engaged users within the Quantified Self movement and instead consider the needs and experiences of everyday self-trackers and the benefits and challenges they may find when engaging with PI tools [10,12].

PI tools are predicated on models of behavior change; empowering users to become more self-aware and take control of their health behaviors [42]. For example, studies have demonstrated that self-tracking tools are beneficial for increasing motivation, self-efficacy, and levels of physical activity [7,8,47]. Nevertheless, behavior models have been criticized for assuming that the collection of data is sufficient to enable data interpretation and action [50], particularly for teenagers who sometimes struggle to know *what* questions to ask of their data and how to interpret the data they collect [18]. To better understand different journeys through self-tracking and some of the barriers to users finding value in self-tracking, some HCI researchers have proposed models of self-tracking to illuminate the different stages of these practices. For example, in the earliest and one of the most commonly used frameworks of self-tracking, Li et al. outline a stage-based model with five iterative stages: *preparation*, *collection*, *integration*, *reflection*, and *action* [42]. Expanding on this model and acknowledging the pervasiveness of self-tracking, Epstein et al.'s model of lived informatics captures the ways in which self-tracking is embedded within the fabric of other practices of everyday life beyond goal-orientation motivations [12,64]. This framework divides *preparation* into *deciding* and *selection*, and suggests two additional stages of *lapsing* and *resuming* self-tracking [12]. Each of these frameworks highlight the challenges that diverse sets of users face when integrating self-tracking tools into their everyday lives and provides a lens through which to consider how individuals might need to be supported throughout their self-tracking journey.

1.1.2 Understanding Teenagers' Use of Personal Informatics Tools

Much work has been concerned with the health behaviors of teenagers as it is during this developmental period that we see the onset of various mental and physical health challenges [30,32,33,36]. Technological interventions have been used to address some of these issues, with a specific focus on self-tracking technologies [25,66]. Beyond managing long-term health conditions, some have celebrated these tools as ‘the solution’ to improving teenagers' engagement in physical activity and teaching them about ‘healthy’ behaviors [5,9,19,22,52] and they have been used in schools to foster engagement with Health and Physical Education [6,49,52].

Whilst digital self-tracking tools might encourage increased levels of physical activity [62], when taken too far they can also encourage more harmful behaviors such as disordered eating and obsessive exercise [24,41]. Previous work has demonstrated that some teens face challenges as they try to make these technologies work for their individual contexts [18,31,59]. For example, there are additional complexities for teenagers who are often tracking in tightly structured contexts, such as schools and families where concerns around privacy and surveillance are central [31].

Within these structures, teens are often thrust into an awareness of self-tracking through social media, friends, and family [19,54]. Without adequate support—particularly around the *preparation* (deciding and selection) and *reflection* stages described in Section 1.1.1—it can be difficult for teens to gain maximal value from PI tools. For example, previous work with young people aged 16-18 in the UK demonstrates that whilst teenagers appreciate being able to strive for goals, instantaneously review data, and compete with others, they struggle to understand how to engage with or interpret their data, often even forgetting to use their PI tools [61]. Recent work has called for additional education around these stages to support teens’ positive engagement with PI tools [55].

1.1.3 Teenagers and The Importance of Dialogic Personal Informatics Education

Adolescence is a pivotal moment for health education as it is here that young people learn behaviors that they carry with them into adulthood [46,68]. They often lack the social and educational support required to feel confident in making informed health decisions [15,28,61]. Technology increasingly sits at the heart of much health-related education as teens change their health behaviors in response to online content [20].

There is an urgent need to move away from a traditionally patronizing and didactic education paradigm around health-related technologies, which can be frustrating for young people and potentially hinder them from getting the best out of technology [16,23]. Instead, we should consider how flexible education interventions might support young people’s interactions without technology curtailing their opportunities [43,71]. Although teenagers have repeatedly been shown to be critical and sophisticated users of PI tools [57], little work has been done to understand how we might scaffold their self-tracking experience with additional educational resources to encourage positive and fulfilling engagement with PI tools in a way that meets their needs and expectations. Here we are presented with a chance to think about how stakeholders might better collaborate to scaffold the self-tracking experience for young people. The importance of dialogic exchange, such as through co-design workshops, is an important step [63].

1.1.4 Co-Design in Personal Informatics Research with Teens

Importantly, we know teens have a desire to be included in the design and regulation of digital technologies for health [61] – it is here that co-design workshops can offer a real opportunity to engage teenagers in a democratic process and ensure their voice is heard and valued. Previous work has clearly demonstrated that teenagers are still underserved in much interaction design and product design research [14,40,56,60]. The problem here, as Spiel et al. [70] emphasize, is that rigid, normative design reflects the goals and ideals of designers, rather than the diverse practices of the end users who might engage with these tools. Many PI tools are designed with adults in mind [65,72] and whilst some are happy to use ‘adult’ tools when supported in the right way [54], this can be frustrating for others [4,20].

In the field of HCI, important work has sought to understand teens’ everyday self-tracking practices through innovative extended co-design and participatory design methods where teens were encouraged to engage with PI tools as part of the study [17,57,58]. This work has highlighted what self-tracking looks like for teens, how we might think about their reasons for self-tracking, and how the effects of their tracking practices differ from adults’. For example, this research emphasizes the importance of affordances of flexibility and self-expression and the ways in which these practices can foster social connection, learning about the self, and identity development [58]. Further, privacy and curation affordances are key for teenagers [58]; they are concerned about how their tracking allows them to fit in with accepted social norms, which are often set by adults [57]. This work highlights the complexity and nuance in the teenage tracking experience; however, our findings demonstrate that more research is needed to explore ways to inform and empower teens to feel comfortable exploring how self-tracking might be incorporated into their routines.

Co-design methods have also previously been used with teenagers to inform the design of educational health resources [48]. This offers a useful way in for researchers to explore the unique affordances of existing PI tools that are of most value to teens and better understand how to enable young people to think critically about the role of self-tracking within their broader information ecosystems. As such, the aim of this study was to work alongside teenagers towards designing a teen-centered educational resource.

Building on these important foundations, in this paper we describe our process of uncovering and recognizing teens' voices in a design space where they are too often overlooked. We sought to break down assumptions of what self-tracking *should* look like, and instead created open, flexible spaces for creativity and imagination. Drawing on previous work [57,58], we wanted to consider how young people's self-tracking practices could be scaffolded with resources beyond the PI tools themselves. This teaches us as an HCI community how we might open up new opportunities for teens to engage with PI tools and support them across different stages of self-tracking, particularly *preparation* and *reflection*. Through these co-design workshops, we collaborated with teens to co-create a resource that could support positive tracking experiences for young people.

2 METHODS

In line with previous work [21], in this study the scope of self-tracking was confined to PI for health and fitness. We conducted five 90-minute online exploratory content co-design workshops (Series A) and two 60-minute follow-up online reflexive prototype design workshops (Series B). These workshops formed part of a larger mixed-methods study involving around 800 teenagers (aged 13-18 years) in the United Kingdom to explore their self-tracking practices and the entanglements with their social and psychological wellbeing (see Figure 1 for an overview of this larger project). Series A workshops were conducted in November 2021 and Series B workshops were conducted in March 2022.

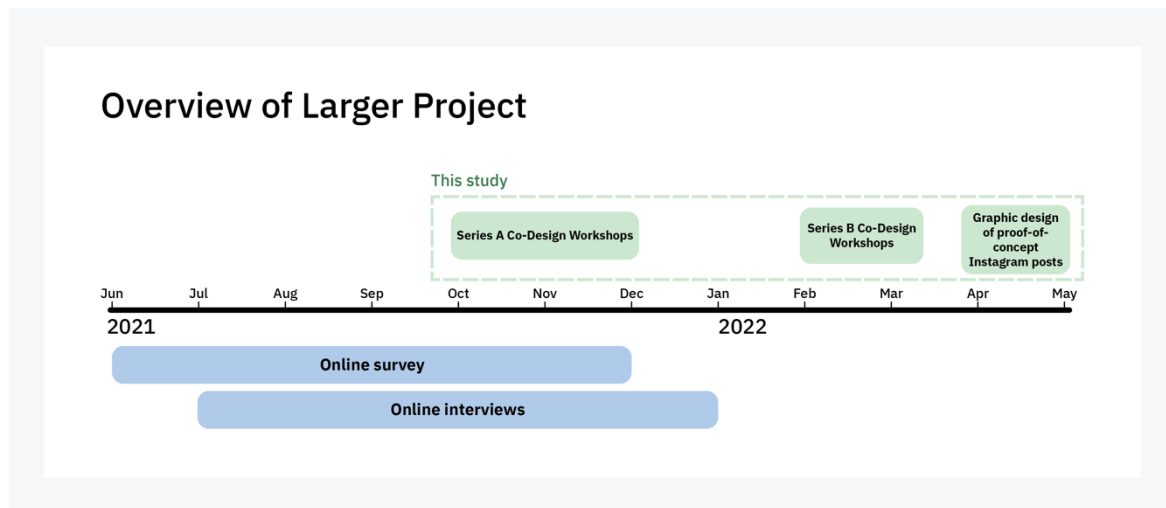


Figure 1. Overview of larger research project and where this paper sits

2.1 Participants

Participants were recruited through a number of channels: the participant pool in the larger study, social media posts, advertisements distributed by youth organizations, and the researchers’ personal networks. Participants were compensated with an online shopping voucher for their participation in each workshop.

Seventy-six teenagers signed up to participate in the Series A workshops, 44 of whom successfully completed a workshop (13 identified as female, 20 as male, and 11 did not disclose). Of these 44 teenagers, 23 were currently using self-tracking tools, 10 had previously used self-tracking tools, three had never used self-tracking tools, and eight did not disclose their self-tracking experience.

Eight teenagers signed up for a Series B follow-up workshop and three successfully returned to take part in a workshop (two identified as female and one as male). Two were currently using and one had previously used self-tracking tools.

This work was underpinned by the idea that we were researching *with* teens rather than *on* them, and as such valued them as equal partners in the research process [44]. In this spirit, from here, we refer to our participants as workshop “collaborators” to emphasize the participatory, reciprocal—rather than extractive—relationship we aimed to develop with teens through these workshops.

Our workshop collaborators were informed they would be participating in workshops where they might “design a self-tracking tool and information for teens”. The definition of self-tracking provided to teens as part of this study was as follows: “Self-tracking allows people to monitor, record and analyze information about their health and physical activity, such as sleep, calorie intake, heart rate and exercise. Have you ever looked at your phone to see how many steps you’ve taken in a day? Have you ever used a fitness tracker to find out how far or how fast you ran? That is self-tracking.”

