UNDERSTANDING AND ORCHESTRATING ADOLESCENTS' INTERPRETATION OF PERSONAL INFORMATICS DATA:
SOCIAL PRACTICES IN SCHOOL AND AT HOME

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I, Kyrill Potapov confirm that the work presented in this thesis is my own. Where information has

been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

Though most teens in the UK are reported to have used self-tracking technologies, little is known about how or why. The sparse prior work in this area has tended to implement such tools as part of behaviour change interventions. The present thesis supports teens' agency in directing their own self-tracking practices, explores how they use these tools and considers how to support their process of interpretation in school settings. Drawing on a cultural-historical theoretical approach, this thesis makes two primary contributions to answer the following research question: how can social practices in a secondary school context facilitate the interpretation of personal informatics data and to what ends?

First, it improves understanding of how teens use self-tracking tools and how schools can support them, particularly in social and emotional learning. Teens prove versatile and creative users of personal informatics tools, adapting them to track a range of factors from their sleep to their worries. I characterise self-tracking as a slow and tentative process in which the meaning is formed through social practice. I examine how data visualization can mediate everyday situations in young people's lives. My findings demonstrate that data visualisations can support learning by acting as a shared object of inquiry in wider classroom discourse. Drawing out the ambiguities and contradictions of personal data can help learners critically evaluate aspects of their everyday life.

Second, I propose a novel theoretical framework for the analysis of meaning in personal informatics. Critically engaging with more familiar methodological approaches in HCI, I draw on the work of Vygotsky to consider meaning at the micro and macro levels of social practice. I characterise the process of self-determination and the development of a critical

stance that learners can experience through ongoing engagement with a technology, on

their own and with others.

Impact Statement

The work presented in this thesis has a multidisciplinary impact inside and outside of academia. Though a majority of teens are reported to have used self-tracking technologies (Rich et al., 2020), there has been little work on these kinds of interactions. My work impacts human-computer interaction in the area of personal informatics by improving our understanding of teen self-tracking for self-directed motives. First, I report on some of the motives that teens have for self-tracking. Second, I demonstrate that tools and tool practices which facilitate self-determination can support teens in making personally relevant and impactful insights about a range of everyday life factors from sleep to self-esteem.

Outside academia, this thesis is relevant to schools and educators. As well as emphasising the important role (positive or negative) that personal data can play in teens' lives, it offers guidance on how schools could approach supporting young people's use and understanding of PI tools. My findings suggest how discussing personal data with others can help teens to become more critical users of this data. I also show ways in which such discussions can contribute to learning in curricula for social and emotional learning. As well as this, the thesis contributes practical guidelines on orchestrating discussions involving personal data that lead to personal insights. The thesis also describes the process of youth-led co-design of *LifeMosaic*, a flexible self-tracking app for teens. This work has formed the basis of two book chapters written for a general audience of teachers and youth workers interested in wellbeing and mental health strategy that empowers young people (Jayman & Potapov, 2021, 2022).

As well as these empirical contributions, my thesis makes theoretical and methodological contributions. I offer sustained criticisms of dominant theoretical approaches in HCI (in and beyond personal informatics) and a defence of activity theory. I expand common approaches to activity theory in HCI, and integrate theoretical work drawing on Vygotsky not previously used in HCI, to better ground description of the thought and experience of the user. My work has also had impact outside of HCI. I have been an invited speaker on Vygotsky and activity theory at a number of events and conferences, including a guest lecture on the course "Technē beyond Monoculture" at the New Centre of Research and Practice. Following this work, I have been appointed associate editor of the journal *Culture and Education*, where I help to disseminate sociocultural/cultural-historical approaches to psychology and pedagogy to a wider audience.

Relevant publications

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- Potapov, K., Vasalou, A., Lee, V., & Marshall, P. (2021). What do Teens Make of Personal Informatics? Young People's Responses to Self-Tracking Practices for Self-Determined Motives. In Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (pp. 1-10).

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1   Introduction

1.1   Research objectives and motivations

Personal informatics is the practice of collecting data about yourself for the purpose of reflection (Li et al., 2012). Personal informatics tools allow users to collect data about their own sleep, diet, work habits and a host of other factors, generally for the purpose of self-improvement (Kersten van Dijk, 2017). HCI work in personal informatics has often treated the practice as a behaviour change intervention (Li et al., 2012; Walsh & Golbeck, 2014; Consolvo et al., 2009). Such implementations of the technology often prove ineffective long-term (Kersten van Dijk, 2017; Hermsen et al., 2016) and potentially limit other benefits that the users could derive from their self-tracking practice (Sharon & Zandbergen, 2017).

Users can interact with their self-tracking tool in varied and complex ways (Rooksby et al., 2014) that may lead to rich insights that are not quantifiable against a goal-oriented metric (Choe et al., 2014). There is still a gap in work considering how best to support users in making meaningful reflections on their own data (Baumer, 2015). Designers often "show the user a graph and hope" (Kay, 2014) rather than facilitating the process of interpretation. Where researchers have addressed this limitation, they have tended to focus on "taming data complexity" (Epstein, 2014) through the design of the tool rather than on supporting users in engaging with such complexity.

The present thesis is motivated to address this gap through a focus on practices of data interpretation and how such practices can be supported. While a number of authors have considered the social contexts in which self-tracking happens (Rooksby et al., 2014; Epstein et al.,2015b; Lupton, 2016), there are few accounts examining what it is about the context

that shapes practice. This thesis adopts activity theory as a framework through which to theorise the relationship between objects (such as data visualisations), the meanings they acquire for a user, and the practices through which they acquire them.

Though as many as half of UK teens are reported to have used personal informatics technologies (Freeman & Neff, 2021; Rich, 2020), this usually happens without adult supervision and little is known about such self-directed use. The school classroom provides a rich context to examine practices of self-tracking and meaning making. The degree of control and flexibility as well as the focus on learning and experimentation could offer productive directions for personal informatics. Personal Informatics work in schools has thus far either focused on student behaviour change (as in Garcia et al., 2015) or used the practice as a learning resource to teach STEM concepts (as in Lee et al., 2016). There is a gap in the literature in adopting a more open inquiry process to allow young people to appropriate self-tracking technologies to their own goals and interests for the purpose of facilitating reflection.

Classrooms are a place full of different kinds of social interactions but work looking at the influence of social interactions on data interpretation is limited (Garbett et al., 2018). The right kinds of social interactions could support users in learning from their data, as they've been shown to do in conversations between doctors and patients in healthcare settings (Chung et al., 2016). Though discussions around user generated data are far more prevalent in the health context, here too, the substance of the practices in which data is discussed is undertheorized (Raj et al., 2017). By bringing a new theoretical framework to personal informatics, the present thesis is motivated to give a rich account of the practices through

which data acquires meaning over time in structured social settings. Specifically, I aim to investigate how verbal and physical scaffolding can support learning (Bruner, 1986, pp. 70 - 100).

To address this purpose, this thesis investigates the following research question:

How can social practices in a secondary school context facilitate the interpretation of personal informatics data and to what ends?

This thesis takes a cultural-historical interpretivist research orientation to address the following research objectives (RO):

RO.1: to develop and apply a philosophical and methodological framework to reconceptualize personal data interpretation in self-tracking as it applies to learning;

RO.2: to investigate the feasibility of teen-led self-tracking, including whether teens choose to engage with the tools, how they choose to use them and the meaning they draw from these uses;

RO.3: to design classroom interventions to facilitate teen meaning making with self-tracking data.

1.2 Research scope and approach

The focus of the present thesis is on the genesis of meaning in personal informatics practices rather than a particular tool or experimental condition. As in *research through design,* study design and outcomes are not prescribed at the outset but develop iteratively to accommodate the needs of the user group in the contexts under study (Zimmerman et al.,

2007). Such an approach has elsewhere been described as constructivist-interpretivist (Duarte & Baranauskas, 2016). This work is interpretivist in taking qualitative data and applying deductive and inductive methods of analysis to achieve conceptual coherence and resonance, instead of focusing on set positivist outcomes (Blandford et al., 2016). This approach was chosen to foreground the importance of the contexts and the concerns of study participants.

The thesis takes an idiographic approach (Runyan, 1983) to capture what is unique about the experience of a participant (Pozzi & Bagnara, 2013), about the way they interact with technologies (Rick et al., 2011), and the history of these interactions (Elsden, Durrant, et al., 2016). Following conventions of sociocultural/cultural-historical approaches (Holland & Lachicotte, 2007; Holzman, 2016) there is more of a focus on individual episodes and less focus on generalisation. I thus take a case study approach, focusing on individual secondary school related contexts and on individual teens in these contexts. The meaningful social setting means studies are necessarily smaller in scale and focused on accurate characterisation of the thoughts, choices and dynamics of agents in situations in this setting.

1.3   Thesis structure

This thesis is comprised of nine chapters of literature review, theoretical critique, and empirical work. Chapter 2 frames and defines personal informatics by retracing some of the history of self-tracking. Following this, there is a focus on the role of personal data in schools, for staff and students. This includes a survey of the limited existing literature on personal informatics in schools. The chapter ends with an exploration of how personal informatics data has been shared socially.

Chapter 3 examines methodologies which have foregrounded the importance of understanding social practices when characterising self-tracking. In this limited survey I critically engage with three distinct dominant strands in research in this area: *practice as discourse,* ethnomethodology, and activity theory. I argue that activity theory best serves to understand personal informatics practices and the learning that they support. I conclude however that none of the methodologies surveyed adequately theorize agency and meaning making.

Chapter 4 presents key aspects of a Vygotskian framework for describing agency and meaning making. Though Vygotskian approaches inform and are coherent with activity theory, I emphasise individual and subjective elements which activity theory has tended to overlook. This chapter offers theoretical tools for the analysis of study data in subsequent chapters.

Chapter 5 frames the empirical work of the thesis. I describe the context in which research was initiated and conducted, briefly outline the planned studies, and connect the study design to the theoretical commitments set out in the preceding chapters. I consider my positionality as a researcher and describe my approach to research ethics.

Chapter 6 is the first of four empirical chapters. It reports on an explorative study of the kinds of interests that teens pursue when directing their own self-tracking. Participants attended an orientation session about self-tracking technologies and then chose a personally relevant topic to explore and self-tracking tool to track it. Teens in the study engaged with

personal informatics tools in diverse ways, some which they found helpful and informative and others not.

Chapter 7 presents the products of a two-year process of youth-led co-design of a self-tracking tool. The teen design team developed *LifeMosaic*: a smartphone app to daily log things relevant to a personal target using sticker symbols and colours. The analysis of this process helped to develop understanding of the kinds of concerns this user group have in the design and use of self-tracking tools.

Chapter 8 builds on the work in the last chapter by testing *LifeMosaic* with a new group of students. Participants used *LifeMosaic* for two weeks to track their sleep, then met as a group in a classroom to share and discuss what they had learned through the process. The chapter emphasises the potential benefits of discussing data with peers as a way of exploring topics for social and emotional learning.

Chapter 9 complements the previous chapter in offering another case study of how self-tracking can be integrated into school practices. I report on the benefits and limitations of integrating self-tracking into a face-to-face mentoring program. Participants use a self-tracking tool with their mentor for a period of six weeks to help set and monitor targets.

Chapters 10 and 11 offer a general discussion and conclusion to the thesis, tying together its theoretical and empirical contributions and offering recommendations for the design and orchestration of practices of personal date interpretation with teens.

2 Self-tracking technology and personal data interpretation

This chapter begins with an account of the history of self-tracking. Before turning to the dominant strands of research on the uses of self-tracking technologies, I examine the more niche phenomenon of lifelogging. I highlight aspects of lifelogging practices which have often been overlooked in wider research on self-tracking. The section concludes with an exploration of the social sharing of self-tracking data. This frames a wider exploration in the second half of the chapter of the use of data about students in schools, as it is collected and interpreted by staff, interpreted by students; and finally, collected and interpreted by students.

2.1 Self-tracking tools and practices

2.1.1 The early history of self-tracking

Though people have kept diaries recording their thoughts and feelings for hundreds of years, and have tracked their weight for at least a hundred (Crawford et al., 2015), digital technology assisted self-tracking is often traced back to the early 2000s and Gordon Bell's "My Life Bits" (Gemmell et al., 2005). For many years Bell digitally captured every letter, photo, and voice conversation he had and stored them in a database. These digital data entries marked times in Bell's life somewhat like diary entries – they came to be called *lifelogs*, and the people who collect them *lifeloggers*. Bell, like many subsequent lifeloggers[1], reports that recording his life has led to a new relationship with his environment and the

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[1] https://mokestrel.wordpress.com/2014/10/30/narrative-camera/

minutiae of his life. Lifeloggers rarely look back on the material they have logged. Instead, the practice of logging is what brings them a sense of self-knowledge (Caprani et al., 2013; Sellen & Whittaker, 2010).

Though many researchers treat lifelogging as "personal big data" to be analysed algorithmically (Gurrin et al., 2014), some include rich descriptions of the meanings participants have developed in reflecting on their own past. A participant in a study of lifeloggers with dementia (Piasek et al., 2014) gave an emotional account of how her lifelogged data demonstrated her interests as well as how her current life had deviated from earlier norms. The data of the lifelog prompted such evaluations of life and identity for several participants.

Kocielnik et al. (2013) note how participants can use their data to reason about life events and relationships in ways that imbue them with emotional significance. One participant in their study used the data to describe differences between the meetings he has with two colleagues. He was enthusiastic about the data's ability to show the excitement he felt when sharing new ideas with one of these colleagues and the trepidation he felt in meeting the other.

Kalnikaitė et al. (2010) show life-logging data does not only prompt the *recall* of past events but also *inferences* about them. Participants in their study often used such inferences to "reconstruct" their memories of an event to come to a sense of "typical" daily practice. For instance, one participant's inference about a day on which she must have taken a taxi, led to further elaboration regarding norms of cycling to work.

Many lifeloggers combine their practice with blogging (Van Dijck, 2004), to make it something like journaling. Members of the global self-tracking community *The Quantified Self* (Wolf, 2016) often describe their lifelogging in "Show & Tell" presentations, focusing on the "journey" of the personal knowledge they've gained (Choe et al., 2014). Like writers of journals, lifeloggers can use their practice to capture idiosyncratic aspects of their own lives. The creation of this physical record allows the practitioner to develop greater mindfulness in their everyday life. The lifelogger can become more attuned to the world; as one lifelogger described it, "bringing it closer to the present" (Villarroel, 2015). That is to say, the lived experience of the lifelogger is enriched through the practice of lifelogging.

Today, lifelogging is generally seen as a separate field to self-tracking (Lupton, 2016) and, most of the focus in lifelogging research is on recognising and modelling activities (Doherty et al., 2011; Qi et al., 2017; Wang et al., 2016) rather than individual users and what they learn through their practice.

This thesis follows Ayobi et al. (2018) in seeking to integrate lifelogging practices into other kinds of self-tracking, i.e. the practice of recording aspects of one's life one finds significant. As Ayobi et al. argue, when self-tracking data collection is a flexible and adaptive process (in which the user can choose and change what they are tracking), it can form part of a discourse that both lets the user tune in to the changing norms in their lives and the emotional significance of events which these norms describe. For instance, one participant in Ayobi et al.'s study was able to use their self-tracking practice to "take some of the hopelessness out of" periods of illness. A similar approach is taken by Elsden et al. (2017) who describe practices of *documentary informatics* by which users use data to document and

narrate aspects of their lives so as to "curate and construct" their identities. Participants in their study choose to hold on to their data as a prized possession because it is evocative for them in indeterminable ways.

2.1.2 Personal Informatics

A separate strand in self-tracking emerged from the health domain. Devices like blood pressure and blood glucose monitors have allowed users to monitor their health at home. The purpose of these technologies has generally been "self-care" (Nunes et al., 2015): maintaining the user's physical or mental health. For example, users monitoring their blood glucose can use their data to make changes to their diet or medication (Swan, 2009).

Owing to a rapid increase in the capabilities of sensor technologies over the last two decades (Schroeder et al., 2019; Swan, 2012) consumers are able to track an ever-growing range of factors, including sleep, breathing, posture, stress, reading and productivity. Users generally approach these technologies with some form of what Kersten-van Dijk et al. (2017) call the "self-improvement hypothesis": they hope that by collecting personal data they will improve some aspect of their life. As in health tracking, this involves reflecting on personal data with a view to making conscious changes. It is this goal-focused approach to personal data collection that has come to dominate self-tracking research.

Li et al. (2010) coined the term "personal informatics" to describe how users use technology to collect data about themselves for the purpose of reflection. Li et al.'s stage-based model suggests a process of data collection and rational reflection by the user. "Personal informatics" is the term for these self-tracking practices used by most researchers in HCI. Li et al.'s work has informed most of the subsequent work in personal informatics

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(Bhattacharya et al., 2018; Epstein, Ping, et al., 2015; Mishra et al., 2018; Shin & Biocca, 2017).

In the rest of this sub-section I will briefly outline Li et al.'s stage-based model of personal

informatics and suggest a few of its limitations.

Figure 1: The stage-based model of personal informatics systems (Li et al.,2010)

In the *preparation stage* users decide why they want to start tracking and select the

tracking tool and data they will collect. After a *collection stage* of gathering personal data

with the tool, there is an *integration stage* in which the data is organised for ease of

reflection. The *reflection stage* is described as involving the user looking at their data and

becoming aware of certain trends or statuses. In the *action stage* users utilise their reflections

to decide on a course of action such as increasing their physical activity or changing their

diet.

Li et al.'s model is informed by the *transtheoretical model of behavior change* (Prochaska

& Velicer, 1997), and as such frames self-tracking in terms of the pursuit of behaviour

change goals. The framing of self-tracking as a behaviour change intervention has existed

from the inception of work in this area (Consolvo et al., 2008; 2009). This framing has

become the norm in personal informatics, with studies often focused on a specified set of

behavioural outcomes from participants' use of self-tracking tools (Gouveia et al., 2015;

Harrison et al., 2014; Walsh & Golbeck, 2014; Wu et al., 2016).

Though some authors find personal informatics to be an effective behaviour change intervention (Aslam et al., 2016; Cadmus-Bertram et al., 2015) such successes tend to be limited to controlled study settings, with many authors finding that long-term *in the wild* implementations of these tools fail to achieve such ends (Epstein et al., 2016; Gorm & Shklovski, 2016; Hermsen et al., 2016; Jakicic et al., 2016; Kersten-van Dijk et al., 2017; Yardley et al., 2016) i.e. that this kind of self-tracking does not tend to change behaviour in ways that are conventionally quantifiable.

Later waves of personal informatics research have challenged these kinds of framing, describing personal informatics in terms of a wider range of motivations not optimally captured by Li et al.'s model. Rooksby et al. (2014) contrast Li et al.'s stage-based model with the often-unsystematic set of behaviours and justifications of real users. PI tools are situated in everyday contexts and the lives users live in them – they call this *lived informatics*. They highlight implicit motivations within self-tracking practices that are not best described as "behaviour change", such as fetishizing the artefacts of a technology and seeking the reward of an app's affirmation. They argue that tracking may affect and be affected by a large range of factors not pre-defined by the sensor (like fashion taste or daily schedule). Choe et al. (2014) have further classified the reasons users cite for tracking into a wide range of sub-categories like "to maximize work performance", "to find balance" and "to be mindful". All this points to self-tracking as a complex set of practices that affect many aspects of one's life.

As Rooksby et al. (2014) argue, self-tracking is unlikely to pass through the distinct sequential stages of use suggested by Li et al.'s (2010) model. Epstein, Ping, et al. (2015) offer a model negotiating elements of Rooksby et al.'s and Li et al.'s approaches to PI. They

emphasize that the stages of Li et al.'s model often overlap and pass through multiple iterations, as well as noting motives for tracking unrelated to behaviour change. They also consider lapses in tool use. Li et al.'s model is worth examining in greater detail because it represents a wider logic in the design of personal informatics tools, and in their adoption by users (Kersten-van Dijk et al., 2017).

Li et al. (2010) suggest that once data has been collected there is an *integration stage* in which "the information collected are prepared, combined and transformed for the user to reflect on". Once reflected on, the data then offers knowledge on the basis of which the user can change their behaviour. Li et al. suggest that the data's readiness for reflection is determined by the "effort" the user puts into its integration. This makes data sound like a stiff door handle. It implies that integration is a question of acting in accord with the affordances of the system: ultimately self-intimating. Indeed, the authors note that many self-tracking tools have tried to automate this process. I   suggest that how the data is "transformed for the user to reflect on" is a key and highly problematic aspect of self-tracking. Such a process relies on a wide network of knowledge on the basis of which to judge what ought to count as data and what it can be data of. Each iteration of Li et al.'s stage-based model (insofar as such a model is actualised) gains not just new data that leads to new actions but also new knowledge through which every stage of the model is restructured. Integration would take less effort if the user had already reflected on the kinds of insights they were likely to make with the data. Rooksby et al. (2014) also point to the wider knowledge self-trackers make use of when reflecting on their data, but the focus here

is on incidental contextual knowledge rather than the knowledge accumulated by users over time.

Li et al.'s model does not help to explain how "viewing" data leads to reflection and insight. This has remained a key challenge for personal informatics. In Kay's (2014) characterisation, many designers simply "[show the user] a graph and hope", rather than supporting users in the interpretation of data visualisations. As I'll argue, the ability to draw appropriate conclusions is dependent not only on the user's mathematical abilities and other competencies, but also their embeddedness in a social practice. Li et al. acknowledge that self-trackers have many kinds of reasons for starting the process of reflection, noting, "Sometimes, the trigger event is combined with an extra push from another person." This thesis aims to give a richer account of what characterises such "pushes" and argues that social interaction not only triggers reflection but also shapes and supports the reflection process at every level.

Baumer (2015) reiterates the need for a better account of reflection in personal informatics; where *reflection* is the process by which users get from data to insight. Baumer attempts to synthesize what is similar across the work of a handful of thinkers, selected for the frequency with which they are referenced in prior work in HCI that refers to "reflection". While Baumer's work demonstrates the value of drawing on a wider theoretical background in conducting research in personal informatics, there are limitations to his approach. Focusing on the use of a particular word by different authors is unlikely to be a suitable method in developing a theoretical framework. The thinkers whose views Baumer attempts to synthesize come from different traditions in which the term "reflection" plays quite

different roles. For example, Dewey uses the term as part of a pragmatist epistemological project, while Heidegger rejects epistemology. Meanwhile, Moon's cognitive constructivism would be seen as formalistic dualism by both Dewey (2020)[2] and Heidegger (1997, pp. 202-203). The present thesis attempts to address such limitations. Presenting concepts within a single theoretical genealogy can improve their coherence and make it easier to draw additional implications from them.

A more nuanced account of reflection in self-tracking could disclose aspects of user practice that are potentially hidden when the focus is solely on behaviour change. Cox et al. (2013) describe a user of the self-tracking app *RescueTime* who set out with the aim of increasing the time she spent on productive activities. After tracking her work hours with the app, she reached the "epiphany" that she was already spending enough hours working. Her practice became not about getting more productive hours but about "feeling a greater sense of control". This epiphany was not the result of a particular system or heuristic, nor was is it obviously manifest in any particular behaviour. The change was in the conceptual framing of the user and manifest in the justifications the user gave: in what she learned.

Similarly, MacLeod et al. (2013) describe users of self-tracking tools who had set out with the aim of behaviour change related to managing symptoms of their chronic illness. Rather than focusing on participants' actions, the authors describe the users' reasoning about their own tracking and the concepts they form through it to help understand their illness; for

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[2] Dewey characterises such work as "intellectual lock-jaw" (Dewey, 2020, p. 91).

instance, "Now I think – 'OK, I can have this [alcoholic] drink' but I know that I'm going to pay for it." The outcome then, is not framed in terms of measurable action, external influences, or behaviour change, but in how the user understands their own practices, of which the self-tracking tool is a part.[3] What's more, they describe how the participants shift their perception of self-tracking itself, from seeing it as an empirical examination of behaviour change to seeing it as a more informal personal exploration of the meanings of life events.

As Hollis (2018) and others have argued, self-tracking tools may prove more helpful to users when they are seen as enabling "self-knowledge" rather than "self-improvement": as supporting insights rather than behaviour change.

I suggest that current approaches in personal informatics do not give an adequate account of how users form insights. While earlier accounts of lifelogging can offer rich descriptions of how the user's self-tracking practice comes to reshape their ways of seeing their everyday life, personal informatics tends to focus on discrete episodes of tracking with pre-framed behavioural outcomes.