2.2 Study Design

To better scaffold educational resources for teens interested in self-tracking, we broke this project into two series of co-design workshops: exploratory content co-design workshops (Series A), focusing on how teens engage with self-tracking and where they could benefit from further support, and reflexive prototype co-design workshops (Series B), centered

around creating tangible prototypes and guidelines for an *Instagram*-based educational guide. The full process for this study is illustrated in Figure 2.

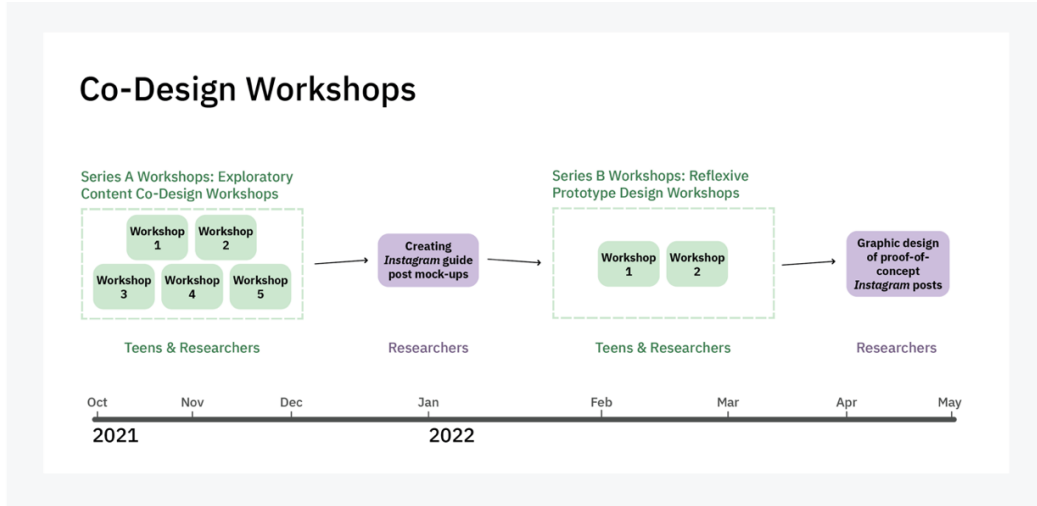


Figure 2. Overview of methods for this paper. We began with Series A workshops, ideated mock-ups for the *Instagram* posts, ran Series B workshops, and then designed final proof-of-concept *Instagram* posts.

2.2.1 Series A Workshops (Exploratory Content Co-Design Workshops).

The purpose of the first series of workshops was to understand how teens perceive self-tracking tools, what features they like and dislike, what effects self-tracking has on their lives, and what resources and information would they like to have to better support their self-tracking. During the activities in these workshops, we asked them to work together to reflect on both their experiences and how they believe others experience self-tracking. We ran five 90-minute online workshops (W1-5) with 4-15 collaborators in each session.² The workshops took place using the videoconferencing software *Microsoft Teams* and the online whiteboard platform *Miro*. Teens were able to use the chat, video, and audio functions in *Microsoft Teams* to participate in whichever way they were most comfortable.

The workshops consisted of three key activities, drawing on previous co-design work with teens using personas to help foster empathy and agency [27,51] and sticky note activities to prompt reflection [29]:

1. **Persona Exploration:** working with personas (defined by the larger study) to uncover a variety of teenage experiences with PI tools (including reasons for tracking, frequency of engagement, opportunities, challenges).
2. **Feature Reflection:** identifying key features of PI tools and their effects to understand pain points and opportunities for improvement (including features of interest, features of concern, and social and emotional effects of PI tools).

² We wanted to ensure we did not compromise collaborators' anonymity on the whiteboards by having too few teens in each workshop. As such, we decided to oversample for each workshop, thus some workshops had more teens than others. We created 'break out' rooms in *Microsoft Teams* if workshops were too large; however, these were not required.

3. **Designing a Teen-Centered ‘User Guide’³**: expanding on Activities 1 and 2 to identify key design considerations for a user guide (content it should include, how it should be formatted, and how it should be shared).

Following each of these activities, we opened up space for critical discussion and reflection on the contributions to draw out any points of tension or agreement amongst the teens. In doing this, we were careful to foster an environment of respectful curiosity and reflection.

It is important to note that our workshop collaborators raised the need for more information and resources around self-tracking before we began Activity 3 (Designing a Teen-Centered ‘User Guide’). For example, in Activity 2 (Feature Reflection), our collaborators considered prompts such as “What could it [PI tool] do differently to work better for me?” and “What would I like to see [in PI tools] that isn’t currently available?”. Despite the fact that this activity was intended to center on PI *tools*, the teens instead asked for links to different informational support, such as clearer information about their data and clarity on how people from different situations might have different self-tracking options. Here, in line with previous work [54], teens shared that they did not necessarily need different tools, but instead wanted more information in order to be more critically aware of how to make existing tools work for them. This helped validate our decision to design Activity 3 with a focus on determining what information, and what format, might be best suited to meeting teens’ needs.

2.2.2 Series B Workshops (Reflexive Prototype Design Workshops).

Through meetings between two researchers (BLINDED FOR PEER REVIEW) following the Series A workshops, we took on board the contributions of our collaborators and redeveloped the notion of a ‘user guide’ to instead focus on a ‘how might you’ guide. During this stage, the researchers generated content for initial mock-ups of a ‘how might you’ self-tracking guide for teenagers and used the graphic design tool *Canva* to build a series of *Instagram* posts to give teens a starting point for their reflections. These sample posts were grounded in the insights that teens had offered during the Series A workshops.

First, our collaborators reflected on their current experience on social media: the types of posts with which they liked to interact, and any existing *Instagram* guides they knew of and liked or disliked. We then shared the mock-up *Instagram* posts with teens and thought together about the content, design, tone, and distribution considerations for such a resource. Once again, our workshop collaborators were positioned as co-designers and experts in their own needs and experiences.

Our collaborators were repeatedly reminded that the ideas were not finalized, and we intentionally left these posts under-developed to encourage them to share how they would change the content or design without feeling as though they were criticizing a finished product. We encouraged our collaborators to share how they thought these posts may fit with their existing social media feeds, what topics they felt were most important for the ‘how might you’ guide to cover, and how they felt it could best to capture the attention of young people. An example of how we and the teens collaborated on Miro is seen in Figure 3.

³ We chose to use the term ‘user guide’ in our workshops to reflect that our focus remained firmly on teenagers as core users. We found teens were familiar with the term ‘user guide’, and this helped them co-design creative solutions in our activities. We oriented away from terms such as ‘educational resource’ or ‘design guide’ as we were not engaging with professional designers or educators.

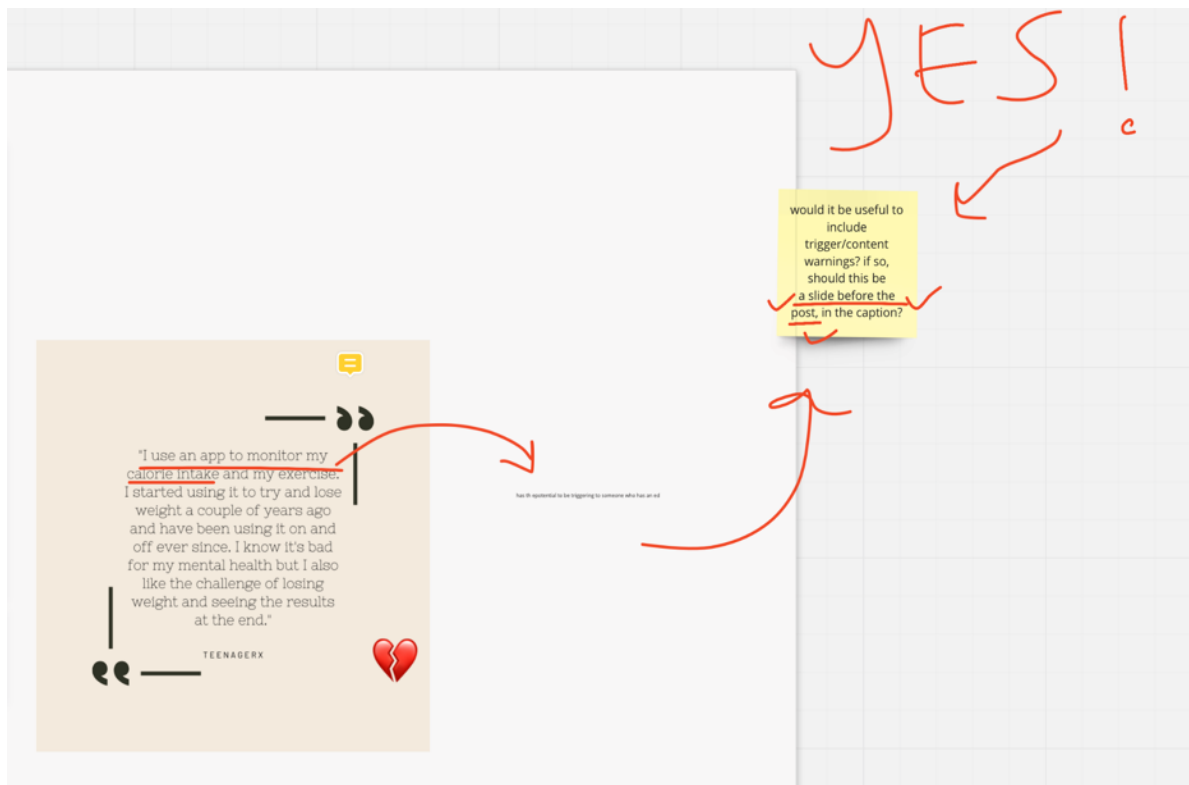


Figure 3. A dialogue between researchers and collaborators on the Miro board in Workshop 7. A researcher poses a question on a sticky note in response to a collaborator's written text comment and collaborators respond by drawing on the Miro board. The small collaborator comment reads: "has th epotential to be triggering to someone who has an ed".

As with the Series A workshops, Series B workshops took place using *Microsoft Teams* and *Miro* and our workshop collaborators were able to use the functionalities of the tools however they were most comfortable.