Some prior work addresses this limitation by framing data within social situations and the internal motives of social interaction. These social implementations of personal informatics are discussed in the next section.

2.1.3 Social sharing of personal informatics data

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[3] MacLeod et al., (2013) call the constitution of such a stance within a practice a "cultural shift".

As Lomborg and Frandsen (2016) argue, we can see self-tracking as a form of communication. Users can engage in self-tracking with an audience in mind and be motivated to form and interpret their practice through their relations to this audience. Such communication is difficult to describe and analyse in part because of the many divergent contexts and practices within which self-tracking data is shared by users.

Work looking at the sharing of self-tracked data can be divided by whether the sharing is done online or in person. Online sharing can be carried out either within the self-tracking app to a community of other users, as within Fitbit or MoodJam, or to a social network like Twitter (Chung et al., 2017; Epstein, Jacobson, et al., 2015; Gui et al., 2017; Zhu et al., 2017). Such uses can often be negatively impacted by the pre-existing social norms of posting on social media (Kersten-van Dijk & IJsselsteijn, 2016; Van Der Velden & El Emam, 2013), i.e. users may not find an appreciative or comprehending audience for their data among their social media friends or followers. Considering online networks with other self-trackers, some work has found that users lose interest in sharing in the long term because other self-trackers' motives are inscrutable from the data or not coherent with their own (Fritz et al., 2014; Park et al., 2016). Puussaar et al. (2017) suggest that a practice of social meaning making can be enhanced if the self-trackers in the practice recognize common motives and activities.

A second strand of work explores the sharing of self-tracking data offline in physical settings. Self-trackers can benefit from the back-and-forth dynamics of discussing their goals and expectations for tracking with others (Agapie et al., 2016). Whilst online sharing gives designers/researchers control over some aspects of the user's engagement with their data,

in-person interaction allows greater control over the dynamics of social interaction. As Rapp and Tirassa (2017) note, social factors like trust and sincerity could shape the social sharing of self-tracking data. Sharing data in physical contexts allows for this barrier to be mitigated by controlling aspects like group size and composition. (Taylor et al., 2015) describe this as Data-in-Place. They emphasize how data is meaningful when it is situated in the relatively stable and persistent structures offered by physical environments and the forms of life of their inhabitants. The tools and data explored in their studies proved significant for the participant community when they implicated material constraints such as traffic levels, as well as the social norms governing why they mattered; for instance, because data on this would be for the "collective good" of the road.

Such contexts can potentially better support learning because the motives valued within the practice structure the practice in ways that mean the norms governing it are open to modification and clarification through the activities of the practice (MacIntyre, 2013), i.e. it is easier to understand other participants' motives and thus for the activity to be structured around "internal" motives like getting advice or relating successes instead of "external" motives like getting Twitter likes[4].

Elsden, Nissen, et al. (2016) carried out a real speed dating event in which participants shared and discussed their personal data. Participants carried out various kinds of self-tracking then transformed their data into graphs or visualisations to be shown to their date

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[4] As in MacIntyre's (2013, p.187) discussion of "internal" and "external" goods.

partners. After this process of data object curation, participants had informal and playful

conversations in which data played an illustrative role, symbolising aspects of their own life

events and identity. The data prompted inquiry that could lead away from the data or be

directed back towards the data for further illustration or justification. The rules, routines and

templates provided by Elsden et al. delimited the practice in ways that led to greater

creativity[5] than is typically reported in personal informatics literature. As Elsden et al.,

explained, the data offered a "ticket to talk" that entitled playful reflection.

Drawing on and extending Elsden et al.'s (2016) work, Fleck et al. (2020) focus on just the

kinds of discourse recommended throughout this literature review. Unlike other work in this

area, the authors detail different aspects of discourse around data that supported its

interpretation. Participants attended workshops on work-life balance and discussed

personally-collected activity data in pairs. The authors report that the mutual sharing of data

supported a dynamic process of interpretation in which discourse recontextualised data,

making it easier to draw practical insight from it. This interpretation was characterised by

asking questions, offering justifications, and drawing conclusions about everyday life.

Other work has structured the social dynamics of data sharing by making use of existing

roles and power relations in which the user already participates. This can be seen in studies

looking at supporting personal data reflection among family members (Lukoff et al., 2018;

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[5] This somewhat paradoxical dynamic, in which certain restrictions on freedom come to maximise freedom (as well as creativity and learning), is discussed by Vygotsky (Derry, 2013, p. 85-93). These positive constraints will be discussed in later chapters.

Pina et al., 2017; Saksono et al., 2019; Saksono & Parker, 2017). The existing expectations and accountabilities helped to shape and motivate data interpretation. Saksono et al., 2019 et al.'s findings show how, rather than prompting advice for behaviour change, discussions often clarified existing norms in the practices of the family and the division of labour across them.

As Kersten-van Dijk & IJsselsteijn (2016) suggest, health tracking is a promising research direction in investigating the potential of self-tracking data sharing[6]. Healthcare visits offer a particular context in which the sharing of self-tracked personal data is widely reported to lead to meaningful insights for the participants. Regular appointments between a healthcare professional and a patient provide many of the structures that this literature review has found to be potentially helpful in supporting the interpretation of personal informatics data. The interpretation of data at a healthcare visit involves discourse between interlocutors who are called to clarify their motives and reasons throughout the practice and to modify these in response to new reasons, as mediated by the data itself. Implicit norms and relevant knowledge domains delimit aspects of the developing practice, clarifying what is appropriate and relevant for practice participants. Typically, the patient brings data to their appointment with the healthcare professional (on their smartphone or a dedicated sensor technology) which they then explain/narrate. This can prompt the healthcare professional to ask

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[6] However, as Murnane et al., (2018) note, this context is also uniquely fraught with stigma and anxiety around the sharing of details of the user's condition.

questions and make recommendations (Chung et al., 2016; Lindroth et al., 2018; Mamykina et al., 2017).

As discussed in Section 2.1.2, personal informatics began with the proliferation of technology that allowed home self-care for health. As both medical devices and consumer devices have continued to grow in functionality and ease of use, the gap between the fields of patient-generated health data and personal informatics has continued to shrink[7]. Although some clinical tests, like the 24-hour ECG, are designed with the healthcare provider as the primary data audience, technologies for patient-generated health data are increasingly designed to maximize a sense of ownership for the patient, involving them in the interpretation of the data (Lai et al., 2017). Involving the patient allows for clinical insights and prescriptions to emerge collaboratively: not from the data directly, but through discourse around the data (Kjærup et al., 2018).

Mentis et al. (2017) describe the doctor's appointments of people with Parkinson's disorder who are tracking how active they've been using a Fitbit. Mentis et al. focus on patient-doctor discourse around the self-tracked data. They describe how the physical activity data scaffolds knowledge that informs the patient and doctor's wider practice. For example, one participant shows on her step data that she is less active on Sundays. This is put down to the fact that she just stays at home and reads on Sundays. Whilst this might

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[7] One key difference is that personal informatics practices may not be suitable for diagnostic purposes and are best treated as explorative (MacLeod et al., 2013).

seem entirely normal and appropriate, it leads to more explanation in the discourse, during which the participant notes that she stops being active at a certain time because it's when her medication starts wearing off. This prompts the clinician to recommend a change in medication.

As Kersten-van Dijk & IJsselsteijn (2016) highlight, there is a barrier in this work, stemming from the fact that the motives and understanding of the patient and doctor may not be aligned. Though data objects can help mediate across this boundary, this is hard to do outside of a clear and consistent practice. While the clinicians in Mentis et al.'s (2017) study made good use of their patients' data, involving the patient in the interpretation whilst also facilitating this interpretation, other uses of patient generated health data have proven less helpful. For example, a patient may expect for the clinician to analyse their data, whilst the clinician may expect them to analyse the data on their own in a more informal capacity outside the appointment. This is to say, following Raj et al. (2017), that it is important to highlight the activities involved in an effective practice of data interpretation: the prescription of self-tracking within the context does not by itself guarantee that the practice will prove insightful.

As Engeström (2016, p. 96) notes, technology mediated interventions often fail when the researcher brings a ready-made tool and set of protocols for using this tool, without considering the existing practices of the intended users. When data sharing is severed from any meaningful context, the user can perceive it as pointless or shallow (Fritz et al., 2014; Sacramento & Wanick, 2017). Meanwhile, when data is situated in a social context in which it matters, it can evocative and impactful (Taylor et al., 2015). As this sub-section has argued,

the sharing of personal informatics data is most meaningful and impactful for the user when it is done as part of existing social practices (such as those in a healthcare visit). Researchers have paid less attention to what it is within these contexts and practices that supports interpretation.

2.2 Current uses of student data in schools

Adolescents (or *teens*) have often been overlooked as a user group in HCI and design, though they tend to be keen and competent technology users (Fitton & Bell, 2014). The prior work explored so far in this chapter was carried out almost exclusively with adults, though a majority of teenagers in the UK have used self-tracking tools (Rich et al., 2020). The present thesis argues that adolescents should be treated as a group with distinctive needs and interests, which design can help to understand and support.

Vygotsky suggests adolescence can be understood as a developmental stage characterised by experimentation with social roles (Rubtsova, 2021). While young children take on roles in imaginative play, the play world remains distinct from and derivative of the real world: a way to explore norms in my culture (Vygotsky, 1967). Nothing outside the game hangs on my now being a bank robber and now a nurse. In adolescence, the roles I take on can say something about me.

The lives of adolescents are still, to a large extent, controlled by adults and institutions like school, but adolescents increasingly find themselves with the freedom and understanding to make choices with real and enduring consequences. The social constraints separate adolescents from an adult world, but in so doing, they also maintain a space for

personal experimentation. When adolescents *try on roles* it is part of a tentative process of finding their place in the world. It is the process through which they form the identities that will be theirs for years to come (Adams & Marshall, 1996).(Adams & Marshall, 1996).

Adolescents' heightened sensitivity to social evaluation is as much a facet of their biological development as the form of their social lives (Somerville, 2013). The neuroanatomy of adolescents is undergoing radical reconfiguration. Adolescents may experience their own emotions as intense and unpredictable, and may struggle to understand and regulate them (Silvers, 2022).(Silvers, 2022).

Self-tracking technology could play a role in supporting the experimentation and mediating the uncertainty that defines the lives of adolescents. On the one hand, adolescents may have the space to use and interpret self-tracking tools in imaginative ways, and on the other, they may use the data they collect to reflect on real and personally relevant and dramatic situations. Work with adults has already proposed that self-tracking could play a role in identity formation (Elsden, Kirk, et al., 2016), but it is particularly interesting to examine self-tracking in the lives of "selves" that are so precarious and fast-changing.

The previous section emphasized the importance of situating data in existing forms of life (Taylor et al., 2015) where it could be implicated in meaningful social interactions. The prior norms and materialities of the places we share with others can provide structure. At their best, schools play this role in the lives of adolescents: creating a safe space for experimentation (Rubtsova, 2021).

In trying to implement a new technology in a school, it is important to consider whether it is likely to be coherent with existing institutional practices. Following Engeström (2016), this section aims to situate the proposed work of this thesis within existing organizational practices and to examine the motives, norms and division of labour within these practices. Since use of personal informatics tools is today far from widespread in mainstream schools, I will review the broader category of technology that makes use of personal data visualisations. I will examine the literature bringing personal informatics into schools against this framing. As discussed in the previous section, the advantages and limitations of current uses of personal data described in this section have parallels in healthcare and other domains (Galliers et al., 2017).

2.2.1 The role of data in schools

Schools are already places where many different kinds of data are collected about individual students. As Wardrip and Shapiro (2016) recount, schools often buy technologies capable of generating complex reports and visualisations about individual learners or groups of learners, though these are rarely used in practice by school professionals and have questionable impact on classroom practice. For instance, *GL Assessment*[8], can generate reports on students' verbal, non-verbal, mathematical and spatial reasoning, while *Doddle*[9] can predict their level of competence in specific curriculum-based skills from their engagement with online quizzes. Other tools aggregate many different kinds of data,

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[8] https://www.gl-assessment.co.uk/products/cognitive-abilities-test-cat4/

[9] https://www.doddlelearn.co.uk

offering reports that can place individual students within a wider demographic and academic context; for instance, their progress relative to other white British girls with a special educational need receiving free school meals[10]. Like Engeström (2016), Wardrip & Shapiro conclude that a tool by itself cannot bring about transformation, nor can data generate its own meaning. The tool must be taken up into the gradually developing social practices.

2.2.2   **Student data for the student**

While most school data technologies have been designed for classroom teachers and school leaders as their target user group, some tools have explicitly considered the perspective of the student. Educational technologies are increasingly giving students direct access to visualisations of their personal data.[11] The paradigmatic case is perhaps *Class Dojo*.[12] *Class Dojo* is a popular points-based behaviour monitoring system. As Maclean-Belvins et al. (2013) describe, several schools have developed successful practices in which students are shown their own behavioural data (visualised with an avatar) as the basis for a discussion about behaviour progress or lapses (at whole-class level, one-to-one, and in other contexts). As the authors conclude, such practices are often successful in teaching students

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[10] For example, https://www.sisraanalytics.co.uk

[11] Carl Standertskjold , BETT London, 26th January 2018

[12] https://www.classdojo.com

self-regulation skills through regular reflection. *Class Dojo* lends itself to primary school contexts, though similar systems geared at older students do exist[13].

Other tools, aimed at older students, such as Renaissance Learning's *Accelerated Reader*[14] (which gives students reports on how many words they've read based on their scores in reading comprehension tests) or GCSE Pod[15] (which shows students how long they've spent revising a subject on the site) imply similar rationales: that seeing a visualisation of their performance can motivate students. This data can also be viewed by class teachers or parents and inform conversations about interventions.

More traditional curriculum-delivery technologies vary in their design choices around the data the student can see about themselves. For instance, while Doddle does not let students view their own reports, Khan Academy[16] visualises curriculum progress through points and badges[17], and Tassomai[18] offers the student detailed heatmaps of their subject mastery[19]. The impact of these design choices is unclear and there is a gap in the literature comparing the use of such affordances. As Wardrip and Herman (2018) suggest, presenting data to the student could either lead to the "lubrication" of learning by prompting user reflection or to a

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[13] For instance, https://www.vivoclass.com/

[14] Renaissance Learning's Accelerated Reader

[15] http://www.gcsepod.com

[16] https://www.khanacademy.org

[17] Though for the purpose of gamification. See discussion of "token economies" in this section.

[18] https://www.tassomai.com/

[19] Showing which topics they've revised, how much and at what level of assessed comprehension.

"perturbation" in the learning which disrupts the learning practice, for instance by acting as a distraction, challenging the learner's perception of their own progress in a way that is disheartening or through any number of other unanticipated consequences.

As with personal informatics interventions based on behaviour change (Kerner & Goodyear, 2017), these tools could potentially mechanize a classroom practice rather than encouraging users to reflect on it. The data provides what Robacker et al. (2016), characterise as the student supplying a behaviour to meet a demand in the system and being paid for their labour. Robacker et al. characterise such a system as an effective way to create behaviour change. As with behaviour change interventions in traditional personal informatics research (as in 2.1.2), "token economies" are potentially limited by the fact that the teacher or designer often fixes the value of the tokens before youth users enter the practice. Several authors have suggested such token economies could limit student progress in the long term (King, 2018; Manolev et al., 2019; Willekes, 2014).

School practitioners may be able to overcome this limitation by making student data the object of class discussion. Class Dojo is often used in the classroom as part of a more open-ended explorative discourse (Maclean-Bevans et al., 2013). Duke (2011) similarly describes a teacher's use of individual students' reading data as part of class discussions about reading routines. In my own professional experience as an English teacher, this is a common way of using reading data: as part of discussions at parents' evening or within mentoring programmes.

Such discourse is explicitly supported through *Class Dojo's* addition of a "Student Stories" feature, through which students can clip their own data or classwork and write reflections about them. Banks (2019) promotes this as a form of "digital storytelling": where technology scaffolds student narration of personal stories for the purpose of social and emotional learning and literacy (see also Gregori-Signes and Pennock-Speck (2012)).

In the preceding sub-sections, I have reviewed a variety of use cases of data technology in mainstream schools. Staff and students in a school context are likely to be familiar with the concept of data, though their interactions will be significantly altered by the nature of the practices within which this data is used. Though technologies personal data technology can limit the user by reinforcing routines and stereotypes, they can also serve discourses which enrich the meaning of such data and lead to meaningful insights for interlocutors (Wardrip & Herman, 2018).

The foregoing discussion helps to frame the efforts that have so far been made to bring personal informatics technologies (as defined in 2.1.2) into school classrooms and other educational contexts.

2.2.3   Personal informatics in educational contexts

There are two main strands of work bringing personal informatics to youth and into schools:

1. As part of a behaviour intervention
2. As a learning resource

The dominant strand of work follows the first wave of personal informatics (Li et al.,2010), with its focus on behaviour change. The focus of this work is *persuasive* rather than *reflective* (Munson, 2012). The studies within this strand view personal informatics as a potential intervention for promoting specific desired behaviours (set by the researcher or an institutional authority). For example, participants may be given a wearable physical activity monitor or may be asked to download a smartphone app to encourage them to carry out more physical activity (Gaudet et al., 2017; Kettunen et al., 2019; Ridgers et al., 2016; Schaefer et al., 2016) or to lose weight (Fernandez-Luque et al., 2017; Jensen et al., 2016; Timpel et al., 2018; Yang et al., 2017).

Kerner & Goodyear (2017) argue that work of this kind positions the self-tracking data as an extrinsic reward rather than necessarily supporting learning[20]. Though some of the work explicitly promotes user reflection, this is arguably still limited by the study's framing. For example, Garcia et al. (2013) created visualisations that allowed kids with attention deficit disorder to reflect on how hyperactive they've been. In their two studies, the kids were given feedback on their hyperactivity through a traffic light system or the facial expressions of an anthropomorphised wearable. Although the participants were encouraged to reflect back on visualisations of their activity data, the study was already framed with a set of norms around what was the appropriate amount of movement; the kids themselves had little input into the form and value of these norms. This can be contrasted with Kim et al. (2015), who used

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[20] As widely reported in the extrinsic reward literature in psychology (Ryan & Deci, 2000).

participatory design workshops to allow youth from lower socioeconomic backgrounds to discuss norms and practices around health and obesity. The researchers in this study used the process to inform the design of a personal informatics system for a health coaching intervention. However, Kim et al.'s approach is not typical within this strand of work.

The second strand of work bringing youth in contact with personal informatics, frames the tools as resources for maths and science (STEM) learning. The studies in this strand evaluate the personal informatics systems in terms of whether they support students in grasping curriculum content (Lee, 2019; Lee et al., 2016; Matteucci, 2017). Personal informatics has proven an effective way to demonstrate abstract scientific concepts, tying them into aspects of the young participants' everyday world. For example, Lee and Thomas (2011) asked fifth graders to create bar charts from data they collected with pedometers while walking to the school library.

Polman (2018) describes how student self-tracked data can serve as a "boundary object", mediating between knowledge collected in everyday life and more scientific knowledge around personal health: the data in their study helped to scaffold student understanding of topics like muscle growth and the dangers of steroids. Similarly, Drake et al. (2018) describe how data visualisations can serve as an "object of inquiry", inspiring and organising a group's discussion of a science topic. This kind of framing, sharing a heritage with activity theory (Akkerman & Bakker, 2011), could potentially prompt greater user creativity in data interpretation. However, the focus within this stream of work on the transfer of specific knowledge means that, as with the first stream, the norms and motives of the practice are fixed and not responsive to the students' own activity, arguably narrowing learning

(Engeström, 2014). In a sense, this is an inversion of the limitation outlined in 2.1.2: adult users of personal informatics tools generally receive *no* direction, and so often do not have an adequate framing for meaning making. The school classroom provides a useful context for supporting users, whilst exploring the dialectical relationship between their own motives and the motives brought by others in the social institution in which they are participating (Edwards, 2016).

Both streams of work bringing youth in contact with personal informatics limit the scope of the meaning of personal data by framing it as flowing from the adult to the child. Although this work shows that children are open to engaging creatively with personal data, this creativity is ultimately limited by the fact that the adult decides what is meaningful and how. There is room in the curriculum (for instance, in the PSHE curriculum in the UK[21]) for a more expansive approach to what young people should potentially learn from their own data.

The discussions of individual motives and of the affect of participants in these two strands of work tends to be limited to an assessment of their "enjoyment" or "engagement" in the use of the technology. There is a gap in the literature around how young people might appropriate personal informatics for uses relevant to their own motives and interests, and

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[21] "Personal, Social, Health and Economic (PSHE) education is a school subject through which pupils develop the knowledge, skills and attributes they need to manage their lives, now and in the future. These skills and attributes help pupils to stay healthy, safe and prepare them for life and work in modern Britain. When taught well, PSHE education helps pupils to achieve their academic potential, and leave school equipped with skills they will need throughout later life." - https://www.pshe-association.org.uk/what-we-do/why-pshe-matters

the meaning they would themselves form through this practice. This concern is addressed peripherally in a number of studies. For instance, Matteucci (2017) reports that one of her participants said they would share the knowledge they gained through their personal informatics practice with their granddad for whose health they were concerned. Section 4.3.1 will offer a richer unit of analysis for these kinds of experiences than *engagement*.

Drawing in part on work done as part of the present thesis, Ploderer et al. (2022) report on a study of teens asked to track their sleep for three weeks using a Fitbit HR. The authors offer a much richer account of teens' sleep practices by allowing them to direct their own practice and to narrate and justify their own choices within this practice. Teens are able to use their sleep data to reflect on their own sleep and think about ways that they might improve it.

Garbett et al. (2018), gave primary school students wrist pedometers and let them see a visualisation of the group's steps in the classroom. They report on the different kinds of discourse prompted in the practice between students, teachers and parents (though again the focus is on "engagement" rather than the meaning of the engagement). The authors designed a tool and context of use which gave young people an opportunity to reflect on their pseudonymized physical activity and its significance for themselves. Some participants made inferences from discourse about their data to their everyday practice, for instance in noting that their mum suggested they should take "better steps" or about how taking steps was related to playing football. A more open inquiry process in which youth are supported in pursuing their own motives could further support insights of this kind.

Freeman and Neff (2021) surveyed and interviewed teens in the UK about their views of self-tracking. They argue that designers and researchers have not adequately addressed the variations of teen experiences and the complexity of their social lives. The teens in their study could see the benefits as well as the risks of self-tracking and were keen to appropriate the technologies for personal goals. They stress that for teens personal informatics is fundamentally social. Personal informatics could help teens to manage social relationships (sharing and talking about personal data to show mutual care),but could also encourage harmful behaviours like social comparison. As Hong et al. (2018) note, teens are still developing skills like communication and self-reflection. Their study suggests how shifting the focus of self-tracking from adult-defined to youth-defined outcomes can allow PI tools to scaffold self-expression. Whilst prior work has tended to focus on adult-defined curriculum content, some prior work suggests PI tools could help young people to learn about and express their own values, feelings and identities (Hodson et al., 2019; Hong et al., 2018; Lee & Briggs, 2014; Pommeranz et al., 2011). As Lee and Briggs (2014) note, this approach can also be valuable in better understanding the risks and challenges involved in bringing PI tools to youth.

2.3 Conclusion

The early history of self-tracking saw groups of hobbyists archiving aspects of their life into "lifelogs", to reflect on their life, potentially becoming more mindful. A separate strand of work introduced technologies as diagnostic tools that let users take charge of some aspects of their lives that might otherwise be overseen by a healthcare professional (Swan, 2012). As the use of these tools expanded from self-care to self-optimisation (Kersten-van

Dijk et al., 2017), users' practices began to take new directions, implicating a wide range of aspects of everyday life (Choe et al., 2014). Meanwhile, the academic work in this area has, following Li et al. (2010), largely remained focused on promoting behaviour change outcomes for the user. This focus on behaviour has left a gap in work considering user interpretations i.e. what the user learns from their data.

Although the use of personal informatics in schools appears to be rare, there is still a literature suggesting that a personal informatics intervention can be implemented coherently in this context. Tools like *Class Dojo* have been shown to support teacher-led discussion of students' personal data (Maclean-Blevins et al., 2013) and many widely used tools allow students to view data about their own usage. This dynamic has already proven successful in the small body of work using personal informatics data as an "object of inquiry" to scaffold learning for STEM curriculums (e.g. Drake et al., 2018). Beyond this, personal informatics can give teens the agency to learn about important factors in their own lives such as sleep (Ploderer et al., 2022).

Throughout this chapter, we have found personal data technologies are most likely to scaffold meaningful insights in contexts in which the data can enter meaningful discourse (Taylor et al., 2015). Practices that encourage discussion of data prompt more creative interpretations and support less experienced participants in mastering tool use. The next two chapters will offer the theoretical tools for characterising social practices of this kind.

3   Critique of theories of social practice

In this chapter I review and critique dominant approaches in HCI dealing with the social practices of users. This will not be a comprehensive review of available contemporary methodologies, but a necessarily limited survey of a few different methodological traditions. I will argue that these theoretical frameworks offer many advantages over approaches which ignore practice, but that they are ultimately limited in their characterisation of meaning making and agency. This will motivate the next chapter in offering a new methodological approach to personal informatics.

3.1   The turn to practice

In a nuanced and comprehensive review of recent work across the field, Kuutti & Bannon (2014) describe a "turn to practice in HCI". They characterise research in HCI as traditionally taking an "interaction perspective", and contrast this against a growing "practice perspective". Within the *interaction perspective*:

> *the focus is on the snapshot of the interaction at the moment, usually focused on an individual, centered on the human-machine dyadic relationship itself. Methods have traditionally come from the psychological sciences, involving controlled short-term, lab-oriented studies with individuals engaged in pre-determined experimental tasks. (ibid.)*

Meanwhile, a practice perspective:

> *examines historical processes and performances, longer-term actions which persist over time, and which must be studied along the full length of their temporal trajectory; they are situated in time and space, and are dependent on many features of the surrounding material and cultural environment, which cannot be simply seen as a surrounding "context", but must be interwoven within the practice. (ibid.)*

The *practice perspective* dates back at least to Suchman's seminal critiques of the mechanistic design of consumer devices like photocopiers (Suchman, 1987), but Kuutti & Bannon suggest that it is only now becoming more broadly adopted and accepted in HCI.

In the last chapter I argued that personal informatics research (particularly with young people), has been dominated by the *interaction perspective*: focusing on pre-determined tasks and outcomes and framed around snapshots of tangible behaviour change (Consolvo et al., 2009) or individual acts of data interpretation (Epstein et al., 2014). Noting limitations of the *interaction perspective,* I argued that emerging work with adult users demonstrates that personal informatics may be more impactful when it is integrated into wider semi-structured practices. This less dominant strand of work may be said to take a *practice perspective*: describing specific contexts from speed-dating nights (Elsden, Nissen, et al., 2016) to doctors' visits (Chung et al., 2016) and the complex ways in which PI data comes to matter through social interactions in these contexts.

Yet, taking a *practice perspective* brings its own challenges. A clear advantage of the *interaction perspective* is that its focus can be clearly defined, while it is not at all clear what one is focusing on when focusing on a practice. The many discordant uses of "practice" in different literatures can both intimidate and raise questions about scientific value and rigour (Turner, 2018). There is a plethora of institutionally well-established approaches to studying practices in the social sciences but as Kuutti & Bannon note, the concurrent turn to practice in these fields has evolved with marked differences to the turn in HCI. Though they characterise HCI as lagging behind social science in its "unsystematic, partial, and tacit" approach to practice, it is not easy to translate ideas and methods directly from one field to

the other. As Hughes et al. argue, HCI and CSCW researchers have distinct aims and interests from social scientists which may deter them from appropriating theoretical frameworks with collateral commitments to issues that do not practically contribute to their work, such as politics and ontology (Hughes et al., 1993). It is clear why many HCI researchers have avoided such theoretical considerations altogether and adopted a "tacit" everyday understanding of practice.

To avoid theorization in such a contentious research domain is to exacerbate issues relating to the scientific value of HCI research. Without examining the concept of "practice", researchers may be reporting on incommensurate or arbitrary phenomena, like Chemists sharing findings about phlogiston in the 18th Century. This is the view taken by Steven Turner:

> *A large family of terms [are] used interchangeably with 'practices', among them. . . some of the most widely used terms in philosophy and the humanities such as tradition, tacit knowledge, Weltanschauung, paradigm, ideology, framework, and presupposition. (Turner, 2018, p.2)*

Turner argues that we should let go of the concept of *practice*: talk of "social practice" is an intellectual fashion which only breeds confusion and encourages false claims. I think Turner overreaches in his conclusion (cf. Rouse, 2007a), but there is nonetheless something important to his critique. To take a *practice perspective* I will need to defend a theory of practice with enough precision to prune what is theoretically gratuitous or unsuitable to the aims of this thesis and for HCI researchers more broadly.

Kuutti & Bannon (ibid.) identify three prominent theoretical strands in the work characterising the turn to practice in HCI. While these approaches originate from separate theoretical traditions, each has proven to be usable and impactful in empirical work in HCI:

1. Practice as Discourse

2. Ethnomethodology

3. Activity Theory

I will examine each approach in turn in the rest of this chapter with a focus on how it has been employed for personal informatics research. This will be a "partisan" discussion, critiquing each tradition to bring into sharper relief the advantages of following the work of Vygotsky and the activity theory approach. I will argue that Vygotsky's work is particularly well suited to the study of personal informatics data interpretation. Beyond this, I make the stronger claim that the trajectories of currently dominant methodologies pose serious limitation for HCI. This will motivate the next chapter in presenting an alternative theoretical framework for HCI methodology. This partial survey necessarily involves mischaracterisation insofar as work can be found in the traditions I survey which escapes my criticism.

3.2 **Practice as discourse**

As Kuutti & Bannon (2014) note, the *practice as discourse* approach has been significantly shaped by the philosophy of Foucault. Indeed, much of the work exploring how self-tracking tools are used in social practice has been conducted within a Foucauldian framework

(Belliger & Krieger, 2016; En & Pöll, 2016; Lupton, 2014)[22]. This framework has supported appreciation of the influence of the social contexts in which self-tracking occurs (Kneidinger-Müller, 2018). Particularly relevant to the present thesis are the accounts of how social norms and perceived social roles help to shape self-tracking and the meanings users derive from their data (Lomborg & Frandsen, 2016; Stepanchuk, 2017). However, most of the work here frames norms as restrictions on the user's self-actualisation (Kou et al., 2019; Ross, 2018; Wright, 2014) which should be challenged in the design of new tools (Sanders, 2017; Spiel et al., 2018; Whitson, 2014). Since interactions in the framework are explained in terms of agents' power within wider institutions, there is often a degree of suspicion about the idea of tools supporting users to make progress (Esmonde, 2020; Kent, 2018). A common implication of the work is thus that users ought to be left to find whatever meaning they can for themselves through "self-constitution" (Bode & Kristensen, 2016; Hong, 2016; Stepanchuk, 2017) i.e. through setting their own standards for what is meaningful. These accounts are limited in what they can say about how such processes of meaning making could be supported and improved.

Mertel (2017) describes "self-appropriation" as an alternative to "self-constitution" in the framing of meaning-making. Self-appropriation involves coming to understand and becoming an active agent in the norms that shape us. For instance, in becoming attuned to the norms of painting, you can come to be a better painter (MacIntyre, 2013 p. 189). Derry

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[22] While many authors writing about self-tracking cite Foucault (Juchniewicz & Wieczorek, 2022), they differ in the extent to which they explicitly adopt a Foucauldian discourse framework.

(2019) discusses a history lesson in which the teacher put a portrait of Henry VIII on the whiteboard and asked students to intuit facts about Henry VIII from it. In being left to self-constitute meaning, the students are left making trite comments like "He looks rich" rather than effectively expanding their learning. Derry suggests that the teacher might have better facilitated the learning if he had helped orient the students with respect to relevant disciplinary knowledge relating to Henry VIII. Derry is drawing on Vygotsky's idea that our concepts and activities only acquire meaning insofar as we find them in a system of other concepts.

> *This enrichment of the immediate perception of reality by generalisation can only occur if complex connections, dependencies, and relationships are established between the objects represented in concepts and the rest of reality. By its very nature, each concept presupposes the presence of certain systems of concepts. Outside such a system, it cannot exist. (Vygotsky, 1987b, p.224)*

When a Fitbit user is notified of their resting heartrate, the experience may be similar to that of the child left gazing at the portrait of Henry VIII. Self-tracking tools are often designed for the user to independently analyse their own data in order to make rational deductions; for instance, "Productivity rate was high on the days that I really needed to get my work done, but on the days that I go out, it was generally low" (Kim et al., 2016). It is however unclear whether "insights" of this kind are effective in facilitating deeper learning. Users of self-tracking tools often find that their data "lacks something"; once the novelty of the tool has worn off; users find that the data fails to offer insights of sufficient value (Rapp & Cena, 2016). Within a Vygotskian framework, we might suggest that personal data often fails to be meaningful for the user because the user cannot constrain it within a wider system

of concepts. A Foucauldian framework is less helpful in theorising such *positive constraints.*

Foucault includes *disciplines* like handicraft in his wider commentary on the *disciplinary*

nature of social life but, in so doing, flattens out the qualities characterising individual

disciplines (Rehmann, 2022, p.255).

Authors drawing on a Foucauldian tradition have made incisive critiques of some of the

wider forces that shape user experience. As Pantzar & Ruckenstein (2017) argue, self-tracking

tools may be used in limited ways because of how designers shape user expectations. For

instance, by implying the user is a sovereign ego rationally deducing appropriate future

action, the often-messy process of meaning-making is potentially subverted (cf. Winner,

2017).

Foucault is suspicious of human sciences (*anthropology*) that take an external perspective

to human practice (Foucault, 2007). He focuses on the finitude of the individual: the way in

which I can only approach knowledge of the world from the limited frame of my own

epistemic context. Foucauldians refocus truth claims onto the positions of the people making

them and the discourses within which they are made. This means that Foucauldians often

overlook questions of materiality and the role of particular objects (cf. Hacking, 2002, p.50).

Researchers within the Foucauldian tradition typically make general claims that rest on

abstractions; for instance, noting that "practices have been framed with discourses of self-

responsibility, empowerment and agency" (Fotopoulou, 2018). Such observations

characterise practices at the level of a culture or institutions, making it hard to describe

particulars of different settings, the practices of smaller groups, or the viewpoints of

individuals. There is a risk of coming to study data with abstract concepts which are not responsive to minutiae of the study data; for instance Jewitt et al. (2021) discuss the "governmentality" of parents using haptic wearables to interact with their baby. There is less clarity about the motives of users and the extent to which the technology supports them. What's more, these concepts all pull normatively in the same direction – suggesting that technological mediation distorts practices. Though Foucault claims that he is not saying "that everything is bad, but that everything is dangerous" (Dreyfus & Rabinow, 2014, p. 231), it is easy to hear this and conclude one ought not to let one's kids play outside.

The "discourses" that Foucauldian approaches take to characterise practices do not refer so much to the talk engaged in by participants as to an implicit background of norms which precedes such talk. Specific examples of talk are often examined according to the extent to which they reproduce and conform to or subvert such general norms (En & Pöll, 2016; Zakariah et al., 2021). Such a focus is helpful in foregrounding the ethical dimensions which may become implicated in self-tracking practices, for instance in the context of a romantic relationship (Will et al., 2020), workplace (Saukko & Weedon, 2020), or other everyday settings (Didziokaite, 2017).

Within the *discourse as practice* paradigm, participants tend to be treated as the subjects rather than the agents of discourse (Till, 2019). This makes it harder to describe users' creativity in drawing on concepts outside their immediate situation. Self-trackers who report drawing valuable insights from their data, often do so by going beyond the personal informatics system and evaluating their activity through some richer external standard or practice. For instance, Cox et al. (2013) and Choe et al. (2014) separately describe users who

tracked their productivity and came to make insights about the very role that concerns about productivity had played in their life. Hollis (2018) found that participants tracking their happiness, tended to find the experience positive not because it improved their happiness but because it let them evaluate the role of happiness in their life, deflating its importance. Another participant in Choe et al.'s (2014) study was actively tracking a range of biometric data but had failed to find them meaningful until she came to see them as "symptoms" of activities for which her emotional state was the "cause". Another participant reflected on "how tragic it is that we all age". In a sense, these participants are in line with Foucault's intentions, in critically reflecting on their own practices, but the studies themselves were not conducted within a Foucauldian framework and mark a contrast with what tends to be reported within studies that are.

Though it is less useful for understanding individual psychology and thought processes, a key strength of the *discourse as practice* perspective compared to traditional approaches to PI is in pointing to the wider social contexts that enable individual creativity, so that under the right conditions, users can draw on this context for meaningful insights, "translating and transforming life based on earlier experiences, cultural understandings and shared knowledge" (Pantzar & Ruckenstein, 2017).

Foucauldian approaches to personal informatics have proven powerful in drawing attention to risks and challenges associated with the use of technologies in different settings. For instance, they have problematized some of the ways in which we use these technologies to police ourselves through our monitoring (Lupton, 2012). However, such approaches are less helpful in offering constructive recommendations for design. There is rarely a focus on

what constitutes local contexts of practice or the material objects within them (except to the extent that they contribute to or are prefigured by a discourse). The analysis of "discourse" in this work has often focused on the responses of individuals to powers and norms beyond their control. There has been less focus on the meaning created by interlocutors in a particular situation. Analysis in this tradition has often described participants' social practices in terms of abstract social roles like "the redemptive self" (Zakariah et al., 2021), rather than focusing on processes by which they come to understand their roles within these practices or the objects that mediate them. I have argued that it is difficult to address these limitations within a framework focused on freedom from constraints rather than the positive local appropriation of constraints i.e. normativity. I return to these arguments in light of empirical findings in the final discussion of this thesis.

3.3   Data work and ethnomethodology

Ethnomethodology is probably the approach to social practice most widely associated with HCI (Button & Sharrock, 2009; Randall et al., 2021). Ethnomethodology describes the particulars of a social practice including the material objects being used. Like Vygotsky, ethnomethodologists recognise that an object's affordances depend on the meanings or "accountabilities" developed through ongoing enactment of the practice. Like Vygotsky, ethnomethodologists oppose disengaged generalisations about research subjects through categories like "IQ", "behaviour change" or "governmentality"; they believe research should focus on real social practice as it unfolds in a particular social context, aiming to "capture what work might be like for the people who are engaged in it" (Rouncefield & Tolmie, 2016 p. 2). A number of prominent researchers have drawn on Vygotsky's ideas while adopting an

ethnomethodological research methodology (Bødker, 1999; Roth, 2013). This makes it a strong candidate methodology for the present thesis. Indeed, a strand of ethnomethodological research has explored research aims close to my own in investigating the collocated sharing of personal data in the context of interpreting home energy data.

Research in this area primarily describes the "data work" of home energy advisors offering energy saving advice to home residents who have installed smart meters which collect home energy usage data. This rich literature supports a key objective of the present thesis (RO.2) in showing the value of discourse in supporting users to make personally relevant insights from their data. The framing of *data work* shifts the focus of research from the intended outcomes of personal data use (such as behaviour change) to processes of interpretation of personal data in specific situations. Accounts of *data work* involve thick descriptions of the wider social contexts in which these interactions occur and become salient for the user. The framework challenges dominant approaches to research and design in personal informatics which assume "the data speaks" (Bode & Kristensen, 2016), i.e. relying on the tool itself to offer insights directly to the user. As Fischer et al. (2017) report, it is the discursive process of reflecting on data as it is implicated in specific situations, rather than the data itself which leads to relevant insights for the user. Parallels can be drawn between the role of an energy advisor and a teacher or mentor in the kinds of school contexts focused on in this thesis. Given the value and relevance of this prior work and the dominance of ethnomethodology in HCI, a strong case needs to be made to nonetheless reject ethnomethodology as a framework for the present thesis.

Subsequent sections will outline some key features of the ethnomethodological tradition and argue that they pose limitations for research on personal data interpretation. In short, while "ethnomethodology has little interest in questions of meaning" (Sharrock & Button in Rouncefield & Tolmie, 2016), the users of personal informatics technologies do have such interests. Overlooking these aspects of self-tracking practices makes it hard to analyse users' insights and learning.

The present section does not aim to offer a comprehensive review of ethnomethodological literature, but to evaluate key features of the framework, as they apply to *data work* in HCI: namely: *rejection of theorization*, *accountability*, *background*, *membership* and *indexicality*.

3.3.1 Rejection of theorization

Ethnomethodology and related approaches aims to describe practices "as they are", without theoretical presuppositions (Maynard & Clayman, 2003). In describing their methodological approach, Crabtree et al. (2000) suggest:

> *Ethnomethodology offers no theories, it does not build theories and does not build them because it has no work for them to do: social practice qua practice in real time cannot be discovered through such rational practices of the imagination.*

Instead, they suggest that researchers should "let the phenomenon itself drive [research]". The impetus for this view ultimately rests with Heidegger. Challenging correspondence theories of truth, Heidegger proposes that truth is letting entities be seen as they are: a process of uncovering or unconcealing (Heidegger, 1962, p. 261). Heidegger is posing a Romantic challenge to Enlightenment Rationalism – he wants to emphasize that

what is true, is true apart from of our rationalisation of it. This informs Heidegger's unusual

view of technology as "the outcome of the 'play' of being, rather than as the outcome of the

judgments, decisions, and actions of determinate human agents" (Zimmerman, 1990, p.248)

Heidegger is critical of technology insofar as it is a tool to measure and mediate our lives

(Heidegger, 1954). It is clear then why ethnomethodologists in HCI would suggest that

"every instance of meaningful action must be accounted for separately with respect to

specific, local, contingent determinants of significance" (Suchman, 2007 p. 84)

Heidegger's theory emphasizes cases in which there is a shared language to make

reports like "it's raining", rather than cases in which the truth is contested by individuals or

arrived at through a process of deliberation (Apel, 1994). If truth just is unconcealment, how

do I distinguish what is true from what is an artifact of my own imagination? As Rosen

argues:

> *If the initial "seeming" of, say, a rose is not in itself veridical, we are not going to arrive*
> *at a purified version of the essence of this seeming by examining subsequent seemings*
> *or intuitions, unless, of course, we have access to the "Idea" of the rose as independent*
> *of the intuitions. (Rosen, 1993, p. 303)*

There is a danger that what I take to be "purification", believing myself to be attuned to

what is primordially true, is in fact the entrenchment of unexamined theory or ideology.

Heidegger himself was not immune to this danger. He connected his views of technology

and modern culture with a Romanticisation of the rootedness of the German peasant, and

what he saw as the corrupting calculating nature of "world Jewry" (Trawny, 2018, p. 11).

Late in his career, Heidegger himself accepted that he was describing the conditions for the possibility of truth rather than offering a rival theory of truth (Smith, 2007). Ethnomethodologists have not followed him to this conclusion.

The Heidegger of *Being and Time* undervalued how humans reason with each-other and act for reasons (Apel, 1994; Sellars, 1950; Tomasello & Rakoczy, 2003). This may be called *normativity* and it is a framing of human activity explicitly rejected by ethnomethodologists (Crabtree, 2011; Suchman, 2007, p. 81). Without normativity through mutual recognition, it is not clear what it could be to be social or act as a "we".[23]

Ethnomethodologists in HCI are in particular drawing on readings of Heidegger by Lucy Suchman's thesis examiner, Hubert Dreyfus[24]. For Dreyfus, rationality is not only superfluous to how we understand human practices, it works *in contradiction* to our "skilful coping" – breaking the flow of our practice and potentially making us "choke", like the baseball player who over-thinks his swing (Dreyfus, 2007). This creates a dualism of embodied coping and disembodied intellect (Sachs, 2017). Following McDowell's critical responses to Dreyfus, this thesis takes rationality to be always already shaping our practices (McDowell, 2013).

3.3.2 Accountability and the moral order

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[23] This is a cul-de-sac into which Foucault too follows Heidegger (Suther, 2023).

[24] Dreyfus can also be credited with bringing Foucault to the US, as well as emphasizing Foucault's indebtedness to Heidegger (Dreyfus & Rabinow, 2014).

Ethnomethodology was founded by Harold Garfinkel in the 1960s in part as a reaction against the sociology of his contemporaries. Garfinkel argued that the theoretical models of figures like Talcott Parsons and Émile Durkheim distracted sociologists from the everyday particularities of the social situations they studied (Vom Lehn, 2014). Researchers have been attracted to ethnomethodology for its promise of a no-nonsense approach , "getting the job done" in a range of study contexts (Crabtree et al., 2000). For an interdisciplinary field like HCI, ethnomethodology offers researchers with different backgrounds a way into research without a lot of specialist learning. Ethnomethodology rejects all theories and ideologies in favour of *common-sense practical reasoning* (Heritage, 2013).

The championing of the *practical, mundane, and common-sense* in resistance to theory is a familiar objective in twentieth century thought. However, it has often been replaced by what Mark Fisher has called a "Business Ontology"[25]: Ethnomethodology has, to some extent, discarded the jargon of sociology in favour of a language of post-Fordist managerialism[26] (Fisher, 2009). Ethnomethodology has focused less on events and individual experiences (as in earlier phenomenological research) and more on *work* and *documents* in specific workplace settings (Szymanski & Whalen, 2011). Where ethnomethodological research *has* reported on individual experiences, be they of parenting (Szymanski & Whalen, 2011) or

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[25] Indeed, Hammersley (2018, pp. 22 - 45) traces ethnomethodology back to the Austrian School of Economics that gave us neoliberalism.

[26] While Fordist society was characterise by explicit top-down structures, such as foremen directing the workers in a factory, post-Fordism is characterise by the internalization of such regimes – epitomized today by the rise of Uber: individuals are given apparent freedom from top-down control, while being held to local systems of accountability – smiling and joking to make sure they get their 5-star Uber rating or a *Good* mock Ofsted. Managers can take off their tie and discharge responsibility to this 'naturally given' local order (Fisher, 2009).

personal bereavement (McGregor, 2020 pp. 109 - 112), these have also been characterised in terms of *work* and making oneself *accountable* to others.

The concept of *account giving* was informed by Garfinkel's own early experiences as an accountant (Vom Lehn, 2014) and has become a widely used theoretical lens for describing and analysing the practices of study participants. Accounts *solicit* or *occasion* certain responses from members of a practice; they make observable the obligations which participants must hold themselves and others to. Accounts thus constitute the local order by which participants judge their actions as appropriate to the situation. For example, Marshall et al. (2018) describe how different tools and technologies are used in the work of a charity. They offer the following vignette from the study data:

> *We're meant to keep this [file], and we do, by the way, but nobody ever asks to see it. I've got files here from ten year ago which haven't seen the light of day. People complain at us that we're not doing our job, and ticking boxes, but we are, but nobody ever comes in. Nobody ever asks. I keep it all. (ibid.)*

This Pinteresque monologue is offered by a participant when telling the researcher about their own work at their company. Here is how the authors interpret this vignette:

> *Martin's frustration indicates that while he is fulfilling legal and stipulated obligations designed to make Youthworks accountable for their work, they are not given the opportunity to demonstrate this properly. When Martin describes how photographs of these chats would be "not very entertaining" we also see that whilst Youthworks could theoretically generate records of these, the effort required to do so would not result in a substantial gain for the charity when trying to demonstrate their value. (ibid.)*

By framing their observations through the lens of *work* and *accountability* the authors have arguably performed the kind of reifying reduction ethnomethodology's rejection of theory is aimed to guard against. They have made the description of what is significant in the study data less rather than more responsive to what unfolds. In explicitly rejecting normative explanations of meaning, ethnomethodological approaches can lead to reductive accounts of participants' motives and experiences.

The lens of a*ccount giving* forms an important part of *data work* focused on the interpretation of home energy data. For instance, Fischer et al. (2017) explore the practices of energy advisors using different kinds of home energy data to give advice to home residents on how they can save energy. They describe how data are *made accountable*, by letting advisors and clients see patterns in the activities in which the clients are engaged.

> *Sensors come to be situated in specific locations with reference to the particular problems that occasion their introduction into the home; there is a reflexive relationship between the articulation of problems which warrant proposals being made to introduce sensing into the home, and the actual placement of sensors. (ibid.)*

The authors note that users adopting data technologies act for reasons related to the problems they identify in their home. There is less focus on what these reasons are and what aspects of the social contexts or practices help to inform them. The focus is on giving a *practical* account of what is going on at a site rather that the meanings individuals draw from their relations to the *work* they are engaged in.