All collaborators in the Series B workshops had also taken part in a Series A workshop. Our mock-up designs were based entirely on the content we created together in the Series A workshops. Following this design activity, we worked with a graphic designer to create the final proof-of-concept designs. These are not mirrors of these initial designs; rather, they are evolved versions based on the designs our workshop collaborators co-created in Series B. Where the teens in our second workshop series resisted the designs presented to them, or felt the direction was not helpful, we worked with them to evolve the designs to better meet their needs and expectations. Given more resources, we would have involved the teens throughout the entire process; however, it was necessary for two researchers to build some basic designs to give our collaborators a springboard for the Series B workshops. This hybrid model, moving between creations and insights from teens, to analysis and synthesis from researchers, allowed us to still ensure their voices were heard and incorporated throughout every stage this study.

2.2.3 Data Analysis.

The workshops were video-recorded and transcribed verbatim. Contributions from teens on the Miro board were anonymous and this is where the majority of teens' participation took place. As such, we chose to analyze all of the data

together as it was not possible to separate teens by gender or age. Transcripts, *Microsoft Teams* chat histories, and *Miro* boards were analyzed together by two researchers (BLINDED FOR PEER REVIEW) using thematic analysis [3]. This approach involved six recursive stages: (1) familiarization with the data, (2) coding, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) writing up [3]. The researchers anonymized and combined the teens' contributions from all sources into one joint *Miro* board, with stickies tagged with the workshop date. A hybrid approach of inductive and deductive coding was used [13]. The visual capabilities of the *Miro* board allowed the researchers to cluster contributions in themes, draw links between and within the themes, and any discrepancies were discussed until consensus was reached. Quotations and contributions on the boards are reported with any spelling or grammatical errors to retain the authenticity of the teens' voice; we did not want to speak for the teens nor erase their own words. Collaborators are identified by workshop number only (i.e., W2 denotes a collaborator from Workshop 2).

2.3 Ethical Considerations

Given the age of our workshop collaborators, we paid great attention to the ethical considerations in running this study, following guidance from previous work in this area [1,37]. Working with young people was not a responsibility we took lightly. Parental consent and participant assent was obtained online for those under the age of 16. For those over the age of 16, online participant consent was given. Before any data collection commenced, this study was granted ethics approval by [BLINDED FOR PEER REVIEW].

3 FINDINGS

Here we describe how teens articulate a need for educational resources and support around their self-tracking practices. First, we draw out the experiences that teens believe can be opened up by self-tracking practices. Next, we explore how teens make sense of the tools and resources at their disposal: how do motivations and uses vary across users, and how do design features encourage or discourage different interactions? Finally, we describe the co-design process with teens to produce an educational resource for young people interested in self-tracking. Drawing together insights from our young workshop collaborators, we highlight teens' perspectives on a proof-of-concept 'how might you' guide.

3.1 Who are we co-designing for?: What different experiences do teenagers believe are afforded by self-tracking practices?

In this section, we explore how different teens experience self-tracking. Before the workshops began, teens shared some questions and words they associate with self-tracking. This helped establish the tone of the workshops and drew out their existing understandings and associations of PI. In the first design stage, we worked with through a persona exploration activity to uncover the variety of teens' experiences with self-tracking tools. For some, they drew on their own life experiences to describe how a certain persona (such as a teenage athlete) engages with PI tools. Others might have reflected on how they see their friends and peers track. This exercise was critical for allowing us to think about the nuanced experiences different teens have with PI tools and resources in their lives.

3.1.1 What can go wrong? Teens' negative self-tracking experiences.

There was a decidedly negative tone towards PI from the outset of many of the workshops. Most commonly, teens associated words such as "*gloomy*" (W4) and "*stressful*" (W5) with self-tracking. Many of these negative associations centered around potential mental health implications of self-tracking. They felt that self-tracking could be "*addictive*" (W5), possibly resulting in teens becoming "*paranoid*" (W4). Some shared personal stories of these "*obsessive and*

damaging” (W5) experiences: *“I used to track my food/calories and it led to developing some bad habits for example, weighing ALL of my food. Literally down to a single grain of rice”* (W2).

Teens were particularly concerned that self-tracking *“can lead to eating disorders especially without medical advice”* (W5). This led to personal disclosures of disordered eating associated with self-tracking, accompanied by stories of the toll unconstrained self-tracking can take on teens’ social lives: *“When i was tracking my calories it really badly impacted my social life. I was so scared to go out to eat with friends [...] just seeing a fork would worry me”* (W2).

Teens were wary that self-tracking could encourage harmful comparison and competition between peers or within sports teams as young people worked to *“achieve their ‘ideal body’”* (W2). They saw worrying links between such comparisons, lowered self-esteem, and teens’ mental health: *“Comparison can be detrimental to a teen's mental health and can make them feel bad about themselves if they aren't doing as much as others”* (W2). Teens feared that these experiences could make people *“more self conscious”* (W1), *“feel guilty”* (W5), or *“feel disappointed in yourself”* (W5). Some young people shared their own experiences of the way self-tracking *“magnifies my insecurities”* (W1) and *“often makes you feel like you could always be doing better and you're never good enough”* (W5). These conversations were persistent throughout the workshops and teens were keen for us to understand the gravity of the situation they saw before them.

Teens also spoke of the ways being online shapes relationships with self-tracking, with many fearing that young self-trackers might *“end up comparing themselves to social media”* (W5) and felt that the online space currently lacked guidance on how to navigate these challenges. Our collaborators could clearly see how self-tracking data sat within a broader information ecosystem that could inform their understandings of their body and health. Social media was described as a driver that could lead young people to self-track, even if they felt they didn’t want to: *“tracking for aesthetic is usually not done because you want to change it’s usually because of social media influence”* (W4). Further, our teens reflected: *“It can be bad for their mental health if they are aiming to mirror a certain body type that they may have come across online. I think that this is really common for teens given the amount of social media exposure we get.”* (W2).

3.1.2 What works well? Teens’ positive self-tracking experiences.

Conversely, many teens also saw how these practices could be *“Helpful”* (W5) for *“Keeping fit”* (W5), *“monitoring”* (W5), and staying *“Organized”* (W4). Many of these positive experiences centered on the promotion of physical health, in contrast to the more negative experiences which centered on the potential mental health implications of self-tracking.

Our collaborators appreciated the cognitive affordances of self-tracking of increased self-awareness and identity as *“self tracking helps realise our strengths and weaknesses”* (W5) and *“could help someone understand their body and how it response to exercise or food etc.”* (W1). For some, self-tracking was a way for teens to feel *“a sense of control”* (W4) over their bodies. This awareness was critical especially during such a transitional phase in their lives—*“the best thing about it is being able to know what my body is about”* (W2)—and during periods of social distancing during the COVID-19 pandemic as it *“helps seek progress in a difficult and monotonous time”* (W5). These benefits of self-knowledge applied to physical activity and fitness, but also to teens’ health more generally. In our workshops, this manifested in perceived improved agency in healthcare situations, more self-aware goal setting and progression tracking, and increased understandings of the relationship between their actions and their health.

Teens were quick to discuss the ways in which self-tracking could be beneficial in monitoring progress and fostering motivation. They felt a great sense of achievement and self-efficacy when they saw they were *“achieving their goals”* (W1). Particularly for teens engaging in competitive sports, they saw that self-tracking could offer physical health benefits as it *“helps them keep fit and can improve easily”* (W4). For them, the ease with which self-tracking tools integrated into their lives was important: *“It almost becomes part of a routine”* (W2).

For teens who thought about using self-tracking to monitor health conditions, they saw how it could enhance communication between doctors and patients, allowing more continuous monitoring. Indeed, they imagined that *“Some can self track instead of unneeded doctors appointments”* (W5). One collaborator shared her personal story of monitoring a chronic health condition using PI. This was seen by many to be a positive self-tracking experience as it afforded young people greater agency in their own healthcare.

Closely tied with increased self-awareness were positive social and emotional affordances of these practices. Teens drew out the relational experiences opened up by *“sharing data”* (W5) with others. They designed a persona of a teen who engages in competitive sports who *“Probably shares data with coach and teammates”* (W4). Similarly, teens saw how competition with friends and family could create communities and motivation to continue to track; it *“could be a positive thing to get moving with your friends outside”* (W4) and could foster a community of like-minded others *“who also care for exercise or tracking”* (W1). Here, self-tracking connected teens and encouraged co-located activities: *“my friends and I go on walks together to achieve daily goals”* (W5).

Nevertheless, in line with what we described in Section 3.1.1, teens were clear that there was a difference between *“healthy and friendly competition”* (W1) and unhealthy competition. They felt that healthy competition experiences were possible with the right community and support. Many spoke of how tracking allows them to *“Feel proud at my progress”* (W5) and they felt that *“if i am more healthy i tend to have more fun”* (W2).

3.1.3 What are we assuming? Teens questioning the self-tracking experience.

Many teens expressed ambivalence or skepticism about the value of self-tracking, recognizing that it *“Can be both useful and harmful”* (W4) and sharing concerns that it can be *“glorified by the media”* (W4). Teens’ open questions about self-tracking centered around two key themes: (1) questioning the assumption that self-tracking is ‘good’: *“is it actually beneficial?”* (W5), and (2) determining if self-tracking is appropriate: *“why are we still using self tracking devices if we know that they are harmful. Especially in this generation”* (W4).

This hesitance demonstrates that teens recognized the fine line between positive and negative experiences with self-tracking: *“the pedometer gives me a feeling of pride or self doubt”* (W1). This was particularly the case for social experiences and comparisons, and they acknowledged that *“where there is motivation and inspiration there is also the problem of people feeling worried that they are not keeping up with “normal” people”* (W1). There was no one approach to self-tracking for young people and teens were eager to learn from resources that might help them critically question assumptions about if and how they should be engaging with these tools. Our workshop collaborators highlighted for us the ways self-tracking may be both beneficial and detrimental, and how easy this can shift for each person. As such, they stressed that any resources for self-tracking must be flexible enough to address this complexity.

3.2 What are we co-designing with?: How do teenagers make sense of the self-tracking tools at their disposal?

Teens discussed a variety of use contexts for self-tracking and could clearly see how the affordances of these tools might vary across individuals and motivations for tracking. Combining our persona exploration exercise (Activity 1) with one thinking through different features and effects (Activity 2), we were able to collaborate to piece together this complex puzzle.