Thinking of practices in terms of *accountability* tends to entail seeing them as *routine* or *mundane* (Heritage, 2013). This is arguably not well-suited to describing the insights users

make over the course of their interaction with a technology. Actions which contradict the routines to which participants are accountable are thought of as "breaches" (Crabtree, 2004). Data advisors are thus said to treat "anything out of the ordinary" in home energy data as disclosing a breach in the client's practices (Fischer. ibid.): significant to the extent that it discloses what ought to be repaired. But how helpful is it to think of the design and research of personal data technologies in terms of preserving a social order? Prior work in personal informatics suggests that users value the flexibility for their tool to adapt to their competing and changing motives (Ayobi et al., 2018).

Some research has inflected *accounting* with the concept of a *moral order*. Garfinkel suggests that members' moves and articulations in practices can be seen as articulating and instituting a *moral order*, understood broadly as what members feel to be their obligations in a social context (Garfinkel, 1967). It is less clear however how researchers can discern what a *moral order* entails in a particular study setting. Goulden et al. (2018) describe *breaches to the moral order* in a family's collocated interaction with common consumer technologies in their home. The authors take an approach to data collection which offers interesting vignettes of interaction. It is less clear on what basis the authors can judge, for example, that a teen participant's act of going on her iPad in bed is a *breach of the moral order,* rather than just

routine teen behaviour, or, as her father suggests in the same vignette, something potentially beneficial, in allowing her to read before sleep.[27]

Data work has tended to introduce "moral order" in terms of Garfinkel's broader description of what participants find appropriate, as enacted in the situation under study (Fischer et al., 2016; Tolmie et al., 2016). Under this definition, a *moral order* is instituted afresh in each situation (Jayyusi in p.235). In practice, researchers have run together what might be described as mundane breaches of habit, such as a participant buying custard cream biscuits when they usually don't (Hyland et al., 2018), and instances of moral judgement proper.

> **Client:** *If I want it on, I'll put it on, and if I don't - it's the same with my partner, she's the same. I'm never going to use a timer on it, never. I'll just put it on when we need it.*
>
> **Advisor:** *Let's just have a quick look at the other …*
>
> **Client:** *Yes, but it's just easier for us to just put it on when we need it. The way I see it, if my house is cold, and my kids are cold, I don't care if we have to pay, I'll put it on. Because I'm not going to make my kids cold. If I have to put more money on, I will.*
>
> (Fischer et al., 2016)

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[27] The authors introduce moral order with a reference to Shove (2003). Shove describes the "co-production of morality" in laundry practices (Ibid. p. 139). She suggests, "we might represent the laundry as an assembly of cogs (textiles; tools, e.g., detergents, washing machines; rationales; skills and expertise) each of which can turn one way or the other, but that together constitute the system as a whole." Presumably, a mum telling her daughter to get off her iPad would also be subsumed into the mundane order of such a system.

The client does not seem to be giving an account of local order in the study setting; he is situating judgements in a broader narrative involving understanding and expression of personal values, with respect to his life as a whole (MacIntyre, 2016 p. 54). He gives a thoughtful answer entirely appropriate to the discourse. Describing what constituted this "breach" is better understood through an account of the mediation of concepts by which the participant evaluates life priorities as relevant to the situation. The authors are aware of the explanatory gap here and make an elliptical reference to a "primordial imperative" by which the participant holds their family to be a priority. The implication seems to be that this is something they hold pre-conceptually, thus allowing *moral order* to remain at the *bottom floor* of embodied coping, rather than an *upper floor* of rational judgement. This absolves researchers of the need to explain the meanings participants attribute to their own actions.

If no distinction is made between what is moral (even in Garfinkel's sense of *what is expected*), and the feelings I express towards it, then nothing can be a better or worse reason for acting, or "breaching" current routines (Habermas, 2015. p. 116 - 118). This limits HCI insofar as ethnomethodologists describe how participants are using existing technologies but not why, or how they might like their practices to be different.

3.3.3 The Background

Without normativity, how does ethnomethodology explain the ways in which practices remain transferable and relatively stable over time? This is the role of *the background*. *The background* is the basis on which we speak and act intentionally (Suchman, 1987p. 63). *The background* involves cultural forces that enable me to adopt abilities to tell what is

appropriate in a given situation. It is however less clear what the background consists in, how it is formed, or how it can interact with my conscious action.

The background has been described as primordial (Dreyfus, 2017p. 142), ineffable (ibid., p. 52), indeterminate (Dreyfus, 1992 p. 15), unitary (Liberman & Garfinkel, 2014 p.240; Button, 1991 p. 143), inescapable (Garfinkel, 1996 p. 249), and yet wholly separate from my motives. *The background* directs (Dreyfus, 2017 p. 156) and is "in agreement [with]" our practices (ibid. p. 22), and yet it is withdrawn beyond our grasp (Dreyfus, 2017). This view contrasts with theories of social practice in which social norms are constantly reshaped through intentional action and mutual recognition (Rouse, 2007a)[28].

For ethnomethodologists it is not rationality but *the background* that fixes the course of a practice. Haugeland suggests this amounts to a picture of people as processing units performing certain operations in response to contours of their environment (Haugeland & Dreyfus, 1996). What is missing from this view is any role for human agency.[29] Neither the

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[28] The other key influence for ethnomethodology here is Wittgenstein's discussions of rule following. Taylor traces two broad schools of interpretation. The first, views rule-following as inscrutable and imposed by society, and the second views rule-following as involving our understanding and open to justification (Taylor, 1995, pp. 167 - 168). Ethnomethodologists adopt the first interpretation (Lynch, 2012); I am following Brandom and others in advocating the second (Williams, 2013).

[29] Suchman focuses the addendum to *Plans and Situated Actions* (2007) on questions of agency and the human. She characterise "autonomous, rational agency" as the product of "Euro-American imaginaries" (Suchman, 2007, p. 228). Her account follows Latour, Haraway and other theorists of posthumanism / New Materialisms (Bennett, Cheah, Orlie, & Grosz, 2010) in viewing humans as assemblages of forces, or objects among other objects. Though we are of course ensembles of objects in the world, acting in dynamic systems of material contingencies, this brackets out the kind of ensembles we are: ones with the self-consciousness to act for reasons (Brassier, 2016).

ground floor of affordances and solicitations, nor *the background* are at the right level to characterise intentional action.

3.3.4 **Membership in a practice**

Ethnomethodologists describe practices in terms of the tasks accomplished by members of that practice (Tolmie & Rouncefield, 2016). A member is anyone with the skills to participate in the practice.

> *Ethnomethodologists treat 'skill' endogenously. That is, seen from the point of view of the person doing the work – the member in the sense we describe above – skill resides in a series of egological questions: 'what do I have to do next?'; 'what do I need to know?' (Randall & Sharrock, 2016)*

But does taking myself to have skills in heart surgery really suffice to make me a member of this social practice? What arguably matters is not that I can ask these questions but that the answers I receive are good and formative of future practice. It is only through an iterative process by which I am recognised as a member of a practice that I can actually orient myself within it and recognise myself as a member. This requires an intersubjective rather than "egological" perspective.

Though ethnomethodologists do attempt to capture intersubjective dynamics of a practice, without a concept of normativity it is hard to analyse the goods internal to a practice or their relation to the motives of its members. Instead, skills and practices are characterised in terms of how they are " ritualized and patterned" (Hughes et al., 2016) i.e. what the researcher observes being repeated. Such an approach is not responsive to how a

practice changes as participants advance towards final ends, or how such ends change through the participation.

The focus on patterns of action rather than the reasons for acting has made it hard to identify the unit of analysis with which to characterise a practice. Researchers adopting an ethnomethodological approach to personal informatics have reported on *practices of silence* (Porcheron et al., 2018), *practices of nodding* (McGregor, 2020) *practices of manipulating information* (Cheon et al., 2016) and *practices of scepticism, assessment and credibility* (Passi & Jackson, 2018). It is unclear what work the word "practice" is doing here. To what extent can these studies be said to be contributing to the same literature? It does not make a difference if these authors take themselves to be members of the same practice.

As Dourish & Button have noted, this poses some problems for HCI in what ethnomethodology can recommend for future work and design (Dourish & Button, 1998). We are left with separate instances of interaction without a clear sense of what recommendations can be made for their improvement or how they relate to wider contexts. This is a question that researchers have grappled with since ethnomethodology's inception. We can contrast Garfinkel's insistence that ethnomethodology "is NOT a corrective enterprise. It is Not a rival science in the worldwide social science movement. EM does not offer a rival social science to the established methods of carrying on analytic studies" (Garfinkel, 1996, p. 121) with Sellars' argument that "empirical knowledge, like its sophisticated extension, science, is rational, not because it has a foundation but because it is a self-correcting enterprise which can put any claim in jeopardy, though not all at once."

(Sellars, 1956, sec.38). Since HCI makes empirical claims and is informed by other sciences, it will continue to have an uneasy relationship with ethnomethodology here.

3.3.5 **Indexicality**

Instead of focusing on the symbolic and normative functions of language and other signs, ethnomethodologists focus on its indexicality. Suchman suggests that "all language, including the most abstract or eternal, stands in an essentially indexical relationship to the embedding world" (Suchman, 2007, pp. 77 - 80). An index is tied to or points to its object. For example, smoke stands in an indexical relation to fire. It's not clear whether Suchman is following Garfinkel in broadening the meaning of "indexical" to simply mean "embedded in states of the world" or Dreyfus in focusing on the physical setting in which an activity is occurring. Ethnomethodologists in HCI seem to take both routes, taking the significance of participants' actions to be tied to aspects of the spatio-temporal environment in which they occur, just insofar as they occur there[30]. The next chapter will follow Peirce in viewing indexicality as one of three kinds of relationship that signs have to the world.

Data work has foregrounded the concept of indexicality as a key outcome of considering data's role in social practice (Crabtree et al., 2019; Kurze et al., 2020). By returning all meaning to its relation to the physical setting, *data work* misses the difference made by the

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[30] Rather than, to take Searle's example, my sense of being in post-industrial late capitalism (Searle, 2001), or going through a breakup.

discursive practices into which it is implicated, or how they change the data's meaning and alter future practice.

What is significant about the practices of energy advisors is surely not that they share a location with a client in observing personal data, but what they each make of the data and the data's role in mediating understanding. The advisor can scaffold the formation of concepts which give the client new ways to think about this here data, as well as contexts outside the immediate situation. This can be seen in the sharing of personal data in healthcare visits, analysed using non-ethnomethodological methods. A patient may only have an insight about their data upon leaving the doctor's room and reflecting on their meeting (Chung et al., 2016).

An illustrative example of the limitations of ethnomethodology's approach here can be found in a study reporting on a family's interaction with an Amazon Echo smart speaker:

> *Activities that we might gloss broadly as "parenting" turn on establishing appropriate ways of behaving during mealtimes, particularly for younger members of the family, such as the instruction to Liam to "keep on eating your orange stuff". All the while, we find these other concurrent activities closely geared into the organisation of Susan's further requests to the Echo. For instance, Susan's second instruction is interleaved on line 11 with Carl's continuation of Susan's prior request to Liam to eat his food. Carl provides a series of and-prefaced turns: "and your green stuff" on line 10, and "and your brown stuff" on line 12. (Porcheron et al., 2018)*

By focusing on indexicality and collocation, the authors have made it hard to grasp the full picture. That activities happen at the same time or in the same place does not explain

their trajectory or purpose[31]. Ethnomethodologists have rightly argued that we cannot

understand practices without understanding the contexts and situations in which they occur,

but a focus on this type of indexicality does not capture the temporalities characterising a

context. We interact with tools across multiple spheres of experience (Peters et al., 2018).

Parenting is a form of life made up of practices that involve actions and motives like telling

kids to eat their vegetables (Jaeggi, 2018). I deal with new or unexpected situations by

appraising whether they are meaningful to me as a parent and how. The affordances in the

situation may embody contradictions across temporalities: between my form of life as a

parent and my form of life as a management consultant; between practices of managing

their bedtimes and practices of managing their homework. This involves, in Vygotsky's terms,

a constant "zig-zag" between the indexical and the symbolic (Vygotsky, 2017, p.419).

Data itself is of course in an important sense indexical. Something is a sensor insofar as it

is responsive in predictable ways to some aspects of the context in which it is situated. There

is however a difference between what a sensor is doing in determining that it is raining, and

what a person is doing in determining it. Brandom imagines a technology which, when I

point it at something, tells me if it is *grivey*[32]; I am told that a light on the device's handle will

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[31] The critique in this section extends to New Materialist approaches increasingly popular in HCI, often alongside ethnomethodology
(Crabtree & Tolmie, 2016). Desjardins and Biggs (2021) invite a participant to imagine that *she is* an Amazon Echo: she reflects on her
experience of relating to the family dog. I suggest such attention to eclectic "entanglements" or "assemblages" of humans and things overlooks
the specificity of social relations and the collateral commitments of adopting a social role.

[32] A nonsense word.

come on if and only if what I point at is *grivey*. I may thus find that the cat, the light across the floor and the computer speakers are grivey, but the microphone and pillow are not. My data about what is grivey does not yet allow me to draw any insights or develop my understanding of what I point at; what's more, I cannot even be said to have acquired the concept of *grivey* – despite being able to offer accounts of what content it is appropriate to call *grivey* in a range of situated interactions (Brandom, 2008b)[33]. Brandom argues that while language and data hold the capacity to act indexically, much of our discourse is not functionally indexical. Indeed, one can already do everything one can do in using indexical vocabulary by using non-indexical (deontic normative) vocabulary (Brandom, 2008a)[34]. This is to say that one need not take meaning as directly *given* by data.

Accounts based on indexicality neglect what is arguably the most important quality of personal data: its capacity to ground my judgements. Making an insight from my data must in some ways involve distinguishing my immediate or prior perception of a situation from how it really is. What changes here is not the data itself or my behaviour, but the concepts through which I see aspects of the situation. Such a change is unlikely to be observable by others and requires rational explication (through symbols rather than just indices).

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[33] Vygotsky conducted similar experiments with real participants and describes how social practice can work up such a system of signs into meaningful insights by which I may solve problems or explain something in the situation (Sannino, 2015).

[34] Brandom gives the example of the ending of Beckett's The Unnameable: 'I can't go on. I'll go on.' The layers of meaning here are unrelated to the indexicality of the two assertions.

Ethnomethodology's approach to study data in terms of separate, context-bound, and ad hoc episodes of activity makes it hard to describe such development or learning.

Part of what makes someone an expert is that they can recognise things in the world through concepts developed in acquiring expertise, meaning they can see things which a novice cannot. By sharing data with me, an expert can help me to see things in it which I may not have previously been able to see. This cannot be captured through a researcher's description of the location of the interaction or the members' actions because the researcher's perception is not mediated by the same concepts as the members. Fischer et al. (2017) are right to criticize systems that assume they can anticipate the meaning you will derive from your data through an algorithmic model, but the process of meaning making is not simply the product of the data's presence in particular everyday situations. To explain how meaning develops over time through my practice I ought to distinguish between passively perceiving my data as I find it in my environment, and actively tarrying with it through different concepts. In this way, what I took as given by the data can turn out to be just a feature of my perception of it. As my concepts of the data change, I can find that my previous implicit assumptions about it contradict what I now see. This is an ongoing iterative process: as I involve the data in my activity, this new reality will too be shown to be a mere appearance, in a way which I cannot now anticipate, and through the process of which my understanding of the data will expand as it takes on new determinations (Brandom, 2019 pp. 88 - 103). For example, data about my productivity could come to signify things about my mortality (Choe et al., 2014).

3.3.6   Conclusion and dialogues with activity theory

While the next section will examine the activity theory approach, here I address some of the debates between activity theorists and ethnomethodologists. In the concluding chapter of *Ethnomethodology at Work* Sharrock & Button note that "activity theory is often recommended as a corrective to Ethnomethodology" and respond to these criticisms (Rouncefield & Tolmie, 2016, p. 221). They cite a helpful critique of ethnomethodology by Bonnie Nardi – an influential HCI researcher working in the activity theory tradition:

> *Situated action models less readily accommodate durable structures that persist over time and across different activities … Situated action accounts may then exhibit a tension between an emphasis on that which is emergent, contingent, improvisatory and that which is routine and predictable. (Nardi, 1996)*

As I have argued, ethnomethodology has often overlooked how practices have developed over time and why. There is a focus on the *moral order* or *background* as it is demonstrated in routines, and an eclectic focus on the minutiae of what is happening now in a particular spatio-temporal setting. It is less clear how these dimensions interact to constitute intentional action. In analysing a context of practice, ethnomethodologists tend to overlook the ideas, concerns and choices of its members.

Shorrock and Button acknowledge this difference between the two theoretical traditions but suggest that ethnomethodologists deliberately exclude these wider aspects of context because they have different research aims and because "such a concept does no analytical work" (Op cit.). They rightly stress that Ethnomethodology is primarily concerned with issues like what everyday work looks like for an engineer. In this regard the contribution of ethnomethodologists has unarguably been significant. HCI researchers have gained rich

insights into organisational contexts like air traffic control rooms (Bentley et al., 1992) or print factories (Button & Sharrock, 2009). But as technology has become ubiquitous in people's lives, ethnomethodology has proven less helpful in describing how practices are established or adapted to emerging motives (Rouse, 2007a).

Rouncefield & Tolmie suggest that Ethnomethodology is concerned with "the problem of trying to capture what work might be like for the people who are engaged in it" (Rouncefield & Tolmie, 2016 p. 2), but ethnomethodologists have presupposed that *what work might be like* for someone involves solicitations, primordial imperatives, and attunement to a background, but does not involve rational judgments, theories and reflections. I have argued that ethnomethodology cannot account for these latter aspects of a practice because it rejects the "normativity paradigm" (Suchman, 2007, p. 81). While ethnomethodologists argue such a concept "does no analytical work", I have followed activity theorists in arguing that this precludes exploration of users' motives for a practice, how it is going, and how it might be improved (Kaptelinin & Nardi, 2006, pp. 17 - 22). While "ethnomethodology has little interest in questions of meaning" (Sharrock & Button in Rouncefield & Tolmie, 2016), I have argued that their study participants *are* motivated by such questions.

Sharrock & Button offer a rebuttal here by suggesting such aspects of the practice "are perfectly well known to everyone and not merely to sociological analysts". I have challenged this claim in noting ways in which the home energy advisor, client and researcher differ in their understanding of and relationship to collocated home energy data. I have argued that analysis of users' insights and learning cannot be conducted at the level of what is known to everyone or what is routine. The motivation for the chapter to come is in the argument that

we can only analyse the meanings participants draw from their PI data with a fine-grained theoretical framework that can describe the concepts and theories mediating their judgements, as well as their dynamic materializations.

3.4   Activity theory

Cultural historical activity theory (CHAT) dates back to the early years of the Soviet Union. The cultural-historical school provided a counter-current of "creative Marxism" to the scientism of Soviet dogma (Artinian, 2017). Yrjö Engeström divides CHAT into three waves: the first wave initiated by psychologist Lev Vygotsky, the second by his student Aleksei Leontiev, and the third by Engeström himself (Engeström, 2014). Engeström argues that each wave built on and expanded the last. What is called "activity theory" today in HCI tends to refer to the third wave. Activity theory studies the genesis of things, and particularly how practices develop over time as mediated by the motives, objects, contexts and social relations of its participants.

In a comprehensive literature review of the use of activity theory in HCI, Clemmensen et al. (2016) report a wide range of applications of the framework for study design and data analysis, among other uses. Though researchers interpreted the framework in many ways, common themes include a focus on context of interaction, collaboration between participants, and the role of the tool in mediating wider activities. For example, Park and Chen (2012) explore the motives and challenges of nurses and doctors as they coordinated activities in an emergency room. The study reports on how the implementation of an Electronic Medical Records system changed how participants saw their own work. Sambasivan et al. (2010) describe the motives and practices of people living in an urban slum

and explored the impact of introducing technology into the community. They report on the collaboration within the community which allowed a few competent technology users to support the motives of a broader social group.

Activity theory research is often interventionist (Sannino & Sutter, 2011): it seeks to support change within a practice for its participants. Unlike behaviour change interventions of the kind dominant in PI, activity theory is formative and generative (Kaptelinin & Nardi, 2006): rather than being predetermined by the researcher and imposed on participants, tools and practices of the intervention are often shaped by participants in collaboration with the researcher, through reflection, discussion and experimentation. There are thus productive parallels between this approach and participatory design (Simonsen & Robertson, 2012). Because interventions are shaped by the concerns and interests of participants, many aspects of study design may not be known at the outset. While these methods overlap with participatory design (DiSalvo et al., 2012), they differ from PD workshops typically carried out in HCI (Bannon et al., 2018) in focusing on existing practices of tool users and the settings in which they are practiced. For example, doctors at a GP surgery attend discussion sessions with the researcher between appointments to design and trial tools that could make information handling at these appointments less stressful (Engestrom, 1993). School kids can attend an after school program to develop strategies for dealing with pressures they face in school (Brown & Cole, 2002). These are arguably neither *in the wild* nor *lab* studies: semi-structured collaborative practices are constructed with the researcher but integrated into wider life.

Activity theory supports change by initiating participants in particular practices or shaping existing practices through (what Bruner (1986, pp. 70 - 100) reading Vygotsky calls) *scaffolding*. Scaffolding involves objects, ideas or practices that positively constrain tasks by breaking them down into smaller steps, modelling good performance or otherwise orienting the learner in completing them (Hammond & Gibbons, 2005). Enculturation involves learning to use the scaffolding and embedding it in the practice: over time I may rely on the scaffolding less because I am now in command of the skills or concepts to which it oriented me[35]. For example, "Zones of Regulation" are a form of scaffolding widely used in schools (particularly for children with special educational needs). These posters/prompt sheets present four categories of emotion signified through four colours. Each coloured box contains examples of emotions in that category e.g., "Sick", "Sad", "Tired" and "Bored" (blue box). This scaffolding is intended to help kids to express how they are feeling and through this process to evaluate whether what they are feeling and doing is appropriate to the situation. Over time children internalize the scaffolding and need it less i.e. they can say "I am in the yellow zone" without reference to the poster, and then skip this process altogether by appropriately regulating their emotions. However, the scaffolding can still be returned to should they need it (Kuypers & Winner, 2011).

In an instructive series of studies highly relevant to the present thesis, Clegg, Byrne et al. (2017; 2018) adopt an activity theory framework to support children in reflecting on their live

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[35] "Scaffolding" is an imperfect metaphor as it implies something rigid and external (Shvarts & Bakker, 2019). Vygotsky's word is simply "tool" or "sign". What's more, the 'teacher' can share or shape the needs/motives, not just the means to attain them (Di Paolo, 2019).

physiological sensing data in science classes. In describing the study context, the authors note physical constraints such as the layout of the learning space as well as social constraints like broaching sensitive topics. Their recommendations for design are centred on how such constraints can be appropriated or overcome. Their findings highlight that while personal data technology can scaffold learning, the technology itself may require scaffolding to enable participants to use it effectively. The researchers draw on the child participants' relevant existing interests and practices to inform study design. After a two-year process of participatory design and implementation, they present various multimodal scaffolding that supported children in being motivated and competent to reflect on their personal data for scientific inquiry. The scaffolding included prompts, vocabulary lists and semi-structured facilitation of group discussions (Byrne et al., 2018; Clegg et al., 2017). This focus on developing the use of a technology so it can be better adopted by users for motives recognized by them contrasts with approaches to social practice which foreground observing practices *as they are*.

Many researchers know activity theory by its triangles. The triangle models of activity systems can provide helpful heuristics for thinking about varied dimensions of a practice but can also pose some limitations for those wishing to adopt the approach.
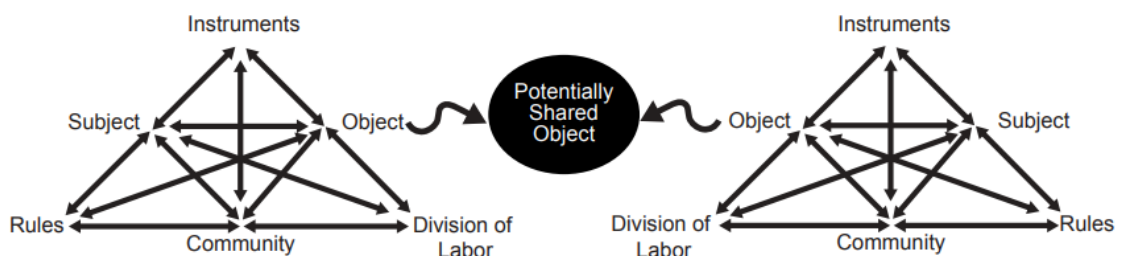
Figure 2: Activity theory model of two interacting activity systems (Engeström, 2001)

Researchers not scared away by this baroque architecture have tended to treat diagrams of this kind like a tick list of separate items for data analysis. Almalki et al. (2016) performed a literature review of personal informatics in real world contexts. They searched for findings corresponding to Leontiev & Engeström's six categories in 26 eligible studies. For example, they reported that a "*subject*... could be life hackers, data analysts, computer scientists, computer literate, early adopters, health enthusiasts, or productivity gurus". Such lists split the practice in ways that abstract it away from the actual activities of the participants and make it hard to see the bigger picture and draw inferences. There is a danger here of the kind of reification for which ethnomethodologists criticise activity theory (Rouncefield & Tolmie, 2016, p. 223). This is a problem for any "toolkit". For example, while an approach called *assessment for learning* has been shown to improve learning in schools (Black & Wiliam, 2010), giving teachers tools for *assessment for learning* like mini-whiteboards, post-its, lollipop sticks, special acronyms, without an understanding of the underlying principles has failed to replicate the same results (Swaffield, 2009).

While Engeström describes activity theory as a cohesive framework of three progressive waves, others have suggested a radical break between the initial research done by Vygotsky and that of subsequent activity theorists (Dafermos, 2018). The main source of contrast is in the focus on groups rather than individual experience. As Derry explains, Leontiev and his followers "could not accept Vygotsky's insistence on the existence of a plane that was not explicable in terms of tool use in an environment" (Derry, 2013, p. 98). Activity theory was adopted into HCI as part of the "postcognitivist" turn launched by Suchman's attacks on the

scientism of existing design (discussed in the last section). Activity theory research in HCI has thus retained its aversion to issues of individual interpretation and meaning-making. This is clearly a limitation for the present thesis, given its focus on interpretation and personal insight.[36]

A handful of cultural-historical approaches have incorporated individual reflection. Dietrich and Van Laerhoven (2015) propose a "reason oriented" approach to support user reflection on physical activity data. They suggest that design could be more responsive to the fact that what a tool indexes as the same activity, the user may call "jogging", "running" or "catching a train" depending on their changing motives. Lee and Drake (2013) explore how the adoption of various self-tracking tools affected how runners described their practice, including their motives and personal identity. They describe the contexts in which tools were used by describing the aspects of personal history that the participant judged significant in shaping their current motives, for instance sustaining a back injury, meeting her husband who she enjoyed racing or finding himself near a marathon that was considered a badge of honour to participate in within the wider community. Lee & Drake are reporting on the narratives participants form in justifying their actions.

Unlike approaches to practice *as a discourse*, CHAT researchers are also interested in how physical objects come to mediate a practice. Lee & Drake's participants describe their current

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[36] While Engeström's activity theory is dominant within HCI, cultural-historical psychology outside HCI has tended to stick closer to Vygotsky. Researchers have sometimes used the designations of "cultural-historical theory" and "activity theory" to signal an emphasis on Vygotsky's framework or on Leontiev & Engeström's.

practices at the "layer" of speeds, paces, times and distances while also using these data artefacts to prompt wider qualitative evaluation.

Kow (2018) describes the practices of e-sport gamers who independently interpret videos of their games to continually modify future gameplay and then share insights with other players. Groups of novice players draw on the advice of expert players. This is a recognizable learning dynamic in which as we gain mastery or understanding of a practice, we internalize norms and values that have been crystallized in the objects of the practice (Postholm, 2015). This is a complex system of social interactions between players and the affordances of the technologies mediating this interaction. Kow argues that while the gaming practice is social, it relies on episodes of individual introspection. As he notes, this is also true of personal informatics.

Despite the above examples, "Third Wave" activity theory is limited in its characterisation of individual processes of learning and reasoning. It is here that we need to return to Vygotsky. Vygotsky's work primarily focused on learning and development, and exploring his theories will help to supplement current approaches in activity theory in HCI.

3.5   Conclusion

I have argued that activity theory offers a number of advantages when compared to the Foucauldian approach and ethnomethodology (as two very different dominant frameworks for the study of social practices of self-tracking). The focus on motives helps to appreciate the agency and understanding of participants and the aspects of context that are relevant to them. The analysis of mediation lets us analyse the function of technologies as physical

artefacts. The emphasis on development means it is possible to analyse how using a technology changes the users' practices and understanding of those practices over time. The use of interventionist methods lets researchers and designers explore how tool interactions might be improved to better align with the users' motives, and to experiment with uses not anticipated by the researcher. Rather than limiting research to individual institutions or workplaces, activity theory considers the wider practices of which users are a part and the values that drive these practices.

These aspects characterise what is unique about a CHAT approach to social practice in HCI, however an objective of this chapter was to define what a social practice is. I finish here with a definition which captures key themes discussed in this section. Rather than providing a topology, Anne Edwards is bringing CHAT into conversation with a tradition of theorists of social practice including Charles Taylor, Marx and Aristotle.

> *People enter historically constructed practices with intentions, which are shaped by and shape what matters to participants in the practice. As participants approach, interpret and engage in activities that make up a practice, they exercise a personal agency, which they learn to align with the motives that shape the practice while also impacting on the practice with their actions. (Edwards, 2016)*

That practices are *historically constructed* can mean that the form they now take has been shaped over generations of struggle, experimentation, and apprenticeship. Even newly formed practices can only be built with the cultural-historical resources available from the past. *What matters* in a practice can involve personal motives, social norms, and the physical objects of the practice (such as a hockey puck or a science lab). These constituents are dialectically interconnected: they are iteratively *shaped by and shape* the practice through

contradictions, problems, and dramas, as punctuated by qualitative changes to the practice as a whole. That practices are *historically constructed* does not mean that they are out of our grasp or force us to conform to a tradition. In a living practice participants can *exercise personal agency*: every aspect of the practice is up for grabs (though not all at once). In MacIntyre's example, being a Jew in part involves engaging in practices to negotiate what being a Jew involves. The tradition is constantly being reinterpreted (Rouse, 2007a). New participants will need to be involved in a practice in ways that gradually increase their self-determination in contributing to it. MacIntyre calls these the "goods internal to that form of activity" (2013, p.187). A boy bribed by his grandfather to learn chess in order to get a chocolate bar is motivated by external goods[37]. When he learns to recognize a good opening he can move his chess pieces in pursuit of this internal good. His self-directed activity will align with the motives that shape the practice. Personal informatics can offer external goods, nudging the user to behaviour change, or they can scaffold users towards the internal goods of their practice. Logging experiences of living with multiple sclerosis on the *Trackly* app, a participant in Ayobi et al.'s (2020) study reflects,

> *"I kind of sat there, like what kind of face would I be pulling? It was like a visual cue to what I would say and what face I would show. If I would be describing to someone, like my husband, or if I would say to myself: how has the healthy eating been today?"*

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[37] There is some overlap here with the concepts of "intrinsic and extrinsic motivation" in self-determination theory (Ryan & Deci, 2000), but they describe individuals not practices. I may find watching football intrinsically motivating but the watching does not constitute football.

The tool supports her in negotiating the goods of managing multiple sclerosis as she

pursues those goods, on her own and with those around her. Practices are complex dynamic

structures involving multiple factors like these, organized around whatever is now at stake.

4 Meaning making and self-determination in social practice

Parts of this chapter have been published in (Potapov, 2021a, 2021b, Forthcoming).

Ethnomethodological and *discourse as practice* approaches to social practice offer rich accounts of the contexts in which users come to technologies and of some of the wider forces affecting their use. They challenge the traditional focus in HCI on instrumental outcomes of interactions. However, I have also argued that these dominant methodologies have significant limitations.

I have suggested that activity theory goes some way to address these limitations. I have also argued that the dominant strands of activity theory in HCI undervalue questions of meaning and individual experience. This motivates the present chapter in returning to the theoretical foundations of activity theory to explore richer ways of characterising these themes. I present a theoretical framework for a largely novel methodological approach in HCI.

4.1 A Vygotskian theory of interpretation

This sections brings together elements that characterise Vygotsky's theoretical framework, as framed around the interpretation of PI data. I situate Vygotsky's thought in a wider philosophical context, and particularly the German Idealist tradition from which he himself drew. I follow Derry (2013) in reading Vygotsky in light of Sellars and Brandom, and follow Deacon (1998) in reading him in light of Peirce. I draw on these figures to expand and

clarify Vygotsky's ideas in terms of what he ought to mean, by his own lights[38]. And in turn,

to make it easier to hold me accountable to what I ought to mean.

4.1.1 Sign mediation

A *sign* orients a *subject* in an *environment* to an *object* according to its *motive*.
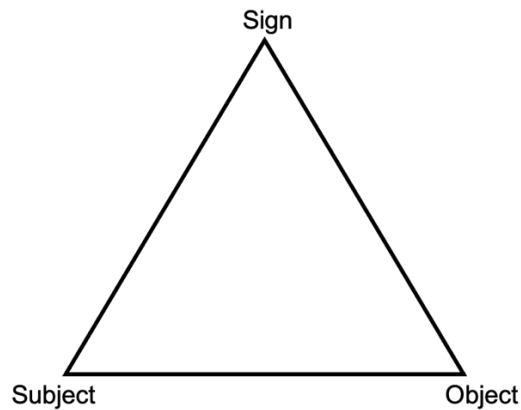
Figure 3: Vygotsky's sign mediation triangle (Vygotsky, 1997, p. 79)

Ripples on the water are a sign of fish in the lake to a heron. Although the fish is the

object of the heron's motive, it does not have unmediated access to fish: the ripples direct it

as to where to dive. At the same time, it is not the ripples, smell or shape of its prey which

motivate a predator, but the prey itself: the object satisfies or sustains the motive. Signs and

objects are tied in the animal's perception of the environment. Animal-sign systems have

evolved to promote behaviours conducive to the animal's survival. A baby seagull will be

more excited by two red lines drawn on a stick than the two dots that are a sign of its

mother's beak (Ramachandran & Seckel, 2012). The seagull cannot detach the sign from the

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[38] i.e. given the common genetic root from these philosophers to himself. For example, both Vygotsky and Sellars were influenced by Hegel, Cassirer and Gestalt psychology.

object to tell it's just a stick, not its mother. What we have so far been calling *a sign* can simply be called *a stimulus*. Though higher animals are more adaptive to states of the environment in pursuit of their motives, they are still bound to a limited repertoire of habits. By training a dog to salivate at the sound of a bell which had previously accompanied its food, Pavlov demonstrated that an animal could learn to respond to a new sign, but that this sign was still wholly tied to its object i.e., that this learning can be explained in terms of feedback loops of stimulus and response.

What is unique about humans is our ability to treat signs *as* signs.[39] In the words of Ilyenkov (Forthcoming), "The human being, and only the human being, immediately ceases to *merge* with the form of her life activity, separating it from itself and placing it before herself, that is, transforming it into representation". A *representation* is a sign interpreted within a particular activity, but we can treat the terms as synonymous for present purposes. I can stick a colourful float onto my fishing line to use as a sign that a fish is on my hook. Treating the sign *as* a sign means I can *select* my course of action. I can let the fish squirm on the hook. Signs let us direct our own activity. I can tie a knot in my handkerchief to remember the milk (Vygotsky, 1997, p. 50). I am here still exploiting a kind of response loop, but in being conscious of it, I am able to form a new relationship to it and subordinate it to new motives: "The use of an orienting sign disrupts the fusion of the sensory and the motor fields and introduces a certain functional barrier between the beginning and end point of the

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[39] Recent work in biological anthropology and developmental psychology has lent support to this thesis. Authors drawing on Vygotsky here include Deacon (1998); Carpendale and Lewis (2004); Tomasello (2019).

reaction, replacing the direct outflow of excitation into the motor sphere with preliminary

closures[40] with the help of higher mental systems" (Vygotsky, 1999, p.32). To put this in

Peircean language, "signals, if not automatically acted on, become suggested alternatives;

when elaborated, they become diagrams of possible action. Diagrams can be manipulated...

they can trace the probable consequences of alternative action" (Short, 2007, p. 147).

Returning home from work, I can use a visualization of my steps and active minutes on my

Fitbit app as a sign to mediate what route I select. I can elaborate that I should walk instead

of getting the bus if I want to hit 10,000 steps today.

Most of the signs that mediate our activity were not produced by us. A road sign may

alert me to be cautious of crossing deer. As we'll see, Vygotsky argues that any sign

mediating our decisions relies on social recognition. Navigating the signs that we find in our

everyday lives means being responsive to a vast network of implicit social norms. As Sellars

puts it, "Above the foundation of man's learned responses to environmental stimuli - let us

call this his *tied behavior* - there towers a superstructure of more or less developed systems

of rule-regulated symbol activity which constitutes man's intellectual vision." (Sellars, 1950) A

socially recognized sign can be given as a *reason*. Asked why I am fishing here, I can point at

the ripples on the water. Asked why I chose to walk home, I can refer to my Fitbit data.

Reasoning is what allows signs to support selection. I can select between signs in my

environment, reasoning that the ripples in the water are not a sign of fish because a chestnut

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[40] I read this as operational closure (Di Paolo, 2019)

just fell off a nearby branch. A reason is the schematisation of consequences: of what follows from what i.e. what is a sign of what.

While developmentally earlier sign use, as in learning to use a spoon, may be dominated by sensorimotor feedback loops, more advanced sign use, as in reading a book, presupposes the ability to be "oriented in the complex internal space that might be called a system of [sign] relations" (Vygotsky, 1997, p. 142). Sellars calls this the "space of reasons" (McDowell, 2004). It is a *space* because reasons can stand in logical relations to one-another that function independently from and are not reducible to the material relations in which they are instantiated. The fact that we are always in the *space of reasons* does not mean that *all practice is discourse* or that reason is decoupled from the material world.

A knot in a handkerchief lets me select my future actions (remembering the milk) by acting both as a physical stimulus and as a reason. In the words of Sellars, it is this "Janus-faced character" of sign use, "as belonging to both the causal order and the order of reasons" that frees us from being tied to our environment (Sellars, 1979, p. 130). Signs as *natural objects* direct affective-volitional responses to things in the world (Vygotsky, 2017, p.489) but as *discursive functions* they let us determine value and give justifications (ibid. p.183).

> *There is a genetic, but not a logical, contradiction between the claim that higher mental functions, an inseparable part of which is the use of signs, arise in the process of cooperation and social intercourse, and the other claim that these functions develop from primitive roots on a base of lower or elementary functions, that is, a contradiction between the sociogenesis of higher functions and their natural history. (Vygotsky, 1999, p. 10)*

The most important system of signs in which this dynamic is realised is still of course language. As should be clear if we've ever been moved by a poem, words have as much of an affective-volitional function as do handkerchief knots (Vygotsky, 2017, p. 51). This means that sign interpretation always involves my embodied relation to the world. Though having a reason may be thought of as following socially acquired rules, "the mode of existence of a rule is as a generalization written in flesh and blood, or nerve and sinew, rather than in pen and ink" (Sellars, 1950). Any explanation of the meaning of a sign will need to consider its function in concrete activity.

The elements introduced in this section allow us to define *self-determination*. Self-determination involves:

1. The selection of possible actions

2. In pursuit of a course of action and

3. The recognition of the action and its motive as one's own

These align respectively with *autonomy, competence* and *relatedness* in the Self-Determination Theory of mainstream psychology (Deci & Ryan, 2008)[41].

4.2 Representation and interpretation

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[41] And to the movements of Hegel's lord-bondsman dialectic. I will return to this point parenthetically in the general discussion.

This section will clarify a central claim of the present thesis: that the meaning of a data visualisation is not *given* by the visualisation itself. It will then advance an alternative theory: that meaning is formed as part of wider practices involving interpretation.

4.2.1 Meaning

The *meaning* of a sign is in the role it is performing in a social practice. For instance, 'dog' has a meaning within our linguistic community insofar as it can be correctly used in certain circumstances, like when referring to the animal that just bit me or the one I plan to walk after dinner. This doesn't equate "dog" with a universal signified like "real dogs"; instead, it focuses on how different concepts relate to each other through the ways they matter in everyday practices. This shift in perspective rejects the picture of meaning as a pre-existing link between words and things, opting instead for an understanding rooted in the dynamic interplay of signs within socially embedded activities. By interpreting a sign, I place it in a system of concepts i.e. I link it to my existing knowledge or grasp of the situation.

> *In characterizing an episode or a state as that of knowing, we are not giving an empirical description of that episode or state; we are placing it in the logical space of reasons, of justifying and being able to justify what one says* (Sellars, 1956).

Meanings involve mutually recognised entitlements and commitments. A two-year-old's shout of "Fire!" does not mean much to those around her. Nothing else follows from it. If we ask her what she means by it, she is unlikely to be able to offer us justifications. Meanwhile, a twelve-year-old's shout of "Fire!" can be recognised as having implications that might mean checking for smoke and getting out of the house (Derry, 2013, p.2). My Fitbit notification has a meaning insofar as I draw implications from it; it could mean that I have walked enough

today and can get the bus home. To commit to a meaning is to also commit to its implications – it is something others can hold me to, whether or not I'm aware of the implications (Brandom, 2007). If a friend discovers that my Fitbit has been counting two steps for every one I take, I will have to reinterpret my data as meaning I haven't walked as much as I intended. We can also say that a meaning expresses an orientation or a course of possible action in the world.

4.2.2 **Representation**

Sellars describes the belief that objects can directly imprint knowledge of themselves onto our intellect as "The Myth of the Given" (McDowell, 2008). The claim here concerns reasoning. It is not being claimed that things-in-themselves are outside of my experience. I cannot perceive the card-table unmediated by my concepts of card-tables, but no concepts will ever subsume the table itself: the new things I can notice about the real table always exceed the concepts I now have of it (Vygotsky, 2017, p.136). We may think of a concept as an internalized sign: one which by habit serves as a reason.

Sellars introduced "The Myth of the Given" as part of a critique of empiricism, and this is how it was used in my discussion of ethnomethodology. However, there is a broader Hegelian message here which is just as useful. It's an important aspect of our dealing with the world that "red" just means "stop" at the traffic lights, without the need for further inference. But the immediacy and self-evident meaning of the red light conceals its history. Both I and my culture had to develop and adapt to this meaning. The light may fail to voice this meaning to someone from another culture or a child. Interpretation involves a process of conceptual development. When we take the meaning of a sign to be self-evident, we use

whatever existing concepts are at hand, and these may not always best serve the differentiation process. To say that concepts support interpretation is to say that they help us identify differences within data and to assign values to these differences. After a difficult process of inference and social feedback, doctors just *see* kinds of fractures on an x-ray and physicists just see mu-meson subatomic particles in a cloud chamber as given (Brandom, 2002). Without this sustained engagement, the representations fail to represent.

Concepts are formed through my experience of division and contradiction in my engagement with the world, as mediated by how it already matters in my culture. We can borrow a helpful analogy from Goodwin (1994, pp.394-395) here:

> *Features [of an archaeological site] can be difficult to see. In order to make them visible to others, the archaeologist outlines them by drawing a line in the dirt with a trowel. By doing this the archaeologist establishes a figure in what is quite literally a very amorphous ground. As a visible annotation of the earth, it becomes a public event that can guide the perception of others while further reifying the object that the archaeologist proposes to be visible in the color patterning in the dirt. The perceptual field provided by the dirt is enhanced in a work-relevant way by human action on it. Through such highlighting and the subsequent digging that it will help to organize, the archaeologist discursively shapes from the materials provided by the earth the phenomenal objects that are the concerns of his or her profession.*

Personal informatics data, like dirt at the archaeological site, can take on contours of meaning through an autonomous social practice[42]. For instance, Lee et al. (2021) describe

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[42] See my discussion of activity theory for a definition of such a practice.

how school children reflecting on movement data come to see it as meaningful by exchanging conflicting interpretations of what was significant about it, as mediated by their understanding of the rules of Four Square and their perception of who did what during the game. The data points on the visualisation, like a trowel line in the dirt, helped to develop the children's concepts of their own play. This applies as much to less obviously immediate and enacted data. For instance, in the case of artists reflecting on their artistic practice through data that included their mood throughout the week (Berdugo & Nicely, 2019). For the things we perceive to convey any meaning we need to already possess relevant concepts by which they can make a difference in our practices (MacIntyre, 1992).

To say that the meaning of a representation is not given is to say that interpretation is an activity we should think of developmentally. Representations and interpretations turn from one to the other through an ongoing dialectical process (Ilyenkov, 2013).

I will use three widely recognized categories of Peirce's semiotics (icon/index/symbol) to describe this process[43]. The aim here is to highlight the dynamics of qualitatively different activities involved in the process of representation and interpretation.

Iconic

Every representation exists in a context of social activities and comes to perform the function of representing through our enculturation in those activities (Vygotsky, 1997, pp.

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[43] Vygotsky uses all three terms in this way but not in this systematic way. His focus is on what Peirce calls *legisigns*: socially formed signs.

135 - 140). That a picture of her doll is *of her doll* is something Vygotsky suggests a child has to learn (ibid.). An example cited by Goodman makes a similar point:

> *More than one ethnographer has reported the experience of showing a clear photograph of a house, a person, a familiar landscape to people living in a culture innocent of any knowledge of photography, and to have the picture held at all possible angles, or turned over for an inspection of its blank back, as the native tried to interpret this meaningless arrangement of varying shades of grey on a piece of paper. (Goodman, 1976, p. 15).*

When a child is developing the ability to use signs in their culture, what is important is not the correlation between signifier and signified but the expression of a move in a broader game or activity.

> *[A] child wanted to show in a drawing how it gets dark when the curtains are closed and he made a forceful line down on the board as if he was drawing a window shade. The drawing movement did not signify a cord, but expressed specifically the movement of drawing a curtain (Op. Cit.).*

The movement here is iconic i.e. it bears some spatiotemporal homomorphy with what it represents. Vygotsky suggests that even the drawing of a picture should first be understood in terms of communicative functions rather than signified objects.

Indexical

Indices are tied to some aspect of the world towards which activity is directed. According to Vygotsky, as the child develops mastery of signs, she moves from expressing intentions in direct action to locating them in a "course of action" tied to her environment, for example in assigning different household objects to function as different buildings of a town. A clock

can represent a pharmacy for a child not because it looks like a pharmacy but because it is able to embody the child's intentions in pretend play e.g., she can walk the doll from the 'fire station' to the 'pharmacy'. The child "isolates one of the characteristics of the object that indicates [what it] must represent" (ibid.) and when a new course of action emerges (e.g. a new game) the sign keeps some sense of what it indexed but loses its wider meaning.

Symbolic

Symbols represent types or universals. The symbol does not depend on the physical properties of what it represents but only on its social recognition. For example, a trophy, a logo, musical notation, or the words on this page. At this stage the courses of action are reified or crystalized in the sign. In a new game the child can grab the clock to mean "pharmacy" when her friend in the role play is ill, though the connection to the activity through which it was baptised a "pharmacy" may be forgotten. Here, the external sign is internalized: that to which the sign was orienting the child, he can now do by habit. This allows a lot in the activity to be taken as given. The child can shout, "The cowboy is getting away!" without telling her friends that the stick is a horse and the boy is riding the horse away from them.

There is nothing inherent in an object that makes it iconic rather than indexical or symbolic, and indeed every experience involves a combination of all three. The distinction depends on what is salient within an activity. Play is by nature repetitious as well as explorative (Singer, 1994). Playing the game reproduces the conditions for properties of the object, like the shape, length, and hardness of the stick (but not its colour), to have the affordances it has in the game situation. But for the stick to be a horse in the game involves

normative commitments unrelated to its properties as a stick. For example, the horse could be fast, brave, or in need of feeding. This symbolic meaning functions in a system of social relations that is distinct from the iconic and indexical systems on which it relies (Brassier, 2016).

Practices involve recognition of signs: a checkmate in a game of chess or a hug at a party direct ongoing practice at *intra* and *inter*-personal levels. They embody what can be done and what it is right to do. A practice is sustained through repeated interpretations and appropriations of signs, as they mediate motivated activity.