3.2.1 Rigidity of design doesn't make sense for teens.

Our collaborators did not subscribe to a rigid approach to self-tracking, and they felt that the design of many self-tracking tools was not flexible enough for their purposes. They were frustrated by *“Not having features that work for me”* (W1) and instead wanted to *“have more options for different situations”* (W1). They wanted alternative presentations of data, such as graphs, because often, the quantitative data presented was not aligned with their individual needs: *“the numbers and words can be confusing to understand”* (W4).

The prescriptive approach of common self-tracking tools (e.g., wearables, apps) was also challenging for teens as *“they often tell you how you should feel about yourself i.e. whether you have exercised enough”* (W5). They felt that the feedback from these tools was often filled with *“criticism”* (W4) and could even be *“Manipulative”* (W4). Our collaborators were wary of *“apps like myfitnesspal telling you you've eaten too much or haven't burnt enough calories”* (W5) without taking their individual context into account. The language and uncertainty surrounding self-tracking tools often led teenagers to feel as if they were being dehumanized: *“Makes me feel like a lab rat as I do not know how the data is stored”* (W4). In this way, teens felt that they were being told what to do rather than supported by self-tracking tools. This presented an opportunity for teens to think about how educational resources might help them navigate the more rigid designs of PI tools and creatively engage with them in ways that made sense for their needs.

3.2.2 Lack of age-appropriate support makes self-tracking challenging.

Some teens suggested that stricter age limits and better education on self-tracking were critical: *“maybe some of these apps like MyFitnesspal should have an age limit or like something that would mean that people understand what they are doing if they go onto the app”* (W4). This spoke to a concern that teens' experiences differed from those of adults, and as such, without additional scaffolding, the use of off-the-shelf PI tools could present challenges for young people. Importantly, teens emphasized age as an important consideration in the tracking experience and questioned whether appropriate support was available for young people who were interested in tracking: *“Is it right that children are getting self tracking devices from such a young age? (Eg fitbits)”* (W4).

For example, teens repeatedly raised the prevalence of social comparisons at this formative lifestage. In the absence of adequate age-appropriate support and resources to think critically about personal data and understand relevant comparisons, teens saw how positive aspects of self-tracking could become negative for young people: *“It can be positive if the comparison can motivate someone to continue with their own self tracking journey but it also runs the risk of trying to replicate someone else's data which would be inaccurate”* (W2). This emphasized the need for new, targeted educational opportunities for young people around self-tracking that spoke to the prevalent concerns of teens.

3.3 What are we co-designing?: What educational opportunities do teens imagine are possible and effective?

Drawing on the insights above, we worked together with our workshop collaborators to design a teen-specific educational experience to support their self-tracking practices. While Activities 1 and 2 of the Series A workshops centered around experiences with PI tools and their features, the teens expressed uncertainty and a strong desire for more information around self-tracking. When describing how PI could be improved, they asked questions rather than positing new features to be integrated into existing tools. This demonstrated the acute need to reimagine the support and resources around self-tracking tools for teenagers. Specifically, they highlighted that this was often the difference between ‘good’ and ‘bad’ self-tracking experiences. They felt that self-tracking experiences with proper support and education, and healthy boundaries, found it more fulfilling and useful. This is where the ‘how might you’ guide came in as teenagers recognized that some *“may need someone else to assist in tracking”* (W5), particularly if they were tracking to help them handle a physical or

mental health condition. This validated our decision to focus Activity 3 on information needs rather than co-designing new tools.

As teens discussed different features and effects of self-tracking tools, they focused on broad themes and practices, rather than highlighting aspects that would be unique to one type of person or experience. This was a promising insight suggesting that, if done thoughtfully, a single, adaptable educational resource might be leveraged for teens rather than needing to create individual, personalized guides. So, together we grappled with the challenge of designing resources and experiences that were broad enough to encompass different perspectives but also personal enough to not be superficial, providing instead beneficial insights for this population. Here, we focused on two key considerations: content and distribution of such a resource.

3.3.1 What key content would teens like to be included in a self-tracking guide?

Teens were clear they wanted the user guide to encourage nuanced, “*not judgmental*” (W2) conversations which acknowledged individual motivations for tracking: “*Ask yourself WHY you want to track yourself - if not positive then don’t do it!*” (W4). As one collaborator stated, “*Tracking is for everyone and also not for everyone. It’s helpful for people who can bear listening or knowing about their health status*” (W3). Our collaborators wanted the educational resource to be unafraid to address these tensions. Teens argued that such a guide must expand this non-judgmental space to include parents and schools as teenagers, educators, and parents need to be aware of individual reasons for engaging in self-tracking and the nuanced experiences, both positive and negative, that come alongside those.

The teens acknowledged the benefits of self-tracking, but many were concerned about it being a slippery slope: “*it is so easy to become obsessed with*” (W5). Our collaborators repeatedly used cautionary language when describing self-tracking, including phrases such as “*be careful*” (W5). Short of defining when too much is too much, our collaborators agreed that individuals should determine their own balance: “*Obviously when pushed to extremes its negative, but as long as you can use your self-awareness to decide if you’re going too far then you should be fine*” (W4). The teens felt the guide should discuss the dangers of obsessive tracking and provide resources for identifying and addressing such habits.

Teenagers agreed that community-building is important for healthy self-tracking practices and suggested that the guide could thoughtfully promote this community orientation. Our collaborators often disagreed on the role of competition in healthy self-tracking practices, as discussed above in Section 3.1.2. Nonetheless, most felt the role of competition should be determined by one’s reasons for tracking. The teens were keen for an educational resource to offer guidance on both individual and healthy community self-tracking practices.

Many teens emphasized the importance of recognizing the context of self-tracked data; our collaborators felt the guide should switch the framing from monitoring numbers alone to more dynamic goal setting which considers other measures of health and wellbeing: “*Numbers don’t define you and don’t take the full picture into account*” (W4). Teens focused on the holistic context of their data, rather than the numbers themselves: “*my weight and fitness level is the least interesting thing about me*” (W5). They wanted the guide to encourage teens “*if you don’t reach a goal, remind you that that is okay*” (W5). They felt that the guide should think beyond quantification, instead offering guidance on how teens might explore more deeply the context of their self-tracked data.

Finally, our collaborators wanted the guide to address the role of third-party actors. They wanted it to answer questions such as: “*how is data stored*” (W4), “*is our data used for studies, do our devices save our data*” (W5), and “*how secure is the data*” (W4). Further, some of our collaborators sought guidance on how to keep their tracking private from peers and family if desired: “*i would love people to respect my privacy*” (W2). However, they also wanted to be directed to information about third-party support; for example, many emphasized how the guide must include resources for mental

health support. These resources were not only seen as important for young people; they emphasized the importance of improving parents' understanding of the complex relationship between self-tracking and mental health, such as anxiety and body-image issues.

3.3.2 Where would teens choose for a self-tracking user guide to be distributed?

Our collaborators were divided over the distribution methods of the guide; yet ultimately, they just needed this information to become available to them. As one teen said, *"there are different ways of passing the information it could be with a video or poster or whatever it doesn't means it just about the information being passed"* (W1). Our collaborators wanted the guide to be simple, with straightforward sentences or bullet points and *"gentle"* (W5), *"peaceful"* (W4) language. They wanted information to be *"very clear and straight forward to read"* (W1). The teens wanted to leverage language to positively reframe the goals of self-tracking away from a focus on inadequacy: *"it should be presented as a way to improve how already amazing you are"* (W5).

Some teens believed schools were useful places to present this information, though in small, interactive discussions, rather than large assemblies. Whether these discussions should be compulsory or not was controversial. Discussing this topic in schools was seen as potentially too encouraging of self-tracking: *"honestly i would say schools and parents shouldn't encourage tracking at all"* (W5). Conversely, some believed that whilst engaging in self-tracking practices should be optional, education around PI systems should be obligatory: *"i think it needs to be talking about full stop I know in my experience I have never had a conversation with someone about tracking"* (W4). Most collaborators agreed that external experts should discuss self-tracking, not teachers: *"I think it should be an expert that comes into schools to talk about it. I wouldn't feel comfortable with a teacher commenting on how I ate/exercised"* (W4). As such, our collaborators proposed that having an informed expert would provide students with a safe environment to discuss the complex topics in the user guide.

Many felt social media was another helpful place for sharing the user guide, as it was accessible and comfortable for teenagers to use and had the potential to reach a large number of young people. Teens also appreciated how social media afforded anonymity in accessing this information. Social media was where many had come across self-tracking for the first time (often with content they considered to be harmful such as content that encouraged disordered eating or obsessive exercise), and as such, they felt it would likely have a large reach: *"I think also on social media, because that's probably where most people pick up ideas about self tracking"* (W5). It was seen as important to meet teens where they currently are. For these reasons, we decided to base our mock-up designs for Series B workshops around examples of other social media-based guides.

3.4 Why are we co-designing?: What do teenagers make of a co-created 'how might you' self-tracking guide?

Following teens' recommendations to consider social media as an important space for distributing additional, supportive resources around self-tracking, two researchers (BLINDED FOR PEER REVIEW) went away to deliberate on how to action these recommendations and design a series of *Instagram* posts that would be appropriate for young people. In what follows, we describe our process of collaborating with teens to co-create such a guide (see Figure 4 for examples of the mock-up posts).



Figure 4. Teens emphasized the types of posts they found to be most useful and information in Workshop 7 (Series B). We prioritized these posts in our proof-of-concept designs.

In particular, something we as researchers had to take pause and think about was whether an educational guide like we were aiming to co-design with teens was even appropriate. As we highlighted in Section 3.1.3, many teens questioned the assumption that self-tracking is in fact good or healthy and were wary of young people their age being encouraged to track. As such, based on the collaborative design process in the Series A workshops, we thought carefully about the tone of the guide and moved away from a practical ‘how to’ guide for self-tracking, and instead focused more on a technology-neutral and practiced-focused ‘how might you’ guide. In doing so, we acknowledged that there are open questions around the value of self-tracking for individuals and aimed to equip young people with the skills and knowledge to question any broad stroke assumptions. We understood that it was imperative that this guide captured different use contexts and experiences, whilst providing tools to support young people as a group in making their own assessments about healthy practices and balances. It was important that this was done without dictating a ‘right’ or ‘wrong’ way to engage in self-tracking.

3.4.1 Who are you speaking to? Balancing wide audience reach with personalization needs.

Teens acknowledged the complexity of social media as a means of distributing information to diverse audiences whilst simultaneously making the content feel personally relevant: *“I do like the idea of reaching a more personal level”* (W7) but *“if you don’t know the person, it’s kind of hard to make a connection with your audience”* (W6). Drawing on the different teenage personas we had discussed in the Series A workshops, we worked together with teens to think through how we might address this challenge and ensure that the guide would reach a broad audience without feeling out of place in their feeds: *“its important to acknowledge that different people have different needs and its important to make the posts accessible to everyone ?”* (W7).

One of our collaborators reframed this challenge and encouraged us to target posts at specific groups to avoid a one-size-fits-all approach: *“I think having certain... certain groups of of posts for different types of people will be quite good [...] you don’t have to create one post that aims at everyone but tries to talk to them individually. But actually talking to them all individually”* (W6). To facilitate this, teens felt that it might be useful to signpost in the image captions that not every post would be applicable to everyone: *“I don’t think you should say this post is not for you. I think you should say*

this post might have some useful information in it if you want to read it, you can, but there are other posts that might suit you better” (W6).

Teens clearly saw how design decisions could also reveal the intended audience of posts and were critical of how this might impact young people’s willingness to engage with this content. For example, in Workshop 7, one teenager shared: *“you often see these types of like formats and um colours and images on sort of health blogs and stuff like that [...] it’s a very targeted audience”*. They were keen that the visuals of the posts were leveraged to signal the content but also strategically designed to ensure certain audiences were not excluded from this resource: *“i think being ‘non specific’ in your posts could be good. eg. for a post on tracking fitness maybe avoid having images of a fitbit or something because it can alienate some people who may not have access to certain resources” (W7)*. Further, they wanted to see themselves reflected in the posts, and shared, *“if you include little avatars/characters on posts then i think making them diverse and representative of a range of demographics would be good” (W7)*. Our collaborators stressed that design can be used to achieve this delicate balance between addressing young people as a group but also acknowledging individual differences in self-tracking experiences.

3.4.2 Who is speaking to me? Establishing a relatable authorial voice.

Teens were focused on the tone of content and were eager to see something that was not *“patronizing” (W7)* which emphasized their autonomy: *“It’s not really telling you what to do, it’s just telling you what you can do” (W6)*, which were important themes also touched upon in the Series A workshops. Our co-created ‘how might you’ content was considered to be a good model of this. Our collaborators liked posts that did not underestimate their intelligence and instead highlighted the choices teens have in *why* and *how* they might self-track: *“I don’t really like being told what to do, but umm I do... I do have common sense. And so like, yeah, I do, like read... If I’m trying to do something new. I do read on it. I do my research and stuff like that” (W7)*.

When it came to testimonials and *“more personal stories” (W7)*, teens were eager to hear from *“someone famous or like someone around... close to my like age, definitely someone who’s not an adult though, definitely” (W6)*. Teens wanted a relatable voice that didn’t feel like a teacher or a parent: *“if it’s an adult, you’ve just feel like it’s your like like it’s your parents telling me to do the same thing over and over again and you start to zone out more and more” (W6)*. However, testimonials from people close to their age were controversial as this *“can be a very slippery slope with regards to leading teens to compare themselves with someone they’ve never met” (W7)*.

Akin to previous work [16], when engaging with health content online, teens were wary of commercial voices and instead were keen to hear from other authoritative, expert voices. Our collaborators felt that the use of testimonials was *“most effective when they’re personal. too often testimonials are about selling some kind of product and quite generic” (W7)*. For example, *“a qualified umm dietitian or doctor or someone like that that umm you can sort of rely on [...] there’s like a lot of lies and a lot of fake advertisement that goes through. Umm so having something that’s backed up medically umm does help a bit” (W7)*. They felt this would help them to determine the trustworthiness of the information in the guide as they navigated the often-overwhelming quantity of other health information available online.

3.4.3 Say what? Finding the right message.

Teens felt that it was important for the guide to present *“non biased information” (W7)* as *“swaying towards one way or another could impact people’s choice in deciding to self track or not” (W7)*. High quality content was central to teens’ decisions around whether to engage with a guide like this: *“I think the content and the quality of the content is one of the most important things, and that would make me follow it” (W6)*.

Despite the prevalence of negative self-tracking experiences in the Series A workshops, when it came to designing an educational guide, teens felt that overly negative content could be read as patronizing or could compromise teens' autonomy to choose if or how they engaged with PI tools: *"When you wanna start doing something for your own benefit, you don't wanna be bombarded with like all the things or the negative things that could happen to you"* (W7). They felt that this removed teens' ability to weigh up risks and benefits in their own mind: *"I feel like people aren't stupid, they do know their limits, and so it's not everyone that will end up having eating disorders or obsessions and stuff like that"* (W7). Such content could be viewed as *"demoralizing"* (W7) or *"an attack to what I'm doing"* (W7) and instead teens wanted the guide to offer a balanced perspective addressing both the pros and cons of self-tracking.

For any content that related to potentially sensitive topics such as mental health, weight, or calories, teens were keen to see trigger warnings or other signifiers that vulnerable young people might choose to move past the post without engaging. Our collaborators were particularly fond of including a slide in every post to remind young people of where they can go for help and wanted this to be carefully designed to ensure maximum engagement from teens when needed as they felt this would be *"helpful for people that do need it to have that constant reminder and then people who don't will gloss over it because they don't need it"* (W7).

3.4.4 What does it look like? Designing for teen trackers.

Reflecting on the sample posts we created for the Series B workshops, teens felt that these were consistent with the other content they engaged with on social media and would not feel out of place on their feeds: *"i think all of these are very 'Instagrammy' and the type of content that i look at on ig [Instagram]"* (W7). A few shared that they were feeling uninspired by the content they were seeing on their existing feeds and were excited by the prospect of a visually-appealing guide to break up the monotony: *"that would be enough to like draw me in, cause a lot of the Instagram pages nowadays aren't like very interesting. So umm I think that would be enough to draw me in to watch and read what it's got to say"* (W6).

Eye-catching visual designs and images were key for teenagers as they shared *"when im looking through insatgram i dont usually read, i tend to gravitate towards the pictures and vedios"* (W7). The teens were drawn to color schemes that were bold and unexpected but appeared gender-neutral: *"I think you've completely nailed it... like in this one it's uh like it's like I didn't think of it being like these two colours, but they fit so perfectly together"* (W6).

Drawing these considerations together, teens felt that a 'how might you' *Instagram* guide had the power to be impactful for young people and the information could stay with them as they went about their daily routines. They saw real value in a skillfully-designed resource to address a real education gap and felt confident that, with a sensitive and age-appropriate approach, it could have powerful effects on teens' engagement with PI tools.

4 DISCUSSION

In this study we worked alongside teenagers to co-design resources which may support young people in their individual self-tracking journeys. Our collaborators were highly reflexive and cautious about the negative experiences of self-tracking for young users; however, they also saw the value in self-tracking with the required level of support and under the right conditions, validating our decision to focus on co-creating an 'how might you' guide.

Our data celebrates the messiness of teens' self-tracking experiences and clearly highlights the challenges of creating educational resources around technology that are relevant to such a diverse user group. While re-designing tools to address the varied experiences of teens—such as more age-appropriate considerations and space for more nuanced interpretations

of data—will be crucial, there is much work needed to support teens through all stages of their PI practices. These different stages should be scaffolded with educational resources, particularly when teens are making important health decisions in response to their understandings of these tools [21]. Here, we suggest that developing more educational resources will help young people, particularly when it comes to the *reflection* and *preparation* stages [12,42], enabling them to make more considered, nuanced decisions about what PI habits are best for them.

4.1.1 A balancing act: Acknowledging the complexities of health and wellbeing.

One of the most apparent findings from the workshops is that teens have no single, agreed upon definition of ‘healthy’ self-tracking. Instead, teens are wary of a trepidatious line between being highly engaged users and ‘obsessive’ tracking, speaking to the broader theme: teens are deftly navigating various balances between healthy (but not obsessive), educational (but not patronizing), and flexible (but not structureless) self-tracking practices and want the autonomy to decide on the most appropriate balance for them. Healthy self-tracking habits could include achieving realistic fitness goals, whereas unhealthy behaviors could be identified by undue focus on physical appearance or strict calorie counting. Teens identify different ways self-tracking can influence mental health, from building a supportive social network, to becoming happier through being healthier, to becoming fixated on numbers and lowering self-esteem. These nuances can be difficult to articulate, but teens are well aware that there is no prescriptive approach to ‘good’ self-tracking or ‘healthy’ behaviors. As a group that is often underrepresented, they desired resources dedicated to helping them work through these unique complexities of balance, health, and wellness as young people.

Likewise, our workshop collaborators were very clear when we discussed the notion of the ‘how might you’ guide that they wanted a balance between positives and negatives. In initial conversations in the Series A workshops, much of the discourse skewed towards a negative view of self-tracking, with critical reflections on the role of self-tracking habits in different people’s lives. However, when teens engaged with the mock-up designs of an *Instagram* resource in the Series B workshops, they were keen to see a more balanced perspective (the evolution of this shift throughout the co-design process can be seen in Figure 5). Teens are all-too aware of these potential harms, but they currently lack educational resources to help them discern what ‘healthy’ and ‘unhealthy’ can look like for them, and how the complexities of this balance may translate into self-tracking behaviors. Particularly when engaging with PI-related content on social media, our teens noted a distinct absence of this critical discourse online. Whilst teenagers do not want an educational resource telling them what

is right and wrong, they advocate for a balanced presentation of information and experiences which preserves their autonomy and personal judgment.