4.2.3 Present and Ideal Form

Interpretation can occur in social situations where participants have varying relations to shared signs . This allows social relations in such situations to support development. This developmental perspective is something that Vygotsky can offer to Peirce and Sellars: an account of how symbolic activity develops. Learning is possible because teacher and learner can share the same sign and the teacher can shape the learner's activity with respect to the sign indexically and iconically (*it's like this*) so that they are better oriented to grasp it symbolically.

One way in which Vygotsky analyses this process is through the concepts of *ideal* (or final) and *present* forms of an activity. On introducing a child to Van Gogh's painting "*Starry Night*" or to Frost's poem "*Stopping By Woods on a Snowy Evening*", the artworks are likely to be happy in their present form but dark and sad in their ideal form. Right now with the limited concepts and habits she has, a child is likely to interpret them as happy, but after a learning process a good teacher can bring them into seeing the same artworks in a new way.

The form of the activity is not "ideal" in the sense of "perfect" but in the sense that it is a socially recognised course of possible action that can guide development. A learner who can recognise that the artworks are sad is likely to be able to do more than one who can't and to have situated their experience within a relevant domain of knowledge.

Of course, the behaviour of calling the poem sad is not sufficient evidence of development. A student may learn to index this poem as sad; this phrase as a metaphor for isolation, but to grasp the poem's meaning is to develop the capacities to *find* it sad. To develop these capacities is to expand the learner's repertoire for how things in the world can be, so that walking through the woods themselves, they might remember the poem and see the dark grove with that particular kind of sadness.

The ideal form develops over the history of an activity. The example of the painting and poem is deceptive because the ideal form is not just in a physical artefact but in the form of the activity in which it functions (Ilyenkov, 2012). Vygotsky gives the example of how language is an ideal form for a child at home with deaf parents versus the form it takes in talk at the child's school. Vygotsky's famous concept of the *Zone of Proximal Development* describes the difference between the present and ideal form: between what the child has the ability to do and see alone, and what she can do with the help of someone more sensitive to an ideal form of the activity.

4.2.4 Everyday and scientific concepts

Though all learning involves the development of concepts, concepts may develop via distinct routes. Vygotsky employs a helpful heuristic here.

An *everyday concept* is one we hold unreflectively. These concepts are used indexically in everyday activity without themselves being the object of deliberation. A child may use "rose" and "flower" independently to refer to things in her garden before she learns to think of roses as flowers (Vygotsky, 1987b, p. 163). The two concepts can exist in an eclectic mix of capacities for dealing with the immediate situation. A child who can only use everyday concepts cannot explain, '*That is not what I meant!*': she cannot yet separate the particulars of what she perceives and feels from her own words and attitudes.

A *scientific concept* systematizes everyday concepts: it locates concepts within a wider *knowledge domain*. A knowledge domain is formed through the discourse in a practice. It is in what we take as a reason for what in the practice. For example, playing a game with friends, I might regroup to discuss *strategy*. The *scientific concept* of "strategy" makes sense in relation to other concepts in the practice, developed through the history of that practice. The *scientific concept* helps us orient each-other to aspects of the practice: it helps us see the right thing to do. By performing this kind of triangulation with others, we can later perform it by ourselves. This means that discourse is a key, if not essential, method for developing *scientific concepts*.

However, Vygotsky also highlights the dangers of focusing solely on *scientific concepts. Scientific concepts* are not better than and do not merely supersede *everyday concepts.* If *scientific concepts* are not grounded in *everyday concepts* and the life activity of the child, they can separate us from reality instead of helping us grasp it. Vygotsky gives the example of a child asked to discuss the Russian civil war. The student is able to elaborate that "Serfs were peasants who were the property of the landowners", but when asked what that was like

for the serfs, he suggests they had a great time. The student initially gives the teacher the right answer according to a kind of learned script, without grasping the everyday implications (Vygotsky, 1987b, p. 218). Here, it is the *scientific concept* which acts purely indexically.

Scientific concepts allow us to make meaningful distinctions in our experience: I could stand and look at a rose, then realise it is a carnation. They make self-reflection possible by letting us hold aspects of our experience as the objects of our own deliberation. We might think of Moliere's character who realises he has been speaking prose his whole life. Our *everyday concepts* may have once been *scientific concepts:* for example, it would be impossible to explain to a toddler or a medieval peasant that I am going for a run. Indeed, once I have acquired relevant scientific concepts, the same word can be used in more *everyday* or *scientific* ways over the course of a conversation. In therapy, a therapist may repeat something I said back to me to encourage me to approach it *scientifically*. This dynamic is explored more fully in the next section.

4.3 Perezhivanie

Analyses of meaning and development cannot be conducted purely at the level of sign-meaning. Later in his life Vygotsky introduced an additional unit of analysis to account for the ways that our interpretations depend on and shape our identity and subjective experience.

Critiquing his earlier work with Leontiev, Vygotsky stresses that we ought to be able to distinguish between the meaning of a knot in a handkerchief and the meaning of a diary to an adolescent (Vygotsky, 2017, p.274). While both are signs/tools by which we can orient our environment, we should distinguish between their ability to facilitate autonomy and transformation within a particular task and within our lives as a whole. The latter sort of meaning interpretation can implicate the whole of our identity and personality i.e. they can have consequences in framing our sense of ourselves, not just our present task.[44]

Though it is shaped in part by factors like hereditary traits and historically available social roles, *personality* for Vygotsky is always developing (Vygotsky, 1994b). This development occurs through significant episodes of lived experience or *perezhivanie*. Current literature on Vygotsky has used the untranslated Russian term because of the particular use that Vygotsky makes of this common word. *Perezhivanie* is a recursive process through which one's stance on the world is changed, in turn changing ourselves. The dynamic may be put in Hegelian form:

> *Our actions and identities manifest our "internalization" of the past (Er-Innerung), the way it has shaped us, as well as our "recollection" of the past (Er-Innerung), our self-orientation in relation to it. (Suther, Forthcoming)*

Vygotsky wanted to highlight the uniqueness of an individual's interpretation of a situation and the uniqueness of every individual's development as a result of this

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[44] These two words are an approximation of the Russian word личность (*lichnost).*

interpretation. This "interpretation" is not just about engaging in reasoning but also about the value imbued in the world by our emotions. The play of these dynamics in specific situations, Vygotsky called *drama*.

Vygotsky makes fun of prevailing Soviet psychology for assuming it can just describe external context and the work of those within it and derive conclusions about a child from "the number of times he visits the public baths and how many newspapers his father reads" (Vygotsky, 2021). For Vygotsky, such contextual information must constantly be recalibrated to the child's own grasp and embodiment of these factors.

> *The perezhivanie arising from any situation or from any aspect of [a child's] environment, determines what kind of influence this situation or this environment will have on the child. Therefore, it is not any of the factors themselves (if taken without the reference of the child) which determine how they will influence the future course of his development, but the same factors refracted through the prism of the child's perezhivanie. (Vygotsky, 1994b pp. 338-339)[45].*

Vygotsky is foregrounding the need to account for subjectivity and individuation in any process of learning or social development. Having introduced an account of the *ideal and present forms* of activities, we can turn to another way to define the dynamic in play here:

> *Perezhivanie is a prism which refracts influences of social environment on child's development through interactions of ideal and present forms [which can lead to]*

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[45] Vygotsky is in part drawing on Lewin. Lewin's ideas here are more familiar in HCI through their development by JJ Gibson in his theory of the ecological niche and affordances. This is not to endorse Gibson's reading. Lewin and Koffka's ideas are valuable in their own right (Kiverstein et al., 2021).

qualitative changes to child's mental functions and therefore might bring changes to

how the child becomes aware, interprets and relates to sociocultural environment.

(Veresov, 2017, p.68)

For example, someone undergoing cognitive behavioural therapy might regularly have

the *perezhivanie* that they are having a stroke. Their therapist can tell them that they should

instead interpret this experience by saying "I am anxious that I am having a stroke", thus

externalising their experience as a sign to work on. Their perezhivanie changed not when

they acquire the knowledge that they should call their experience something else but when

they immediately interpret it as "I am anxious that I am having a stroke" (widely known as

Theory A/ Theory B framing (Sighvatsson et al., 2021; Wells, 2011)). *Perezhivanie* therefore

involves projection into the future as well as reflection on the past.

4.3.1   **Perezhivanie and sign mediation**

Drawing on Freud and Aristotle, Vygotsky uses an example from Chekhov's *Cherry*

Orchard to consider how a play affects an audience (Vygotsky, 1974). Vygotsky asks why the

sale of the cherry orchard is such a terrible misfortune for the rich Ravenskaya. "Perhaps she

lives permanently in this cherry orchard. But then we learn that she spends her entire life

traveling abroad and that she never could or would be able to live on her estate. Perhaps the

sale could mean ruin or bankruptcy for her, but this motive falls away, too, because it is not

the need of money that places her in the dramatic situation." Indeed, there is no *instrumental*

explanation for the value of this artefact. The selling of the cherry orchard plays a role in a

symbolic order familiar to Ravenskaya and Chekhov's audience. The play works because we

invest the cherry orchard with a meaning beyond that directly given in its present material

form, as land or real estate:

> *"The melancholy of Chekhov's [characters] becomes the emotion of the whole audience because it was to a large degree a crystallized formulation of the attitude of [wider] social circles..." (Vygotsky, 1999, p. 241)*

The cherry orchard helps scaffold what neither we nor Ravenskaya can yet fully grasp: the impact of the contradictions at the heart of being a member of the Russian intelligentsia at the start of the 20th Century. Yet the example can also highlight that there is something unique about our own experiences within this ideal form; something we each bring to it. Perhaps the cherry orchard evokes some childhood image of white blossom, the smell of cherry, a painful loss[46].

Aristotelian psychoanalyst Jonathan Lear describes a client who happened to leave the door of Lear's office slightly ajar at the start of their session. Over the course of his sessions with Lear, the door started to take on a host of meanings:

> *"Leaving the door ajar meant that nothing he was going to say was going to be so important or private that it should not be heard by someone outside. He longed for us to be working together on a collaborative project, and if we both closed the door, we were a team. My noticing that he left the door ajar meant that I was sensitive." (Lear, 1998, p.x)*

The door here mediates the drama between real people rather than actors. It was appropriated into the situation to express wider ideas appropriate to the roles of analyst and

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[46] This initial characterization may imply that the *ideal form* regulates us while remaining beyond our grasp, like the phenomenological concept of *background* or Bourdieu's *habitus*. Vygotsky departs from these regularist (Rouse, 2007b) theories of social practice. As he clarifies, the *ideal form* of an activity is grasped in reciprocal action (Vygotsky, 1994).

client. This process gave the client new concepts with which to grasp experiences outside therapy.

Commenting on Freud's treatment for Little Hans' horse phobia, Lear suggests, "*Freud is... giving Hans a set of concepts with which to think about his wishes. This does more than enable Hans to conceive of a reality that existed in toto antecedently to his newfound ability: it enables him to conceptualize his wishes in a certain way. The wishes themselves absorb this conceptualization and thus enter into commerce with secondary-process thinking.*"[47] (ibid, p. 113).

Vygotsky refers to such dynamics as "perezhivanie". Veresov explains perezhivanie in terms of the "dialectic between present and ideal forms" (Veresov, 2017)[48]. Lear traces a similar dynamic in Freud's "dialectic between loss and love"[49] [ibid, p. 160].

> *Psychic structure can continue to develop because the world outstrips my ability to appreciate it. As I develop complexity, so does the world as it exists for me. The internalization of structure can thus continue at ever higher levels of complexity and refinement... what were once taken to be forces of nature, I now recognize as my own active mind. [ibid, p.177]*

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[47] Conversely, (in clinical observations) Vygotsky suggests the consequences of *lacking* such concepts: "There are no concepts and there is no mastery of the self, i.e., emotionally there is the drive to get out, but refracted through the prism of a complex and not a concept, without understanding himself, in the dark, in the twilight of consciousness..." (Vygotsky, 2017, p.194)

[48] Veresov gives an authoritative explanation of *perezhivanie*. This concept has gained recent prominence in research.

[49] Vygotsky himself draws this parallel after a lecture by Vera Schmidt. (Vygotsky, 2017, p.391)

As Lear (1998, p. 177) describes it, the developmental process by which we invest the world with meaning means that "what were once taken to be forces of nature, I now recognize as my own active mind." Against the Freudian focus on "active mind", it should be stressed that for Vygotsky we transform our world in concrete activity rather than in thought: in Vygotsky's materialist phrasing, "what results is a certain form of activity which then becomes a child's internal asset, his property and a function of his personality (Vygotsky, 1994b, pp. 338 - 354)".

The client has to do work in psychoanalysis to grasp adequate reasons. As Lear discusses, the psychoanalyst cannot simply tell the client the reason she is always getting fired is that she is scared of her father. She would laugh at the absurdity. Her reasons can only function as part of a system of other reasons tentatively interacting with a plane of emotions, as the client gradually develops abilities to feel her emotions in a more self-regulated way. This recognition involves taking actions and motives that on reflection I find were mine all along and situating them in a more adequate network of reasons.

For Vygotsky, this is the process by which humans actualise freedom (Vygotsky, 1997, p.209). According to Sévérac, *"Perezhivanie is [the] cognitive and emotional modification through which the power of the milieu is expressed in the individual, or provides direction for the very power of this individual"* (Sévérac, 2017). Perezhivanie arises in dramatic situations – the intensity of a situation; how much it matters to the people experiencing it; develops the extent of its influence on development.

Perezhivanie is a valuable concept for researchers and educators because, "through

perezhivanie, we are able to understand the relationship between an individual's

consciousness and the environment, and the ways in which this changes with development."

(Veresov & Mok, 2018) Learning stands us in a new relationship to our environment

(Engeström, 2014); learning changes our range of responses with respect to the same stimuli.

Learning that fully implicates perezhivanie lets me stand in a new relation to my past

experiences and emotions, changing the nature of who I am. Objects can scaffold this

process. Just as a map can help me navigate an unknown city, an old diary entry can help me

navigate an unexpected breakup. Objects can support us in our deepest and most significant

experiences.

The introduction of *perezhivanie* to HCI can contribute to work shifting the focus of

design from utility to personal meaning (Mekler & Hornbæk, 2019; Kaptelinin, 2018; Kappler

et al., 2018). It bridges the gap between instances of operationalized meaning attribution like

"This notification means I've walked 10,000 steps", and evaluations of meaning affectively

tied to my sense of who I am, like "I've walked 10,000 steps, which means I'm on the road to

recovery". *Perezhivanie* as a theoretical tool, contributes to a stream in activity theory

pursuing affective, developmental and emancipatory objectives (Brown et al., 2012;

Karanasios, 2014; Lee & Sparks, 2014; Ssozi-Mugarura et al, 2016). This theoretical tool can

support accounts of user interaction that spread across multiple spheres of experience

(Peters et al., 2018), from social influences on the user to the user's interface with individual

technological tools. This versatility allows for fine-grained analysis of the process of adopting

and using a tool.

The present thesis focuses on personal informatics tools and data visualisations as objects that can mediate student understanding of their situation. In taking up *perezhivanie* as a unit of analysis, I adopt a more expansive view of what such an object can *mean*: considering expressions of emotion, perspectival shifts and moments of drama as well as rational abstractions of meaning. Returning to Vygotsky's geological imagery, the discourses in which students will interpret their data are grounded on layers of experience. The acts of narration may themselves form experiences that lead to later changes in how the object is interpreted, and the object's power in mediating the participant's relations to their environment in and beyond the study.

The empirical chapters to follow aim to demonstrate that deep prior theorisation of the kind offered in the preceding two chapters can help us see things that have been overlooked in prior work in personal informatics. Instead of mapping concepts from the present chapter directly to study data, I will draw on them as heuristics. They inform study design as well as data collection and analysis.

5 Framing of empirical work

The last two chapters presented a theoretical framework for personal informatics. I first argue for the importance of theory in conducting empirical work in HCI. At the same time, I argue this work should be situated in concrete social practice. I advance an understanding of social practice drawn from cultural historical activity theory, and supplement this with a finer-grained focus on individual processes of interpretation, drawn from the work of Vygotsky. I position personal informatics data as "signs": nodes in the activity that express and enable the motives of its participants. Within our practice, we can appropriate data indexically (to point to what is relevant) and symbolically (to challenge, justify, or pose alternatives). Data can scaffold social interaction, and learning (as two moments of the same process), orienting participants to what they cannot yet grasp. I emphasize that data is normative: it crystalizes and explicates what is good, right, and relevant in the practice. This means that data is situated within particular forms of life, in particular contexts, and that its meaning develops through the social interactions in these contexts. I suggest that empirical work in PI should focus on such "dramatic situations" and on the discourses through which this drama unfolds. PI tools and data can serve as joint objects of attention for interlocutors to share meaning. I focus on meaning-making as the mechanism for learning, exploring how individuals internalize meaning for everyday use. This "use" can be purely instrumental, or, particularly for teenagers, formative of our identities, experiences, and how we relate to the world. These theoretical commitments inform the empirical research presented in the rest of the thesis; they shape how studies were planned and executed, as well as the analysis of study findings.

The present chapter briefly contextualises the empirical work in the rest of the thesis. In the first section, I reflect on the study context, the genealogy of the thesis, and my positionality as a researcher. The second section outlines the planned empirical work, and foregrounds key choices in study design and approach to research; these are justified with ties to cultural historical activity theory. The final section explores the ethical dimensions and challenges of the research, including how ethical approval was obtained, and issues and strategies which emerged during the studies.

5.1 Context for empirical work

The empirical work in this thesis was carried out at two secondary comprehensive schools in London, UK. I was working as a teacher at one of the schools, and contacted the other through my professional network. The participants were Year 8 to Year 13 students at the schools and the studies were conducted in classrooms and other school spaces. When the work began, I had been an English teacher for six years, and I continued to teach throughout data collection. My role in the school posed some complexities. Though I did not recruit participants from the classes I was teaching, the pupils at my school knew me well as a teacher. This posed a challenge as students may have felt pressured to participate or not to withdraw. I tried to limit this risk by making explicit that my role as researcher was different from my role as teacher: that they should only participate if they are truly interested and that they could withdraw at any time with no punishment and without giving a reason. It was also important to explain what withdrawing during a study session would involve, and ensuring this can happen with minimum disruption e.g. avoiding times when a participant would have to disrupt a class to return to lessons. At the same time, some students and parents arguably

found it easier to discuss the studies and raise concerns with me than they would have with an unknown university researcher. Another limitation of my role as teacher was in the extent to which participants shaped their responses to meet my expectations. They may have restricted their speech in certain ways or employed certain talk genres because of existing student–teacher dynamics. Though I tried strategies like getting participants to call me by my first name in studies or using phrases like "with my teacher hat on", the roles were difficult to keep separated. Because of my research, the schools wanted me to teach topics like online safety and using technology for revision, and to support extracurricular activities involving technology. These experiences in turn came to shape my research. Where problems arose, my role as a teacher always took priority i.e., supporting the education and wellbeing of students above research aims.

My teaching role also afforded several advantages. I was exploring interventions which school staff could use with students, and, as in action research (Kane & Chimwayange, 2014). I could draw on my own experience as someone embedded in this context. I understood how schools worked and had a good sense of what would work in them. I understood the priorities of teachers and management and whether what I was proposing could be adopted in schools. I knew what was likely to engage students and how to support and check their understanding. The interpretation of personal informatics data turned out to have useful parallels with the interpretation of poems. I had extensive experience in questioning students and supporting group discussion. My pastoral experience was also important across each study. I was able to maintain a good relationship with participants and be sensitive to their

needs e.g., checking in with them outside the study session about something they might have found upsetting.

However, these advantages are in another sense limitations. It is unclear if the approaches I take in this empirical work could be adopted by researchers without this level of teaching experience. At a minimum, it suggests HCI researchers should collaborate with school staff. Equally, the research raises questions about how the strategies I recommend can be adopted by school staff with less understanding of technology and familiarity with PI.

5.2 Outline of empirical work

The course of the present thesis changed significantly during the PhD. I initially planned to conduct an explorative study of how personal informatics could support learning, and then to focus on PI for academic coaching. I was interested in how PI could be used in a goal-setting intervention called *mental contrasting with implementation intentions*, and whether PI data could help improve other forms of "metacognition". As I began to pilot this work, I was frustrated to find that teenagers were largely uninterested in improving their metacognition or increasing their productivity. At around this time I saw a lunchtime club working on their entry for the Longitude Explorer Prize; they were designing an IoT technology to support teen mental health. I heard many of the same students talk with passion about the role of technology in their emotional experiences. Though I felt there was something important here, it did not fall within the scope of my thesis. However, over time the work of the club came to form the heart of the whole thesis: it led me to reconceive the thesis plans and objectives. It took a long time to grasp that what interested me here was precisely students' talk about their experiences with technology. Struggling to find a

framework in HCI that could help me articulate my observations, I remembered Vygotsky from my teacher training, and that he said talk supported learning. I began to read Vygotsky's work and the philosophy that informed it. The structure of the present thesis is the outcome of a long dialectical process.

The focus of the empirical work is on social practices as dynamic phenomena. The approach is interventionist as well as constructivist: allowing participants to lead study design, as well as designing with the aim of supporting their practices. As in *research through design,* study design and outcomes are not prescribed at the outset but develop iteratively to accommodate the needs of participants in the contexts under study (Zimmerman et al., 2007). Concepts, activities, and artefacts emerging from earlier studies inform later studies. I suggest that what participants learn in interpreting their PI practice and data develops over time, as they acquire new concepts and skills of interpretation. The meaning of data develops in particular situations, and across wider timescales beyond them. To trace this development, the work is longitudinal and conducted across multiple sessions.

In contrast to more "in the wild" approaches to personal informatics, I intentionally prime participants with relevant concepts with which to see available actions and reflect on their experience. Following Vygotskian conventions, participants learn these concepts in small-group activities and discussions, prior to independent self-tracking.

The empirical work in the next four chapters follow Vygotsky's fundamental question: how do sign-meanings develop?

Study 1: Exploring how teens can use personal informatics tools

Study 2: Co-design of a personal informatics tool for teens

Study 3: Implementing personal informatics for group-based sleep education

Study 4: Implementing informatics for one-to-one mentoring

In activity theory research begins by studying the **motives** of people acting in a loosely shared context: what concerns or problems do they have and how do these materialise in their interactions with others and the social norms to which they are bound? (Engestrom, 2000) The purpose of this interventionist research is to support the **self-determination** of participants in the motives that matter to them. The first study thus seeks to understand concerns and motives of teens in the loose context of exploring factors affecting their school learning. This work is constructivist on the one hand, because it demonstrates whether allowing teens to define the means and outcomes of PI increases their sense of self-determination, and the kinds of meaning they draw from their practice, and on the other hand, because the concerns they raise will inform later studies. Drawing on the preceding chapter, I suggest that motives are often not well understood at the outset of an activity and will develop over its course. I argue that signs (such as PI data) can **reify these activities / crystallize these motives** in ways that help participants reflect on them.

I interview participants about their practices because being called to justify or narrate their actions explicates the **normative** frames that structure them, and according to which they find them meaningful. That is, I explore how PI mediates participant explanations of what is good, right, and relevant in their everyday practice. The emphasis here is not merely on the instrumental ends to which PI is applied, but also the **perezhivanie** in which the data is active. Whether PI can support wider processes of self-determination is in part examined in

data analysis through the extent to which participants have **internalized** concepts and activities from PI to everyday situations they find significant.

Activity theory develops **scaffolding** to support groups in addressing their concerns and problems. It is important here for participants to contribute to the design of this scaffolding, so that it is shaped by and concurrent with the motives it will support. The second study gives a group of teens the freedom to design their own personal informatics app. This work assumes that helping teens act together with common motives lets them **negotiate and explicate** goods, values or ideals of their practice. Teen descriptions of the artefacts they create are used to clarify the norms crystallized in these artefacts. I offer details of the activity itself to contextualise how these artefacts were created.

This study emphasizes the social nature of data interpretation and suggests ways in which its meaning is a **function in a social practice**. The design work emphasizes how data visualizations form **systems of signs** which can be drawn on to express and adapt meanings.