Collaborators' contributions to mock-ups in Series B workshops



Updated designs by graphic designer based on workshop feedback

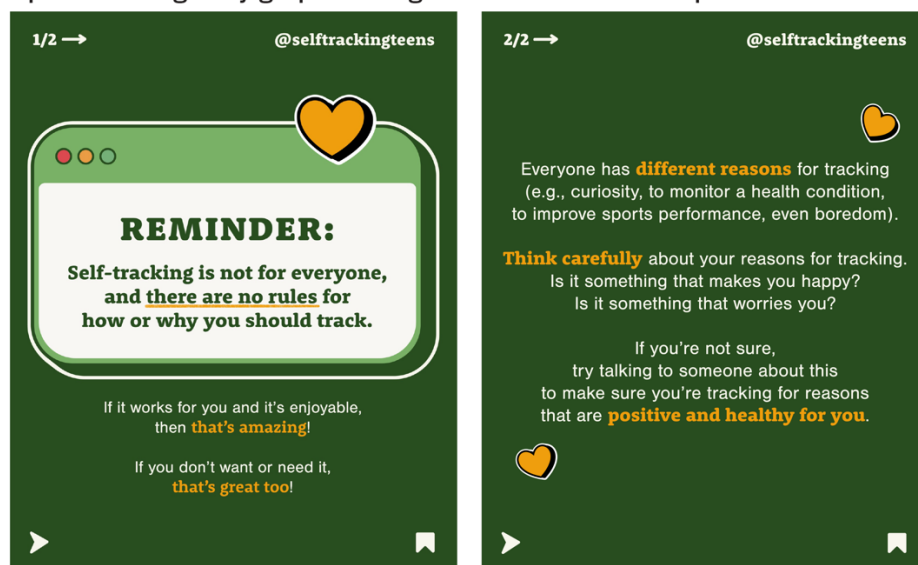


Figure 5. Evolution of changes from initial mock-ups in the Series B workshops to the final posts created by our graphic designer

4.1.2 Putting the personal in personal informatics.

The concept of the 'self' sat at the core of this project and although there is an important social component of many teens' self-tracking behaviors, they still largely view self-tracking as a highly personal habit. As such, they want resources which

similarly value individual experiences. This can be seen in their approaches to resource content, testimonials, and empowering other voices. Our workshop collaborators initially expressed their thoughts on self-tracking through personas in Series A. By considering the nuances of self-tracking in the form of varied personas, whether that was self-reflection or placing themselves in the proverbial shoes of someone else, we were able to construct complex dialogues around what self-tracking is and how it manifests for different people. Self-tracking is truly about the self, it is unique for each person, and teens resisted any cookie-cutter model of how to self-track.

The rigidity of today's tools [70] makes such personalized practices difficult, if at all possible, for young people to achieve. As such, teens see real potential in a guide which opens up avenues to be creative and playful. Despite the narrow conceptions of health often encouraged by PI tools [9], teens do not want to be fed ideas of normalized health, such as quantified metrics which lack context and personalization (i.e., achieving 10,000 steps a day). As such, the co-designed guide prioritizes these notions of personalization and individual experiences through a balance of professional resources and peer testimonials; providing critical education to help teens understand how to “move away from asking what is normal toward ‘what is normal for me?’” [50]. These more personal touches create a sense of intimate conversation, providing suggestions and resources for how one *might* think about something, in opposition to firm ‘how to’ guides intended to serve and instruct everyone.

Moreover, in line with previous work [16,20], our study demonstrates that social media spaces such as *Instagram* are valuable as resource sites for education on health technologies. These more ‘informal’ platforms afford a space for young people to engage in (often difficult) conversations. Teens are resistant to the idea of being lectured and seek a relatable, empathetic voice. They want education around self-tracking to find them in *their* space (e.g., in schools or on *Instagram*), and they want to see people who look and sound like them working through these challenges. By creating resources in an environment that teens are comfortable with and feel creative in, we can help cultivate a sense of feeling heard and included in conversations around self-tracking.

These workshops teach us that, in order to design resources around technical practices for populations for whom these tools are not explicitly designed, it is critical to think about how to balance a variety of perspectives, positives and negatives, and to promote an awareness of unique, personal experiences. Interacting with technologies is not just engaging with the tools themselves, but rather broader interactions in our information ecosystems. Schools, organizations, and other spaces can also leverage these points of balance and celebrating individual differences. This goes far beyond designing an *Instagram* guide, and even resources for young people, and speaks to the ever more varied technological use contexts of populations across the globe.

4.1.3 Resources, not just re-tooling.

For populations who might be overlooked in design, part of the purpose of an educational resource can be providing information to critically assess assumptions and arguments to inform their interactions with technology. For this research, this included questions such as: Does self-tracking work for everyone? Do I have to self-track to be healthy? Should teenagers self-track? Teens express a strong desire for spaces that foster *conversations*—not instructions—acknowledging the complexities of health and balance and allowing space for personal experiences rather than generalizations. Teens highlight that these conversations and support can be the difference between positive and negative experiences with self-tracking. As highly inquisitive and reflexive thinkers, our collaborators had many questions around the role of self-tracking in their lives. The ‘how might you’ guide may not necessarily have answers for all those questions, but it would help provide teens with resources they could look to in order to answer those questions for themselves, and help them ask new

ones. While PI tools may provide teens with data about themselves, creating resources which promote nuanced discussions and encourage question asking will empower teens to make PI decisions that work best for them.

Previous work has emphasized the centrality of *reflection* in data practices [54,55,69] and the teens in this study posed many questions that influenced their reflection on self-tracking data. This is why a ‘how might you’ guide is so valuable for this group, as it affords us an opportunity to consider individual differences and move beyond a prescriptive ‘how to’ approach to self-tracking. Instead, a ‘how might you’ guide can meet teens at whichever stage of self-tracking they are at, from *preparation* all the way through to *lapsing* and *resuming* tracking [12,42]. As teens might move through these stages fluidly, in different orders and at different times, a readily-available ‘how might you’ guide offers important flexibility for teens navigating the complexities of their interactions with PI tools.

To take a first step, taking direct action on the work done in our Series B workshops, we worked with a graphic designer to create a series of 15 proof-of-concept *Instagram* posts bringing together the insights from all seven of the workshops. An example of these posts is available in Figure 5. Two researchers curated a list of the key insights offered by our collaborators and shared this with the designer to ensure that the teen voice was reflected in every stage of the design process. Working through the challenges alongside teens, we saw just how reflective young people are about their technology habits and needs. This led us to engaging, dynamic, and fruitful discussions and a useful output that encapsulates the core insights from these workshops.

We are not advocating against redesigning tools, but rather are promoting a more holistic information ecosystem to be available for teens to support their interactions with health technologies. These findings show there can be great impact in offering age-appropriate, effective resources to better support practices for these populations. In many cases, the technologies we have are acceptable for young people [54], but what is lacking is the means to educate people on how to make these tools work *for them*. We saw from our collaborators that there are difficult balances that need to be struck when deciding if and how to incorporating self-tracking into one’s regular routines. Determining this balance is deeply personal, and requires an individual, tailored approach. We saw in our findings from the Series A workshops that many teens find current tools to be too rigid to work for their purposes. This is what makes resources uniquely valuable, as they are more flexible in content, presentation, and distribution, allowing for more diversity in the types of information, experiences, and use cases shared. Resources are an important step forward, but they should not be designed without first listening to and hearing the people we are seeking to design for.

4.1.4 Limitations.

We saw a high collaborator attrition rate between our Series A and Series B workshops and this limits the generalizability of the findings from the Series B workshops. There are a number of reasons for this, such as lower incentive rate (Series B were shorter, and therefore the compensation was less). Furthermore, there was an increase in cases of both the flu and the Omicron variant of COVID-19 at the time of the Series B workshops, and many collaborators were unable to attend for health-related reasons.

Recruiting through social media allowed us to engage with teenagers where they often come across self-tracking content, but it also posed a variety of challenges. As we prioritized anonymity, it was hard to verify the ages of collaborators and, to promote inclusivity, anonymity, and comfort for teens, we allowed them to participate with their cameras off if they wished. Nevertheless, these online workshops allowed us greater geographic reach and the ability to bring together different voices, without collaborators bearing the cost of travel [37].

We began this project with a self-awareness that we lacked the means to create brand new self-tracking tools. Limited by budget, resources, and means, we prioritized compensating our workshop collaborators for their time and drawing out

informational needs of young people. This limited our potential to co-design new self-tracking tools, but instead we uncovered something new: the value of ‘how might you’ guides.

We know that social media is an important space for health information to reach teens [16,20]. The proof-of-concept *Instagram* guide we designed goes some way to show the possibilities here; however, we would be remiss not mention the ways in which the affordances of this platform shaped the guide. For example, we focused on image and text-light based content and were constrained to standard image sizes for the platform. Future research might consider other format opportunities for the guide and what new educational opportunities these might bring.

5 CONCLUSION

By working alongside teens, we gained invaluable insights into their experiences with current self-tracking tools, the impacts these have on their mental and physical health, and importantly, the types of educational resources they would like to engage with to better support their engagement with PI tools. Teens walk a delicate line between dependence and independence [2], which is reflected in their ideas about self-tracking tools and resources. Our collaborators spoke of the increasing prevalence of PI tools in conversations around personal health and wellbeing. As such, they wanted more *information* that could support them at various stages of their self-tracking journeys (particularly around *preparation* and *reflection*). Teens want to learn more about personal and personalized informatics practices. They sought to understand how to make informed decisions for themselves and to better integrate PI tools into their lives as they continue to develop their interaction patterns with technology.

Importantly, teens showed us that simply re-designing tools is not enough. Rather, they saw the value of educational resources that accompany self-tracking tools to be a flexible space for nuanced conversations, which should be scaffolded alongside PI tools to cultivate broader health informational ecosystems. A ‘how might you’ guide rejects normative and rigid conceptualizations of health in-built into many PI tools, instead encouraging teens to ask questions relevant for them, and their user experience with such tools. When designing future educational resources around PI tools we suggest embracing the messiness of self-tracking and teen experiences, while ensure the tone and content remain supportive, and non-patronizing. Particularly, teens require support at all stages of self-tracking practices. We found that educational resources, such as this ‘how might you guide’, are particularly helpful at the *reflection* and *participation* stages but more work is required to determine how best to implement support across all stages of teens’ self-tracking journeys.

ACKNOWLEDGMENTS

This work was supported by [BLINDED FOR PEER REVIEW].

REFERENCES

- [1] Elin A. Björling and Emma Rose. 2019. Participatory Research Principles in Human-Centered Design: Engaging Teens in the Co-Design of a Social Robot. *Multimodal Technologies and Interaction* 3, 1: 8. <https://doi.org/10.3390/mti3010008>
- [2] danah boyd. 2014. *It's Complicated: The Social Lives of Networked Teens*. Yale University Press, New Haven, CT.
- [3] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3, 2: 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- [4] Carme Carrion, Maurizio Caon, Stefano Carrino, Liliana Arroyo Moliner, Alexandra Lang, Sarah Atkinson, Marco Mazzola, Paolo Perego, Carlo Emilio Standoli, Conxa Castell, and Mireia Espallargues. 2015. Wearable Lifestyle Tracking Devices: Are They Useful for Teenagers? In *Adjunct Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2015 ACM International Symposium on Wearable Computers, UbiComp/ISWC '15 Adjunct* (Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2015 ACM International Symposium on Wearable Computers - UbiComp '15), 669–674. <https://doi.org/10.1145/2800835.2809442>
- [5] Ashley Casey, Victoria A. Goodyear, and Kathleen M. Armour. 2017. Rethinking the relationship between pedagogy, technology and learning in health

- and physical education. *Sport, Education and Society* 22, 2: 1–17. <https://doi.org/10.1080/13573322.2016.1226792>
- [6] Ashley Casey and Benjamin Jones. 2011. Using digital technology to enhance student engagement in physical education. *Asia-Pacific Journal of Health, Sport and Physical Education* 2, 2: 51–66. <https://doi.org/10.1080/18377122.2011.9730351>
 - [7] Sunny Consolvo, Predrag Klasnja, David W. McDonald, and James A. Landay. 2009. Goal-setting considerations for persuasive technologies that encourage physical activity. *Proceedings of the 4th International Conference on Persuasive Technology - Persuasive '09*: 8. <https://doi.org/10.1145/1541948.1541960>
 - [8] Sunny Consolvo, David W. McDonald, Tammy Toscos, Mike Y. Chen, Jon Froehlich, Beverly Harrison, Predrag Klasnja, Anthony LaMarca, Louis LeGrand, Ryan Libby, Ian Smith, and James A. Landay. 2008. Activity sensing in the wild: a field trial of ubifit garden. *Proceeding of the twenty-sixth annual CHI conference on Human factors in computing systems - CHI '08*: 1797–1806. <https://doi.org/10.1145/1357054.1357335>
 - [9] Annaleise Depper and P. David Howe. 2016. Are we fit yet? English adolescent girls' experiences of health and fitness apps. *Health Sociology Review* 26, 1: 1–15. <https://doi.org/10.1080/14461242.2016.1196599>
 - [10] Gabija Didžiokaitė, Paula Saukko, and Christian Greiffenhagen. 2018. The mundane experience of everyday calorie trackers: Beyond the metaphor of Quantified Self. *New Media & Society* 20, 4: 1470–1487. <https://doi.org/10.1177/1461444817698478>
 - [11] EE. 2020. EE Network trends highlight the changing habits of the UK during lockdown [Press release]. Retrieved from <https://newsroom.ee.co.uk/ee-network-trends-highlight-the-changing-habits-of-the-uk-during-lockdown/>
 - [12] Daniel A Epstein, An Ping, James Fogarty, and Sean A Munson. 2015. A lived informatics model of personal informatics. *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing - UbiComp '15*: 731–742. <https://doi.org/10.1145/2750858.2804250>
 - [13] Jennifer Fereday and Eimear Muir-Cochrane. 2006. Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods* 5, 1: 80–92. <https://doi.org/10.1177/160940690600500107>
 - [14] Daniel Fitton, Janet C C. Read, and Matthew Horton. 2013. The challenge of working with teens as participants in interaction design. *CHI '13 Extended Abstracts on Human Factors in Computing Systems on - CHI EA '13*: 205–210. <https://doi.org/10.1145/2468356.2468394>
 - [15] Jaimie Lee Freeman, Patrina H.Y. Caldwell, Patricia A. Bennett, and Karen M. Scott. 2018. How Adolescents Search for and Appraise Online Health Information: A Systematic Review. *The Journal of Pediatrics* 195: 244–255.e1. <https://doi.org/10.1016/j.jpeds.2017.11.031>
 - [16] Jaimie Lee Freeman, Patrina H.Y. Caldwell, and Karen M. Scott. 2020. The Role of Trust When Adolescents Search for and Appraise Online Health Information. *The Journal of Pediatrics* 221: 215–223.e5. <https://doi.org/10.1016/j.jpeds.2020.02.074>
 - [17] Jaimie Lee Freeman and Amanda Nicole Curtis. 2022. “Ask yourself WHY you want to track yourself”: Co-Designing a Self-Tracking Guide with Teenagers. *CHI Conference on Human Factors in Computing Systems Extended Abstracts*: 1–6. <https://doi.org/10.1145/3491101.3519650>
 - [18] Jaimie Lee Freeman and Gina Neff. 2021. The challenge of repurposed technologies for youth: Understanding the unique affordances of digital self-tracking for adolescents. *New Media & Society*: 146144482110402. <https://doi.org/10.1177/14614448211040266>
 - [19] Victoria A. Goodyear and Kathleen M. Armour. 2018. Young People's Perspectives on and Experiences of Health-Related Social Media, Apps, and Wearable Health Devices. *Social Sciences* 7, 8: 137. <https://doi.org/10.3390/socsci7080137>
 - [20] Victoria A. Goodyear, Kathleen M. Armour, and Hannah Wood. 2018. Young people and their engagement with health-related social media: new perspectives. *Sport, Education and Society* 24, 7: 1–16. <https://doi.org/10.1080/13573322.2017.1423464>
 - [21] Victoria A. Goodyear, Kathleen M. Armour, and Hannah Wood. 2018. Young people learning about health: the role of apps and wearable devices. *Learning, Media and Technology* 44, 2: 1–18. <https://doi.org/10.1080/17439884.2019.1539011>
 - [22] Victoria A. Goodyear, Charlotte Kerner, and Mikael Quennerstedt. 2019. Young people's uses of wearable healthy lifestyle technologies; surveillance, self-surveillance and resistance. *Sport, Education and Society* 24, 3: 1–14. <https://doi.org/10.1080/13573322.2017.1375907>
 - [23] Victoria A Goodyear, Hannah Wood, and Kathleen M Armour. 2018. *Young People, Social Media and Health*. <https://doi.org/10.4324/9781351026987-2>
 - [24] Samantha L. Hahn, Vivienne M. Hazzard, Katie A. Loth, Nicole Larson, Laura Klein, and Dianne Neumark-Sztainer. 2022. Using apps to self-monitor diet and physical activity is linked to greater use of disordered eating behaviors among emerging adults. *Preventive Medicine* 155: 106967. <https://doi.org/10.1016/j.ypmed.2022.106967>
 - [25] Liane D. Heale, Saunya Dover, Y. Ingrid Goh, Victoria A. Maksymiuk, Greg D. Wells, and Brian M. Feldman. 2018. A wearable activity tracker intervention for promoting physical activity in adolescents with juvenile idiopathic arthritis: a pilot study. *Pediatric Rheumatology* 16, 1: 66. <https://doi.org/10.1186/s12969-018-0282-5>
 - [26] Nils B. Heyen. 2020. From self-tracking to self-expertise: The production of self-related knowledge by doing personal science. *Public Understanding of Science* 29, 2. <https://doi.org/10.1177/0963662519888757>
 - [27] Mahsa Honary, Beth T Bell, Sarah Clinch, Sarah E Wild, and Roisin McNaney. 2019. Understanding the Role of Healthy Eating and Fitness Mobile Apps in the Formation of Maladaptive Eating and Exercise Behaviors in Young People. *JMIR mHealth and uHealth* 7, 6. <https://doi.org/10.2196/14239>
 - [28] Ruth N. Jeminiwa, Natalie S. Hohmann, and Brent I. Fox. 2019. Developing a Theoretical Framework for Evaluating the Quality of mHealth Apps for Adolescent Users: A Systematic Review. *The Journal of Pediatric Pharmacology and Therapeutics* 24, 4: 254–269. <https://doi.org/10.5863/1551-6776-24.4.254>
 - [29] Stian Jessen, Jelena Mirkovic, and Cornelia M Ruland. 2018. Creating Gameful Design in mHealth: A Participatory Co-Design Approach. *JMIR mHealth and uHealth* 6, 12: e11579. <https://doi.org/10.2196/11579>
 - [30] Peter B Jones. 2013. Adult mental health disorders and their age at onset. *British Journal of Psychiatry* 202, s54: s5–s10. <https://doi.org/10.1192/bjp.bp.112.119164>
 - [31] Mikkel S Jørgensen, Frederik K Nissen, Jeni Paay, Jesper Kjeldskov, and Mikael B Skov. 2016. Monitoring children's physical activity and sleep: a