The third study in the thesis tests the scaffolding developed in the second study in a practical context: a session to teach teens about sleep hygiene. This scaffolding includes both the app designed by the participants of the previous study and the social practices of interpretation modelled in their design. It is also informed by the first study's development of scaffolding sessions to introduce and frame self-tracking. By situating this work in social emotional learning about sleep hygiene I can investigate the role of personal informatics in a context in which learning should develop towards an ideal form; following Vygotsky, I attempt to facilitate learners' own progress towards this ideal form (and to equally have it

clarified to myself through this process) rather than simply transferring prepackaged

knowledge. I choose to conduct this study through peer group discussion to analyse the

discourse in which the meaning of data is negotiated. I propose that such teacher-facilitated

discussions between peers can create a **zone of proximal development** in which the

multiple interpretations of data reveal opportunities in the practice and support normative

reflection. Data is displayed on the board as a shared object of inquiry to support such

reasoning. I have argued that the deliberative talk between participants in a practice is a key

process and method by which meaning develops and scientific concepts are formed. This

thesis thus foregrounds participant discourse. This again is *discourse*, not in Foucault's sense

of social structure/mechanism, but in the sense of the talk[50] participants engage in in

pursuing their motives and justifying their actions.

I interview each participant to explore how this deliberative practice supported relevant

learning as the meaning making in the session developed individual's own concepts. My

analysis focuses on the discourse in **dramatic situations** in the study sessions in which the

meaning of data is enacted. I retrace this learning process as a dynamic of **everyday and**

scientific concepts by focusing on the collateral commitments of interlocutors' data

interpretations and the anaphoric chains by which other participants pick up terms already

introduced into the discourse. The study seeks to move beyond the instrumental learning of

curriculum content to the learning involved in teens' identity development.

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[50] Vygotsky's "речь" (*rech)* has this more everyday meaning.

The fourth study again focuses on the implementation of personal informatics in a real practical context. I present the case study in this chapter and the last having argued that the particular social contexts in which personal data interpretation takes place can productively constrain and structure the process of interpretation through the situated norms and affordances. The focus on academic mentoring allows me to explore an alternative practice and dynamic of discourse. The study follows the mentoring process across multiple weeks and sessions. I focus on the multiple roles of PI in structuring the discourse and practice: the narratives in which teens cast their own lives. This also allows a sharper focus on teens' **perezhivanie** i.e. the ways in which the experiences they engage in and reflect on in mentoring contribute to their wider stance on / experience of the world. Discourse analysis allows me to explore how the **meaning of data develops** through the multiple interpretations of multiple actors, through its role in the drama, and over wider timescales as learners acquire new concepts. Developing findings from the first study, I explore how PI tools and data help to **externalise** concerns in teens' everyday lives.

5.3 Ethical considerations

A strong approach to research ethics is key to the kind of work presented in this thesis. Teenagers are a vulnerable population and working with them presents unique challenges. The presentation of teenagers may resemble that of adults and can mask some of their vulnerabilities. Teenagers can increasingly make choices about their own lives but can also open themselves up to risks. HCI work with teens needs to engage in a lot of groundwork before inviting them to participate in studies (McKellar & Toth, 2016). The planned work went through extensive review and was approved by a university research ethics committee.

I ensured that schools where the studies took place understood and actively informed the research. I sought permission from the schools in a meeting with the headteacher of one, and the deputy head of the other before each study. In these meetings, I explained the aims of the study, the study protocol, and my proposed methods for recruiting students and acquiring consent. there was no incentive for taking part in the studies. I also had meetings with the relevant staff in the specific contexts I was investigating. For example, before the third and fourth study, I consulted the two teachers at the school responsible for Relationship, Sex and Health Education. They gave helpful feedback on study plans and resources. I also had an extended meeting with a school counsellor to consider possible risks of the research for participant wellbeing.

In my role as a teacher, I participated in annual safeguarding and child protection training, with modules such as online harassment and FGM. I had enhanced DBS checks and understood how my own conduct was regulated and supported through statutory frameworks like Keeping Children Safe in Education. I also had diverse practical experience of dealing with safeguarding concerns. I was well equipped to identify risks and concerns that arose during a study, and knew the systems to call on for additional support outside the study setting.

Teen and parent motives for taking part in research may not align. A parent may want their child to take part without their own full agreement. Additionally, a teen may not fully understand or have misconceptions about the study. Participants in the thesis joined studies by receiving information sheets directed to them and by returning forms of parental consent as well as their own assent. Participants were not offered an incentive for participation to

prevent undue pressure from this. Before every study I invited participants to a short briefing to explain what it meant to be in a study, my role as a researcher, details of the study, and how they could withdraw.

My recruitment process attempted to balance inclusivity in allowing young people to access the study opportunities with an awareness of those for whom the study may pose additional risks, for instance because of mental illness, or because their behaviour was likely to create risks for others. I spoke to form tutors and heads of year about the needs of their students and pooled participants from groups without students who were known to be at risk. Beyond this, I attempted to differentiate for the needs of all participants. On occasions, I recognised potential risks during a study and discussed with the participant why I was asking them to withdraw. Participants were told about the study in tutor period and put their hand up if they were interested. They were then given information sheets and consent forms to return to their tutor. The element of opportunity sampling as a recruitment method meant that participants tended to be motivated to take part.

The studies could prompt participants to discuss and explore personal and sensitive topics. Participants were never asked to do so and were directed back to the study focus when they did so. Where a relevant sensitive topic was discussed, it was important to listen empathetically and offer support inside or outside the session where relevant. For instance, by involving the school's pastoral system. Participants were reminded they could leave the session or take a break if they found a topic upsetting. Teens are unlikely to say when they find a topic upsetting or to leave a session for this reason. It was therefore important for me personally to be alert to this happening and finding an opportunity to offer an exit such as

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giving everyone a break, and following up with the student later if necessary. It was also important to set ground rules for the session and to have a zero tolerance approach to mockery and bullying. There was a challenge here in managing my dual roles as teacher and researcher as I manage behaviour. This was managed by quickly sending students out of the study session, back to their scheduled activity, if an issue arose.

There was an ethical challenge throughout the research around using teens' phones in studies. Teens were asked to download apps onto their personal smartphones. These devices held sensitive and important information and it was important to respect teens' agency and confidentiality in managing it. For the phone, as for the study as a whole, it was also important to explain the conditions under which such confidentiality would be broken i.e. if a safeguarding concern arose. In certain circumstances, the school could contact the child's parents and request to search the phone: an experience the child is likely to find invasive and distressing (this did not arise in the research). These risks and priorities were managed by minimising contact between participants' phones and the research team. I did not touch participant phones, instead guiding the participant themselves through any troubleshooting. At the start of a session I said, "You can either show it on your phone or just tell me about it" and did not subsequently direct them to show anything. I obtained permission for the participant to share screenshots from their phone but decided not to encourage this or to store any as research data. Although they were directed to download an app, I explained that they could choose not to or could uninstall it at any point without giving a reason. If a participant offered an excuse, such as that their phone was out of space, I did not question this or withdraw them from the research. Indeed, one participant continued to attend study

sessions for several weeks without downloading an app. They subsequently withdrew and were not interviewed for the study. Where a participant was using an app I saw as potentially harmful, I discussed this with them rather than telling them to uninstall it. This could happen alongside following school procedures for reporting safeguarding concerns.

To preserve participants anonymity, sessions were audio rather than video recorded. Recordings were stored on a secure drive and deleted once I transcribed the audio, modifying names and identifying information.

6 Teen responses to self-tracking practices for self-determined motives

Parts of this chapter have been published in (Potapov et al., 2019; Potapov et al., 2021).

6.1 Introduction

Work investigating how young people use PI tools has tended to implement behaviour change interventions in which young people track progress towards a quantifiable outcome, such as increased physical activity (Gaudet et al., 2017; Kettunen et al., 2019) or weight loss (Fernandez-Luque et al., 2017; Timpel et al., 2018). PI has often formed part of a system of extrinsic reward, bypassing the young person's own motives (Kerner & Goodyear, 2017). These adult-directed implementations of PI tools are unlikely to adequately represent this user group's experiences, the majority of which happens with no adult supervision (Rich et al., 2020).

Teenagers are still developing a sense of the world, as well as of their own goals and identities (Somerville, 2013); technology could play a role in supporting this development – helping young people to explore, organise and express their thoughts and feelings (Davis, 2012). While we know adult users can appropriate PI tools to support a variety of personally meaningful outcomes (Sharon & Zandbergen, 2017), there has been less focus on how young people may use PI for purposes not prescribed by a researcher. What goals do teens pursue when provided with a personal informatics tool, and what meanings do they derive via their personal data? A richer description of the wider social practices in which tool use occurs is needed to better understand the "data work" (Elsden et al., 2016) of teen users.

The present study explores young people's personal motives in pursuing a self-tracking practice and the ways in which they understand these practices within specific social contexts. Rather than focusing on a curriculum area like mathematics, the study examines the roles personal data can play in teens' everyday lives. The study explores in what ways and to what extent self-tracking addresses their personal interests and concerns. Participants are encouraged to be both creative and critical tool users. This is supported by scaffolded discussions among peers in a classroom at their school, followed by the opportunity to continue using the tools in contexts of their own choosing outside the classroom. I frame PI as a developing and tentative social practice, showing how young people draw on their lived experience to motivate and reflect on their activities. By foregrounding aspects of the social context in which tracking occurs, I report on the individual experiences of young people with a wide range of concerns, interests, and perspectives. The study's findings suggest opportunities for design to better support young people's personally meaningful reflection on PI data. The study addresses RO.2 of the present thesis:

RO.2: *Investigate the feasibility of teen-led self-tracking, including whether teens choose to engage with the tools, how they choose to use them and the meaning they draw from these uses.*

This RO is subdivided into further research questions which will motivate the present study:

RQ.1: What kinds of motives do young people pursue when engaging in self-determined personal informatics practices?

RQ.2: How do young people interpret their own personal informatics data?

RQ.3: Can introducing young people to personal informatics in a classroom context support them in personally relevant meaning making?

6.2 Methodology

6.2.1 Participants

Students (aged 14-17) at two comprehensive secondary schools in London, UK were invited, by their tutor class teacher, to take part in a study about self-tracking apps and learning. They joined the study by returning letters of their and parental informed consent (approved by an institutional review board). Twenty-five participants (10 from School A and 15 from School B) joined the study in total, eighteen of whom (9 female; 9 male – mean age 16) completed the study to interview stage. I discussed key aspects of the information sheet and the plan for the study with participants before the start of the study. Some participants dropped out at this stage because they had misunderstood the aims of the study. Other participants dropped out of the study because their friends were not involved, or because they did not continue to show interest after the first session. Study sessions took place during tutor period in a classroom at the participants' school.

6.2.2 Procedure

Given their possible lack of experience with PI tools (Matteucci, 2017), it was important to introduce participants to the concept of self-tracking and allow them to practise data interpretation in a semi-structured setting before they began using the tools by themselves. The present thesis argues that skills of meaning making may need time and support to

develop. Following previous models (Clegg et al., 2017), the study consisted of a learning phase in which participants were enculturated in the practice and an exploration phase in which they used the tools independently. The learning phase is split across multiple sessions to give time for consolidation of learning. Four thirty-minute scaffolding sessions (SS.#) supported participants in choosing what to track (RQ.1), interpreting data creatively (RQ.2), and sharing insights from personal data (RQ.3). This work was framed as working together on a toolkit for other students exploring the same topic. Participants were asked to evaluate aspects of these sessions throughout.

Teens are a vulnerable population and the scaffolding sessions helped to guide participants away from potentially unhelpful framings, and to check in with them for any problems or risks that could arise. For example, a participant wanted to track how many press-ups he could do. I suggested that in this study we were not using apps to push ourselves but to reflect, and asked whether the number of press-ups impacted his learning. I suggested he instead track when in the week he had exercised so he could see if it affected his learning.

The sessions were first piloted with undergraduates. The scaffolding sessions took place in four iterations with a group of four to six participants. Participants were asked what they found helpful in the sessions, informing adjustments to the protocol such as questions asked to support understanding, and the removal of redundant activities.

Table 1: Timeline of study activities

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9

SS.1	SS.2	SS.3	SS.4		Interviews
	Independent self-tracking				

6.2.2.1 Developing young people's expertise in personal informatics

Scaffolding session one: Participants were introduced to self-tracking[51] as a diverse set of practices through screens of different self-tracking apps, shown on the whiteboard. The focus here was on mobile apps rather than IoT devices. I gave examples (from the Quantified Self website) of common and unusual self-tracking practices through visualisations of the users' personal data (such as socks owned, or kinds of things complained about in a month). I then specifically focused on different kinds of visualisation, including those in analogue practices such as the Dear Data project[52]. Participants were prompted to discuss what the user might learn from the data. To help frame this discussion, and following prior work (Stornaiuolo, 2020), participants were asked to consider the impact of different contextual factors such as the user having a disability or carrying out the self-tracking with their child. The session ended with a discussion of what self-tracking could tell them about their own lives.

Scaffolding session two: Participants were offered cards with prompts of what could be tracked in a self-tracking practice: e.g. "How long I spent on an app", "Places I've been", "What I'm grateful for". These were informed by discussions in SS.1. Participants worked as a group to sort these cards by the impact they felt the factor could have on their school

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[51] This was chosen as a more intuitive term than "personal informatics".

[52] http://www.dear-data.com/theproject

learning. Following an activity theory approach (Engeström, 2014), this supported learning by mediating disagreement and allowing participants to develop perspectives on the motives for self-tracking (RQ.1). Participants each chose a factor they would be interested in tracking. I suggested a free off-the-shelf app they could use to carry out this tracking (on a personal smartphone) or lent them an activity tracking tool (Fitbit Charge HR or Misfit Shine) to take home and use for the duration of the study.

Scaffolding session three: I checked whether participants had successfully downloaded a self-tracking app and advised participants on any technical issues they were having. For example, helping them to sync their Fitbit device with their smartphone, and showing how to adjust permissions on what aspects of their computer activity were tracked by *RescueTime*. This was an opportunity to screen what tools participants were using and to offer guidance on using them safely. I was able to follow up with participants about these issues while they were tracking independently.

Scaffolding session four: Participants fed back to each-other about how their self-tracking was going and anything they were learning from their data. This allowed participants to share ideas about what they could track and gave additional opportunities to practise the "articulation work" (Tolmie et al., 2016) of interpreting the meaning of their data to present as insights (RQ.3). The emphasis here is on explicating norms of PI data interpretation as a domain or speech genre.

6.2.2.2 Independent personal informatics practices

The scaffolding sessions supported participants in developing PI skills and allowed them to make an informed choice around what they wanted to track. After the scaffolding

sessions, participants were invited to continue tracking something of their choice for a further four to eight weeks (until their interview)[53]; being encouraged to draw on their experience in the scaffolding sessions to explore whatever interested them. They were free to change the tracking focus or tool at any point. This longitudinal study design supports the theoretical commitments of the present thesis in centring on social practices and their development rather than interactions between user and tool. This design gives the user time to develop a relationship to the tool, to adjust it or how they use it, and to integrate it into existing practices.

None of the data gathered by participants was stored by the research team. We also chose not to collect screenshots or photos of data visualisations. The participants could choose to show data to me during sessions or interviews on their phone.

6.2.2.3 Data collection and analysis

Each participant took part in a one-to-one semi-structured interview. Interviews lasted around twenty minutes and participants were asked about what they had been trying to do and why, whether they noticed anything interesting or learned anything as a result of their tracking, and what their data meant to them or what it expressed about themselves and their life. As in prior work (Elsden, 2014), the interview aimed to support participants in freely exploring their own interests and reflections.

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[53] This scheduling was dependent on the school timetable.

All scaffolding sessions and interviews were audio-recorded and transcribed. Transcripts were initially inductively thematically analysed (Clarke & Braun, 2014) and checked against hand-written notes from the sessions using NVivo: broadly focusing on participants' construction of meaning. Twelve coded categories were identified through repeated readings of transcripts. Data extracts within each category were then deductively analysed through an activity theory framework. This involved evaluating extracts in terms of practices, social norms, settings, motives and the role of physical artefacts (typically through references to personal data in the transcript and hand-written notes) (Kaptelinin & Nardi, 2012), as well as the systems of concepts explored by the user (Veresov, 2017). This process organized codes and extracts into five themes. Codes and extracts were shared with co-researchers and adjusted based on areas of disagreement in the analysis. The final themes broadly described user motives for engaging in self-tracking: confirmation of existing practice; judging and authority, behaviour change, evaluation of personal significance in everyday life, and supporting wellbeing.

Table 2: PI apps and devices used by participants, what was tracked and whether they had used a PI tool at the time of the final interview or before the study (Though these signifiers do not fully capture the evolving practices).

	Tools used	Focus of tracking	Still tracking?	Ever tracked before?
P1	TapLog	Worries	No	Yes
P2	Fitbit	Exercise	Yes	Yes
P3	RescueTime, Fitbit	Online activity, steps	Yes	No
P4	Samsung Health, Daylio	Steps, mood	Yes	Yes

	Tools used	Focus of tracking	Still tracking?	Ever tracked before?
P5	RescueTime, HabitBull	Online activity, habits	Yes	No
P6	Daylio, Moves	Mood, steps	Yes	No
P7	Misfit, Toggl	Steps, sleep, time revising	No	No
P8	RescueTime	Productivity	Yes	No
P9	RescueTime, Taplog, Multi Log	Revision quality, anxiety level	Yes	No
P10	Fitbit	Exercise	No	No
P11	RescueTime, TapLog	Productivity, times distracted	No	No
P12	RescueTime, Strava	App usage, running	Yes	Yes
P13	RescueTime, Toggl	Productivity, time revising	Yes	No
P14	Daylio, MyFitness Pal, Health Mate	Mood, sleep	Yes	No
P15	Daylio, LifeMosaic, MyFitness Pal, Fitbit	Mood, steps	Yes	No
P16	LifeMosaic	Mood	Yes	No
P17	LifeMosaic, Daylio, Fitbit	Mood, steps, sleep	No	No
P18	Daylio	Mood	No	No

6.3   Findings

Participants used fifteen self-tracking apps and devices in total for a broad range of

motives (Table 1). Most participants were able to form and maintain a self-tracking practice

and to also draw insights from the data they collected. Most changed or adapted the focus

of their tracking from the learning phase to address everyday situations (RQ.1). These

findings suggest that PI practices supported young people in making personally relevant

insights, as well as having broader effects on their everyday activities (RQ.3). The various

overlapping modes of engagement for gaining insight with personal data, identified from the interview data, are described below.

6.3.1 Confirmation of existing practice

Most participants found that the data they collected confirmed rather than challenged their expectations. For some participants, this meant that the data they collected was trivial or unnecessary.

> *I'm using my phone just what I'm using it for, so having the ability to track it, to me, it's fairly redundant. Because you know, I can see and I know I spend most of my time on a certain app. That's what I want to do. (P12)*

> *It was very silly to me to have this showing the steps. I went on a walk with my friend and then it tells you "8039 steps", great! It just doesn't tell me anything. (P3)*

P12 was already aware, at least qualitatively, of how he spent his time and did not feel PI would support his agency. However, there were other instances when the external confirmation helped participants to maintain a practice. Indeed, these different modes of engagement could appear in the same individual.

> *So I run, and we have a little saying with Strava: If it's not on Strava, it didn't happen. Like if you didn't track it and put it online, it didn't actually happen. It's like if this thing isn't recorded to me, if my usage isn't recorded, I can easily dismiss it. (P12)*

While in the context of tracking productivity at home, PI data felt *"redundant"* to P12, in the context of running with friends, it formed part of ongoing discourse and shaped social norms and motivations for the practice. There was a clear contrast here between existing everyday social practice valued by the participant, and the practice prescribed by the present

study, which assumed values that may be deemed desirable by an adult. While the study attempted to maximise teen self-determination, the practices it prompted could still, and to varying degrees, feel imposed or artificial.

Despite this, many participants saw the data as *"unbiased"* (P7) and independent from their social practice. The apparent objectivity of the PI system could offer *"concrete evidence"* (P5) that could make participants feel *"reassured"* (P12) in what they were doing.

Whilst some users valued systems that offered simple reassurance, others sought out personal insight for its own sake or out of curiosity. Some participants explicitly preferred apps that let you *"see your own natural patterns of doing things"* (P4), rather than judging your data for you and making recommendations.

6.3.2   Judgement and authority

Several participants suggested that PI tools could help maintain everyday practice around tasks that might be difficult or undesirable. Some characterised this as being like *the "gentle nagging"* (P3) or gaze of an authority figure like a teacher. Some participants wanted to imagine that their tool constrained their activity or held them responsible for sanctioned behaviour like completing schoolwork.

> *It's kind of like someone over your shoulder going "You haven't done this yet, hurry up"... If you don't do it, then you can sort of call the cops on yourself with it. (P5)*

PI could help young people to judge whether what they were doing in their everyday activities (e.g. sleep or revision[54]) was *"right or wrong"* (P8).

> *I find it helpful especially if I'm doing sports to just look at what it's doing. I want to see if I'm being healthy or not. If I'm making bad or good choices when I'm just in everyday life. Fitbit just makes that a lot easier. (P2)*

> *It actually tells you what you've been doing wrong. Well, it outlines what you've been doing on your phone and you can yourself analyse what is good and bad for you. (P8)*

The authority instituted by the self-tracking practice could also be used to legitimate some actions that would not otherwise be judged acceptable or appropriate. Tracking data allowed for some personal transactions to take place between time that had been "well-used" and time used in less authority-sanctioned ways.

> *It also made me less guilty knowing that I spent for example two hours on revision. And then I can have a break and have fifteen minutes on social media. (P3)*

While some participants portrayed their tool as a separate agent, others reported that it was they themselves that had been given more authority. P17 had been told by her parents about the importance of sleep and knew rationally that they were right but had been unable to act on this knowledge until she started self-tracking.

> *I think it changed a lot [Shows Fitbit weekly sleep data] ... And then again slightly better... I don't know how to explain It. Before, I just couldn't say to myself that no you*

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[54] Studying for an exam (UK).

have to go to bed but the tracking made me do that... to say for myself that no I really

have to go to bed and start sleeping. (P17)

As well as making insights about her sleep, P17 was the only participant to report lasting

behaviour change. Self-tracking allowed some participants to make explicit what they were

committed to doing. Although judgement had often ostensibly been deferred to the

authority of the app, it was mediated by the user's own knowledge and interests.

Working out, obviously you're tearing muscles so it's painful, but if you... have

something to hold you to it, you're going to do it, and in terms of habits ... it takes

twenty-six days for a habit to be formed. So if you kind of promise yourself you're going

to do it for twenty-six days, and it's like you have like a vision of "Oh, have you logged

this yet?" (P5)

PI data could prompt participants to reflect on their activity and give reasons for what

they were doing. P2 reported returning home from rugby training to find his step count *"was*

quite low, so what I thought is, it's my intensity". P2 drew on his own understanding of

training intensity in interpreting his data and what he did "wrong".

6.3.3   Behaviour change

Though few participants reported that self-tracking led to behaviour change, many

framed their self-tracking through concepts consistent with behaviour change models of PI

(Li et al., 2010). Participants often referred to *"correlations"* and other maths and science

terms to explain the meaning of their data (with varying competence in applying them

appropriately). Others used implicit deficit models as rationale for tracking behaviour

change.

I think when it comes to self-tracking, there's basically three stages: there's understanding, control and change. Understanding is you basically figure out what's wrong with you; control is controlling that, allowing yourself, just doing a few changes... (P6)

Although P6 admitted he had not yet successfully implemented this model in his own self-tracking practice, using it to reflect on his activities during the interview allowed him to identify specific *"changes"* he was interested in making; for instance, around getting into the right mindset for homework. Participants sometimes described systems that were not fully thought out or unrealistic, such as increasing their step count by two thousand steps every day (P15). This gap between espousal and practice suggests some participants may need more support to develop their ability to interpret data. The discourses participants engaged in during the study allowed them to experiment with scientific concepts to explain the significance of their experiences in relation to ideal forms of their activity (Veresov, 2017).

Some participants carried out behavioural experiments: altering some aspect of their everyday routine for the purpose of assessing the impact. For example, going for a run (P15) or changing bedtimes (P7); these only tended to last a few days.

Despite not reporting behaviour change, many participants saw their self-tracking tool as something which *"shows your progress"* (P4) and *"gives you something to aim for"* (P5). Participants often mixed motives related to behaviour change with other descriptions of what they found meaningful.

Conversely, some participants reacted against behaviour change framings of their activity, taking a critical stance on the behaviour *"expected"* (P14) of them. They characterised

functions prompting behaviour change as controlling or *"irrelevant"* (P9). Some participants

contrasted apps that just gave you instrumental *"information"* (P15) about a narrow goal with

apps that prompted *"reflection"* (P15) and self-understanding.