- study of surveillance and information disclosure. *Proceedings of the 28th Australian Conference on Computer-Human Interaction - OzCHI '16*: 50–58. <https://doi.org/10.1145/3010915.3010936>
- [32] Ronald C Kessler, G Paul Amminger, Sergio Aguilar-Gaxiola, Jordi Alonso, Sing Lee, and T Bedirhan Ustün. 2007. Age of onset of mental disorders: a review of recent literature. *Current opinion in psychiatry* 20, 4: 359–64. <https://doi.org/10.1097/ycp.0b013e32816ebc8c>
- [33] 33. Ronald C. Kessler, Patricia Berglund, Olga Demler, Robert Jin, Kathleen R. Merikangas, and Ellen E. Walters. 2005. Lifetime Prevalence and Age-of-Onset Distributions of DSM-IV Disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry* 62, 6: 593–602. <https://doi.org/10.1001/archpsyc.62.6.593>
- [34] Dorte Brogård Kristensen and Minna Ruckenstein. 2018. Co-evolving with self-tracking technologies. *New Media & Society* 20, 10: 3624–3640. <https://doi.org/10.1177/1461444818755650>
- [35] Bhavesh Kumar, Rebecca Robinson, and Simon Till. 2015. Physical activity and health in adolescence. *Clinical Medicine* 15, 3: 267–272. <https://doi.org/10.7861/clinmedicine.15-3-267>
- [36] Johanna H. van der Lee, Lidwine B. Mokkink, Martha A. Grootenhuys, Hugo S. Heymans, and Martin Offringa. 2007. Definitions and Measurement of Chronic Health Conditions in Childhood: A Systematic Review. *JAMA* 297, 24: 2741–2751. <https://doi.org/10.1001/jama.297.24.2741>
- [37] Kung Jin Lee, Wendy Roldan, Tian Qi Zhu, Harkiran Kaur Saluja, Sungmin Na, Britnie Chin, Yilin Zeng, Jin Ha Lee, and Jason Yip. 2021. The Show Must Go On: A conceptual model of conducting synchronous participatory design with children online.
- [38] Victor R. Lee. 2014. What’s Happening in the “Quantified Self” Movement? In *ICLS 2014*.
- [39] Victor R Lee and Mary Briggs. 2014. Lessons learned from an initial effort to bring a quantified self “meetup” experience to a new demographic. *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct Publication*: 707–710. <https://doi.org/10.1145/2638728.2641321>
- [40] Amanda Lenhart and Kellie Owens. 2021. *The Unseen Teen: The Challenges of Building Healthy Tech for Young People*. Data&Society.
- [41] Cheri A. Levinson, Laura Fewell, and Leigh C. Broscof. 2017. My Fitness Pal calorie tracker usage in the eating disorders. *Eating Behaviors* 27: 14–16. <https://doi.org/10.1016/j.eatbeh.2017.08.003>
- [42] Ian Li, Anind Dey, and Jodi Forlizzi. 2010. A stage-based model of personal informatics systems. *Proceedings of the 28th international conference on Human factors in computing systems - CHI '10*: 557–566. <https://doi.org/10.1145/1753326.1753409>
- [43] Sonia Livingstone and Ellen Helsper. 2010. Balancing opportunities and risks in teenagers’ use of the internet: the role of online skills and internet self-efficacy. *New Media & Society* 12, 2: 309–329. <https://doi.org/10.1177/1461444809342697>
- [44] Ben Arnold Lohmeyer. 2020. ‘Keen as fuck’: youth participation in qualitative research as ‘parallel projects.’ *Qualitative Research* 20, 1: 39–55. <https://doi.org/10.1177/1468794118816627>
- [45] Deborah Lupton. 2020. Young People’s Use of Digital Health Technologies in the Global North: A Narrative Review. *Journal of Medical Internet Research* 23, 1: e18286. <https://doi.org/10.2196/18286>
- [46] Jennifer A. Manganello. 2008. Health literacy and adolescents: a framework and agenda for future research. *Health Education Research* 23, 5: 840–847. <https://doi.org/10.1093/her/cym069>
- [47] S. A. Munson and S. Consolvo. 2012. Exploring goal-setting, rewards, self-monitoring, and sharing to motivate physical activity. *2012 6th International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth) and Workshops*: 25–32. <https://doi.org/10.4108/icst.pervasivehealth.2012.248691>
- [48] Ivana Nakarada-Kordic, Nick Hayes, Stephen D. Reay, Carla Corbet, and Amy Chan. 2017. Co-designing for mental health: creative methods to engage young people experiencing psychosis. *Design for Health* 1, 2: 1–16. <https://doi.org/10.1080/24735132.2017.1386954>
- [49] Stephen Nation-Grainger. 2017. ‘It’s just PE’ till ‘It felt like a computer game’: using technology to improve motivation in physical education. *Research Papers in Education* 32, 4: 1–18. <https://doi.org/10.1080/02671522.2017.1319590>
- [50] Gina Neff and Dawn Nafus. 2016. *Self-Tracking*. MIT Press.
- [51] Mariesa Nicholas, Penny Hagen, Kitty Rahilly, and Nathalie Swainston. 2012. Using participatory design methods to engage the uninterested. *Proceedings of the 12th Participatory Design Conference on Exploratory Papers Workshop Descriptions Industry Cases - Volume 2 - PDC '12*: 121–124. <https://doi.org/10.1145/2348144.2348183>
- [52] Bonnie Pang, Valeria Varea, Sarah Cavallin, and Alexia Cupac. 2018. Experiencing risk, surveillance, and presumption: health and physical education students’ perceptions of digitised health and physical activity data. *Sport, Education and Society* 24, 8: 1–13. <https://doi.org/10.1080/13573322.2018.1491835>
- [53] George C Patton, Susan M Sawyer, John S Santelli, David A Ross, Rima Afifi, Nicholas B Allen, Monika Arora, Peter Azzopardi, Wendy Baldwin, Christopher Bonell, Ritsuko Kakuma, Elissa Kennedy, Jaqueline Mahon, Terry McGovern, Ali H Mokdad, Vikram Patel, Suzanne Petroni, Nicola Reavley, Kikelomo Taiwo, Jane Waldfogel, Dakshitha Wickremaratne, Carmen Barroso, Zulfiqar Bhutta, Adesegun O Fatusi, Amitabh Mattoo, Judith Diers, Jing Fang, Jane Ferguson, Frederick Ssewamala, and Russell M Viner. 2016. Our future: a Lancet commission on adolescent health and wellbeing. *The Lancet* 387, 10036: 2423–2478. [https://doi.org/10.1016/s0140-6736\(16\)00579-1](https://doi.org/10.1016/s0140-6736(16)00579-1)
- [54] Laura R Pina, Sang-Wha Sien, Teresa Ward, Jason C Yip, Sean A Munson, James Fogarty, and Julie A Kientz. 2017. From Personal Informatics to Family Informatics. *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*: 2300–2315. <https://doi.org/10.1145/2998181.2998362>
- [55] Bernd Ploderer, Shannon Rodgers, and Zilu Liang. 2022. What’s keeping teens up at night? Reflecting on sleep and technology habits with teens. *Personal and Ubiquitous Computing*: 1–22. <https://doi.org/10.1007/s00779-021-01661-x>
- [56] Erika S Poole and Tamara Peyton. 2013. Interaction Design Research With Adolescents: Methodological Challenges and Best Practices. In

- (Proceedings of the 12th International Conference on Interaction Design and Children), 211–217. <https://doi.org/10.1145/2485760.2485766>
- [57] Kyrill Potapov, Victor R Lee, Asimina Vasalou, and Paul Marshall. 2019. Youth Concerns and Responses to Self-Tracking Tools and Personal Informatics Systems. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems, CHI EA '19* (Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems), 1–6. <https://doi.org/10.1145/3290607.3312886>
 - [58] Kyrill Potapov and Paul Marshall. 2020. LifeMosaic: Co-design of a Personal Informatics Tool for Youth. In *Proceedings of the Interaction Design and Children Conference, IDC '20*, 519–531. <https://doi.org/10.1145/3392063.3394429>
 - [59] Kyrill Potapov, Asimina Vasalou, Victor Lee, and Paul Marshall. 2021. What do Teens Make of Personal Informatics?: Young People's Responses to Self-Tracking Practices for Self-Determined Motives. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*: 1–10. <https://doi.org/10.1145/3411764.3445239>
 - [60] Janet C C. Read, Matthew Horton, Ole Iversen, Daniel Fitton, and Linda Little. 2013. Methods of working with teenagers in interaction design. *CHI '13 Extended Abstracts on Human Factors in Computing Systems on - CHI EA '13*: 3243–3246. <https://doi.org/10.1145/2468356.2479657>
 - [61] Emma Rich, Sarah Lewis, Andy Miah, Deborah Lupton, and Lukasz Piwek. 2020. *Digital Health Generation? Young People's Use of "Healthy Lifestyle" Technologies*. University of Bath, Bath, UK.
 - [62] Mickael Ringeval, Gerit Wagner, James Denford, Guy Paré, and Spyros Kitsiou. 2020. Fitbit-Based Interventions for Healthy Lifestyle Outcomes: Systematic Review and Meta-Analysis. *Journal of Medical Internet Research* 22, 10: e23954. <https://doi.org/10.2196/23954>
 - [63] Glenn Robert, Jocelyn Cornwell, Louise Locock, Arnie Purushotham, Gordon Sturmey, and Melanie Gager. 2015. Patients and staff as codesigners of healthcare services. *BMJ : British Medical Journal* 350: g7714. <https://doi.org/10.1136/bmj.g7714>
 - [64] John Rooksby, Mattias Rost, Alistair Morrison, and Matthew Chalmers. 2014. Personal Tracking as Lived Informatics. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '14* (Proceedings of the SIGCHI Conference on Human Factors in Computing Systems), 1163–1172. <https://doi.org/10.1145/2556288.2557039>
 - [65] Sara E. Schaefer, Cynthia Carter Ching, Heather Breen, and J. Bruce German. 2016. Wearing, Thinking, and Moving: Testing the Feasibility of Fitness Tracking with Urban Youth. *American Journal of Health Education* 47, 1: 8–16. <https://doi.org/10.1080/19325037.2015.1111174>
 - [66] Tali Schneider, Laura Baum, Alman Amy, and Couluris Marisa. 2019. I have most of my asthma under control and I know how my asthma acts: Users' perceptions of asthma self-management mobile app tailored for adolescents. *Health informatics journal*: 1460458218824734. <https://doi.org/10.1177/1460458218824734>
 - [67] Tamar Sharon and Dorien Zandbergen. 2017. From data fetishism to quantifying selves: Self-tracking practices and the other values of data. *New Media & Society* 19, 11: 1695–1709. <https://doi.org/10.1177/1461444816636090>
 - [68] Elaine N. Skopelja, Elizabeth C. Whipple, and Peggy Richwine. 2008. Reaching and Teaching Teens: Adolescent Health Literacy and the Internet. *Journal of Consumer Health on the Internet* 12, 2: 105–118. <https://doi.org/10.1080/15398280802121406>
 - [69] Petr Slovák, Christopher Frauenberger, and Geraldine Fitzpatrick. 2017. Reflective Practicum: A Framework of Sensitising Concepts to Design for Transformative Reflection. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems, CHI '17*, 2696–2707. <https://doi.org/10.1145/3025453.3025516>
 - [70] Katta Spiel, Fares Kayali, Louise Horvath, Michael Penkler, Sabine Harrer, Miguel Sicart, and Jessica Hammer. 2018. Fitter, Happier, More Productive? The Normative Ontology of Fitness Trackers. In *CHI'18 Extended Abstracts, April 21–26, 2018, Montréal, QC, Canada*. (Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems), 1–10. <https://doi.org/10.1145/3170427.3188401>
 - [71] Mariya Stoilova, Sonia Livingstone, and Rishita Nandagiri. 2020. Digital by Default: Children's Capacity to Understand and Manage Online Data and Privacy. *Media and Communication* 8, 4: 197–207. <https://doi.org/10.17645/mac.v8i4.3407>
 - [72] Ellen Wartella, Vicky Rideout, Heather Montague, Leanne Beaudoin-Ryan, and Alexis Lauricella. 2015. Teens, Health and Technology: A National Survey. *Media and Communication* 4, 3: 13–23. <https://doi.org/10.17645/mac.v4i3.515>
 - [73] Mark Whooley, Bernd Ploderer, and Kathleen Gray. 2014. On the Integration of Self-tracking Data amongst Quantified Self Members. <https://doi.org/10.14236/ewic/hci2014.19>
 - [74] Gary Isaac Wolf and Martijn De Groot. 2020. A Conceptual Framework for Personal Science. *Frontiers in Computer Science* 2: 21. <https://doi.org/10.3389/fcomp.2020.00021>