> *Daylio makes you reflect but Fitbit is just information there like "Oh, you've done ten thousand steps". You feel proud for a moment but it doesn't continue. It's not like you're reflecting how many steps you've done that day. Well it's kind of like that but it's not that reflective as Daylio is. (P15)*

> *I think a lot of the apps are based on moving forwards… So, "improve your mood" rather than "accept your mood can vary". [But] Daylio will not say you've had a good streak if you've come downhill, but if you realise that and accept that to be the case and then think I can go on and it brings you a new sense of deeper ease with what things are like. (P4)*

Some participants abandoned their PI practice because of contradictions between their

own judgements and lived experience and what they were prompted to do by their tool. P10

abandoned his Fitbit after receiving notifications that he should take more steps when he felt

he had *"already exercised well"*.

6.3.4 **Evaluation of personal significance in everyday life**

Several participants found that their practice *"helps you to learn more about yourself"* (P9)

and *"[reminds you] of who you are"* (P16). Self-tracking offered some participants a chance to

reflect on what was significant in their everyday life in ways that *"expressed different*

experiences" (P1).

> *It was 4.02 when I woke up! … I was like already not feeling so good and then. OK what day was it? [Searching through Daylio data] It says that I had a bad day, because I had*

homework to do. I read a lot, and I had to do sports that day. I ran and I hate running.
(P14)

The self-tracking practice embedded participants' activities in systems of values and meanings. This allowed them to reflect on, share and potentially reorganised their experience (Veresov, 2017). Participants appreciated being able to adjust the units of analysis used in their self-tracking practice to adapt to their developing values and motives to give them *"new ways to think about"* their data (P5).

I tracked my unproductive time and then I tracked things that were not productive but that I liked doing and are good for me, like relaxing... then I tracked different school subjects individually. And then... like a whole category of stuff that is good and that helped me towards my goal... like doing stretches before work... I realised a lot of my unproductive time was quite valuable to me, so I adapted it. (P13)

While participants could defer to their tool to judge whether they were engaging in an activity appropriately according to an implicit system of norms (Derry, 2013), they could also challenge such norms through wider evaluation against their life and identity.

[RescueTime] makes you think, do I want to be someone who spends all their time on this site? (P8)

By offering representations of existing norms, PI tools could scaffold young people's creativity in reflecting on such norms with respect to their social context and everyday practices.

You know it says OK my mood is good or bad... my sleep is good or bad. You can go back and see... with me my friend went [to another school] so of course it is bad

because I care about my friend, but if maybe for another three days it is bad… I might do some social stuff… I might go to the cinema. (P16)

PI data could support learning by opening up wider topics and offering a "ticket to talk" (Jarusriboonchai et al., 2014; Sacks, 1995) for young people to discuss issues of personal significance they might otherwise find difficult to broach. Participants' ability to assess data critically developed over the course of the scaffolding sessions as they engaged in discourse around the social context in which it could be collected (RQ.3). P14 came to a scaffolding session (SS.4) having tried the *MyFitnessPal* food tracking app. The scaffolding session setting allowed participants to explore ideas around food tracking and discuss social norms around dieting and eating disorders. Three participants subsequently gave critical accounts of food tracking in interviews; for instance, regarding the *"guilt"* (P18) and *"wrong ideas"* (P14) they could prompt.

The scaffolding session and interview process acted as a powerful setting for PI to support personally relevant learning, potentially helping participants make better informed choices in the future.

Because if you start really really caring about what you eat, you end up being obsessive, not eating anything. You know, it's important to eat what you enjoy… I eat bad a lot of the time but I'm at least more aware of it now and I might go easy on it but I'm not that fussed. (P12)

These participants were able to develop a new relationship to the perceived authority of their data, and through this process to gain self-knowledge about their everyday practice.

6.3.5 Supporting wellbeing

Most participants discussed mood or emotions in connection with their self-tracking. While it did not tend to change their behaviour, for some participants PI proved therapeutic[55] in prompting reflection that reframed emotions or behaviours they judged bad.

> *I have a science test in two weeks and... I feel really really stressed about it... [Shows Daylio data] You can see every single day this week I've done homework because I've been revising so much for it. But I think when I put it down [on Daylio] I just realise how much I've been revising; I just kind of think to myself "It's fine!" (P14)*

The data helped to externalize negative judgements for the user to build a new relationship to them; for instance, by *"figure[ing] out how much time I waste [worrying]"* (P1). By attributing meaning to data artefacts, participants were able to work through their experience and add granularity to their perspective on a problematic situation (Veresov, 2017).

> *Toggl... was very calming actually... Hav[ing] a physical record [of my activities] there, you get yourself into a position to have your stress at the right level... [When] you're like, "Oh my god, what if I've not done anything!" To really just have a number there and be like "I have!" That's quite good. (P13)*

> *Yes, emotions are meant to grow but also, they are still growing depending on how you think about them. And I feel like it's easier to understand things when they're simplified down like a complicated maths problem. So I find it easier to simplify my emotions in the way that I think about them and not the way that I feel about them. (P18)*

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[55] In the psychoanalytical sense of personal understanding rather than the clinical sense of treating symptoms.

By explicating and validating some aspect of the user's everyday actions and emotions, the self-tracking practice was able to act as a ground for self-understanding. One participant used *Multi Log* to develop a 1 to 5 scale for tracking her anxiety. This process helped her discern the quality of individual episodes of anxiety; such knowledge brought a sense of empowerment.

> *Even if I don't get up and do anything, I still feel like it is this kind of anxiety so I know what it's like, and I can watch a video online or just maybe do some drawing. So even if it's not a big correlation of 'this causes this', you still know you have certain choices and you can remind yourself because you're actually sitting down and tracking it. (P9)*

Personal informatics enabled some participants to report feeling a sense of self-determination over some aspect of their life through the personal knowledge they brought to bear upon it in practice. Their data provided an external artefact to reframe emotions that were negative, confusing or overwhelming. Notably, some participants had internalized (Vygotsky, 1987b) concepts from their self-tracking practice to apply them to everyday activities when they were not using the tool.

> *You get to know, OK this is a 2 out of 5 so I can watch one of my favourite YouTube channels and I'll be fine soon; or it is a 5 and I need to lie in bed, and I can forget about work. (P9)*

Though P9 had largely stopped using *Multi Log*, the categories she developed on the app continued to act as a unit of analysis, mediating her response to her anxiety.

Some participants implied a link between their personal use of technology and their wellbeing. They contrasted the impact of low-value or *"not healthy"* (P15) activities like social

media and watching YouTube with high-value or *"better for me"* (P18) activities like painting or spending time with friends (P14).

> *On my "meh" day or my "bad" day, I was watching movies and I was sick, so that also tells me I shouldn't be watching movies when I'm sick. I should be doing something like painting. (P18)*

> *Sometimes you look at your screen time and you see you've had like eight hours on the weekend and it's like really freaky and you want some distance. It's just not healthy for your body or your mind. (P15)*

PI data could implicate many aspects of young people's everyday social practices which they found it helpful to reflect on, both independently and in expressing their experiences to others.

6.4 Discussion

This study aimed to investigate what kinds of motives young people pursued when directing their own PI practices (RQ.1), how they interpreted PI data (RQ.2) and whether this process could support young people in personally relevant meaning making (RQ.3). Participants developed self-tracking practices through a diverse set of concerns, values and prior experiences. This section identifies some opportunities and challenges for future work interested in bringing PI to young people.

6.4.1 Developing units of analysis

As their experience of PI developed, participants often switched between self-tracking tools and found new ways to appropriate them to meet their evolving motives. Others found

the information they gathered to be unsurprising, trivial, or contrary to what they felt was already true. This generally led to abandonment.

Some saw PI as an opportunity to pursue and monitor change, making their use consistent with behaviour change models of personal informatics (Li et al., 2010). These participants began to appropriate scientific concepts from the PI system or their own practice as units of analysis for aspects of their lived experiences (Veresov, 2017; Vygotsky, 1987b). Even familiar everyday concepts like "worry" (P1) and "anxiety" (P9) could develop through PI: expanding the granularity of the young person's experiences, including when they were not using the tool.

Following an activity theory orientation, I note that by making some aspect of the users' activity into an external artefact (Postholm, 2015), the data afforded a wide range of interpretations (RQ.2). This could involve operational judgements, like whether they were using their homework time well (P5), or wider evaluations that implicated emotional experiences like parting with a close friend (P16). The self-tracking could provide a system of personal currency by which young people could "allow" themselves time on Snapchat (P3) or a lie-down (P9). Other participants just appreciated seeing their "natural patterns" (P4) and learning more about themselves.

Participants stressed that their PI tool should be able to adapt to their developing concerns, rather than trying to fix the meaning of their data (P15) or telling them what to do (P14) or what is important (P4). Designers of PI tools and practices for this user group should

prioritize flexibility: allowing users to set and modify their tracking focus and the units of analysis by which it is framed.

There was a contrast to be made here between automatic and manual tracking. Participants often found automatic tracking "pushy" or representative of concepts and ideals they did not hold. Manual tracking better supported self-determination by better allowing teens to critically examine their data and practice. Manual tracking may also be better suited for teen users in limiting the risk of the system presenting the user with information they could find unsettling or harmful. Another key dimension here was whether the data was grounded as an objective quantity. *MyFitnessPal* allows users to manually log what they ate, but assigns a calorie count to this and encourages them to compare meals quantitively rather than qualitatively e.g., by how tasty or filling they were. Meanwhile, *RescueTime* automatically tracks productivity but did not prompt unhelpful habits in the present study because "productivity" was more symbolic and the judgement of whether they were being productive ultimately still rested with the user.

6.4.2 Exploring norms and ideals

Following Weiner et al. (Weiner et al., 2017), it can be said that participants "borrowed authority" from the PI system to add weight to decisions or personal judgements. Žižek uses the example of Watson to Sherlock Holmes and Hastings to Hercule Poirot to describe the "big Other" we take to be watching over us as we try to make sense of the world (Žižek, 2012). Watson and Hastings offer the sensible perspective of society at large. They evaluate the detective's actions and offer common wisdom but lack the creative energy to solve the crime. The participants in our study often characterised their self-tracking tool as the voice or

gaze of a teacher, police officer, or another representative of the social order[56]. In speaking

for the adult world, the data provided them with security and a sense that they were doing

the right thing, giving them the freedom to draw new insights. As Pantzar & Ruckenstein

argue (Pantzar & Ruckenstein, 2017), "numbers and data visualisations provide a stable

frame of reference that stands in opposition to subjective forces of knowledge formation." In

playing with their data, young people reorganised their experience to form a new

relationship to their routines, experiences, identities and future activity (Veresov, 2017;

Vygotsky, 1987b). For example, viewing a weekly reduction in YouTube use on *RescueTime* as

preparation for university (P8).

Of course, in conducting interviews with participants, I was myself a representative of the

social order in which they were situated. In describing the authority of the tool, they were

also in part reflecting what they recognised in my own authority. They were not passively

reporting their experience, but presenting it in a form I would find acceptable. PI served a

communicative function (Lomborg & Frandsen, 2016), mediating the social relation between

the participant and me, at the same time as prompting self-reflection. The line was often

blurred between what the participant offered based on recollection of lived experience, and

what they offered as the "right answer": abstracted from lived experience or embellished for

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[56] This dynamic is also well captured by Foucault's concept of "technologies of the self" (Foucault, 1988) and Foucauldian discussions of self-tracking as "sousveillance" (Lupton, 2012).

the dramatic situation. In either case, PI reified wider social norms to which the participant could demonstrate their sensitivity in discussing their practice.

These findings contribute to research considering the *data work* of users in "making data visualisations accountable to local activities and events" (Fischer et al., 2017), though contra Fischer et al., my description is focused on normative judgements. As Elsden, Kirk et al., (2016) stress, *data work* is as much defined by its rhetorical power to express what is personally meaningful to the user. They characterise *data work* as the qualification necessary "To situate and contextualize one's data in a present narrative, accounting for this data in relation to everyday life, as recognized and remembered." The social norms committed to by the user in interpreting their data implicated many aspects of their social context, including where they were, who they were with, whether others were using the tool and what others thought about their wider practice. The self-tracking practices created accountabilities (some welcome, some not) and validated young people's judgement. Perhaps the most meaningful distinction to be drawn from adult users of self-tracking technologies is in the reconciliation of still-forming personal identities in a world in which what is considered good or desirable is still framed by adults and not always negotiable. When personal realisations fit with the framings of adults, such as being productive in their studying, young people could find validation in their tracked activity (P3).

The authority of the tool could also prompt potential risks or worries. Participants tended to react disagreeably to tools that directed them to take a particular course of action (such as a set number of steps), but some put trust in the tool and relied on it to determine what future action was acceptable. As P18 noted, such uses could introduce the risk of developing

unhealthy habits or promoting bad health decisions, as related to diet. The risks of food tracking for young people have long been recognized (Simpson & Mazzeo, 2017), but further work is needed to explore how to support the growing number already engaging in such practices of their own accord (Rich, 2020). This study's findings contribute to work suggesting that schools could play a valuable role in supporting young users in this domain (Evans et al., 2008). Addressing RQ.3, the findings illustrate how PI practices can create spaces for youth to explore health topics and other social issues implicated in PI data. The semi-structured collaborative scaffolding sessions (Postholm, 2015) allowed me, as the facilitator, to offer guidance, ask questions and highlight potential risks. Contradictions between the user's lived experience and the meanings or systems of norms they attributed to the data could prompt reflection and re-frame their relationship to the practice, potentially shaping future choices.

While these findings point to potential strategies for managing risks, they also demonstrate the ethical challenges of conducting this kind of research. Introducing young people to PI could expose them to tools that are harmful to them and legitimate their use. The diverse, often emotionally charged experiences of the study participants suggest that such harms may be hard to anticipate and will vary significantly between participants. It is important to acknowledge my positionality as a teacher able to build good relationships and treat participants with empathy. Researchers without similar training and experience may need to collaborate with teachers and spend more time on support systems and scaffolds for broaching these topics and practices.

6.4.3 Supporting social and emotional learning

The dominance of mood tracking in the data spoke to the importance of emotions in young people's lives (Rosenblum & Lewis, 2003). Following Vygotsky's account of *perezhivanie* (Veresov, 2017), I note that emotion did not just colour participants' existing experiences but formed part of a process that restructured these experiences with respect to past experiences and current drama, for example in reflecting on how an inconsistent sleep routine was impacting their wellbeing by affecting their attitude to revision (P7) or how they were glad to have a low mood as it showed that they valued a friend they'd been separated from (P16). For many participants, the "chaos" (P6) of their emotions was something that they appreciated support in dealing with. The data could turn the "ambiguity and messiness into something manageable" (Pantzar & Ruckenstein, 2017). As in prior work (Winterburn et al., 2016), teens appreciated the ability to externalise their emotions in the symbolic forms of the system. For some, PI data provided scaffolding, helping them regulate their emotions. Self-tracking put things into scale (P15), letting young people weigh up the significance of their experiences. There are opportunities for future work to explore how PI can support young people's social and emotional learning in semi-structured contexts, such as mentoring or Relationship, Sex and Health Education (RSE)[57].

As with practices like calorie counting, the findings here point to important ethical challenges. While PI can offer young people ways to express and reflect on their emotions, this may not always be desirable or helpful. The practice may prompt rumination and

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[57] New UK curriculum promoting young people's self-efficacy to make informed decisions about their health, relationships, and wellbeing.

reinforce negative life evaluations (Eikey et al., 2021). Similarly, a negative trend or a reminder of a past event in the data could trigger anxiety. It was important to ensure that wider support systems were available for students at all parts of the study. For example, while P16 reported his feelings of separation from his friend in a positive way, it was important to catch up with him outside the study setting to see if this was something he wanted to talk about further.

As in prior work, the study encouraged participants to narrate their experiences in positive empowered ways to model ways of thinking about them (Stornaiuolo, 2020); supporting awareness of norms and influences implicit in their life. Data-mediated narratives proved a powerful technique for meaning-making. This study follows prior activity theory approaches (Clegg et al., 2017) in noting the positive impact of a learning phase involving semi-structured collaboration with peers in developing young people's skills for the process of narration i.e. reason giving. Like Ploderer et al. (2022), I find that simple scaffolding such as a card sort can support the reflection process.

As Pantzar & Ruckenstein argue, when the framing of self-tracking is widened from the individualistic rationalism assumed by much design in PI to the developing social practices into which PI tools are appropriated, "the metrics of life promoted by self-tracking can generate new types of discussion wherein encounters with the data and culturally shared understandings can inform each other" (Pantzar & Ruckenstein, 2017). This is a tentative process which could not occur if young people saw their activity as valorised by an extrinsic standard beyond their control.

6.5   Limitations

In the study design I had seen the end-of-study interview as a way to collect data about experiences that had already in some sense been completed. Over the course of the interviews it became clear that the interview itself formed a key part of participants' process of meaning making. As Mishler (1991) and others have stressed, an interview is itself a discourse in which I cannot bracket out my own contribution. My analyses had not accounted for what Elsden et al., (2014) among others call the performative dimension of data interpretation. For participants from my own school, my personality as a teacher no doubt contributed to the interpretations I elicited. It was hard to separate the norms and values guiding participant practice from what they gave as socially desirable interview answers.

My approach to the selection of PI tools to recommend to participants was fairly unsystematic – relying on my sense of whether the tool could support the goal or interest the participant wanted to pursue. Future work focusing on different kinds of PI tools and variables like automatic vs. manual tracking could better support understanding of how aspects of tool design contribute to the effects reported in this chapter.

6.6   Conclusion

This chapter addressed RO.2: To investigate the feasibility of youth-led self-tracking, including whether teens choose to engage with the tools, how they choose to use them and the meaning they draw from these uses. The findings demonstrate that youth-led self-tracking is both feasible and of great interest to many in this user group. The various modes

of engagement with PI systems presented in this study illustrate various uses of PI tools unexplored in prior work with teens.

Research in HCI interested in bringing PI to young people has tended to focus on prescribed outcomes, with expectations for the young person around acquiring curriculum content or behaviour change. The findings in the present chapter show that young people can draw meaning from their practice that is self-determined and related to their own concerns (RQ.1). Study participants were able to negotiate personal motives over time through complex and changing everyday situations (RQ.2). By testing and reappropriating PI tools to pursue personal interests, participants developed concepts and skills that they could generalize to other aspects of their life (RQ.3). This suggests the potential of PI to support development and learning in areas outside of STEM.

Participants varied in the extent to which they found tool use beneficial or conducive to self-determination. One determinant here is in how the practice framed tool use; for instance, given too much freedom users felt the data was trivial or confusing, but with too much structure, they felt the technology was trying to control them, or found it harder to interpret their data creatively. The PI practice needed to offer enough constraints to orient the user: as a stable ground for their judgements, but enough freedom to be adopted into the particular situations they experienced. Conversely, some of the participants' PI practices surpassed the ephemera of instrumental goals to be embodied in ways that draw meaning from the whole of their life and identity.

Another determinant of how helpful and relevant participants found their PI practice concerned the design of the PI tool. Since few PI tools are designed with adolescents in mind, they may present this user group with concepts and measures that do not adequately represent their everyday practices or interests. To characterise and address this challenge, it is necessary to investigate the kinds of features and functions young people themselves value when given agency over the form of their PI tool. Although this study's findings show that the opportunity for discussion in scaffolding sessions enhanced PI practices, a lot of the insights participants made only came out in the final interviews. Future studies will need to place a greater emphasis on the iterative process of discussion, reflection and practice to show how insights can develop over time. Involving young people in a longer-term process of design and deliberation could allow for more nuanced evaluations and more concrete design suggestions.

7 LifeMosaic: Co-design of a Personal Informatics Tool for Youth

7.1 Introduction

Chapter 2 discussed how prior work on teen interaction with PI tools has privileged the attainment of specific outcomes over the agency of teen users. This focus on adult-defined outcomes has potentially restricted understanding of the perspectives and experiences of teens. Therefore, although teens are increasingly likely to interact with PI tools, a gap remains in the literature on how such experiences could be best harnessed and supported. While the preceding chapter suggested some potential directions for future work, in characterising practices in which teens implemented PI tools for their own motives, it did not explore how the design of the tools themselves can support these interactions.

While many participants had a positive experience of self-tracking and made insights which they valued, some did not get anything out of the experience. The last chapter suggested that some of these differences of experience relate to the feelings of agency and constraint the participants felt whilst tracking. The present chapter focuses explicitly on giving participants agency over their technology and its uses.

While some prior work has explored technology that prioritises personalisation and agency in the design of self-tracking apps, these are often not well suited to teen users. Though work on the customisable PI tool *OmniTrack* has supported users in making meaningful insights about how they spend their own time (Kim et al., 2017), the setup of tracking parameters and presentation of the data may be too complex for teen users. *Trackly*

meanwhile provides a simpler more appealing interface (Ayobi et al., 2020), with users

colouring sections of an image to index their MS symptoms, but the symbolic value of this

data is more limited. It is hard to anticipate how best to balance aspects of customisation for

teens without a far more detailed understanding of their needs and motives and the uses to

which they might put such a PI tool.

As Druin and others have noted (Anderson et al., 2009; Gelderblom, 2014; Guha et al.,

2013), co-design can be a powerful method for voicing the concerns and understandings of

young people. Allowing young people to "initiate and lead" (Yip et al., 2013) can challenge

prior norms and assumptions and point to opportunities for future work. However, even

within this approach, youth participants often indirectly inform the plans of a researcher,

rather than acting as the "protagonists" of design (Iversen et al., 2017). The present study

reports on a process of adolescent-led and initiated co-design of a PI app. The young people

played an active role in the decision to do the work, the framing of what the work should

focus on, and the direction of the overall project – enabling exploration and explication of

uses, motives and responses that diverge from prior work in PI. The team's two-year

dialectical process of collaborative meaning-making[58] and design is reported through

images of the designed artefacts, interviews with team members and personal observations

by me, as an adult member of the design team.

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[58] i.e. motives and meanings emerged iteratively, in light of prior activity, whilst also shaping future activity (Vygotsky, 1998).

The central motivation for the present work was to find ways to empower young people in a process of design which they find meaningful. The design activities and analyses were chosen to reflect the personal values and ideas of teens as experts on their own lives. The design team were asked to design a technology to make young people's lives better.

This chapter contributes to work facilitating youth-led co-design, illustrating the value of youth voices in guiding design choices. It demonstrates that this population can be keen and competent agents of PI practices: using their data in ways that are more expressive and polysemous than has been reported in prior work.

In addressing RO.2: *To investigate the feasibility of student-led self-tracking, including whether students choose to engage with the tools, how they choose to use them and the meaning they draw from these uses,* the present study is motivated by the following research questions:

RQ.1: What design features might teens seek in a PI tool and why?

RQ.2: How can teen agency be supported in PI practices?

RQ.3: How could collaboration and discussion support teen understanding of PI?

7.2 Co-design with teens

The value of giving young people agency in the design process has been widely reported in interaction design with children (Gaye & Tanaka, 2011; Guha et al., 2013; Iversen et al., 2017). Co-design can give voice to the perspectives of young people as an often-ignored designed-for population (Anderson et al., 2009; Coenraad et al., 2019). Co-design allows

young people to explicate values and concerns which can lead further design, in a dialectical process (Iversen et al., 2012). However, the role of youth in the design process varies widely, with many co-design studies restricting design activities and the extent to which they directly shape design outcomes (Iversen et al., 2017). Youth in co-design of mobile technologies have often been employed as reviewers (*informants*) rather than producers (*design partners*) of the designed artefacts (Stigberg, 2017). Such restrictions could potentially affect the motivation of some youth participants, as well as the authenticity and depth of their contributions (Bratteteig & Wagner, 2016). When design partners are teenagers, it may be particularly important to enable them to pursue their own motives, collaborate meaningfully, and develop a sense of ownership within the design process (Bell & Davis, 2016; Chimbo & Gelderblom, 2014; Iversen et al., 2013).

Co-design of personal informatics tools for teens has primarily focused on supporting self-care for a health condition (Andersen et al., 2015; Hong et al., 2018; Kim et al., 2015; Raeside et al., 2019). This work has typically employed young people as informants rather than design partners, but with notable exceptions (Bell & Davis, 2016; Hodson et al., 2019; Lee & Briggs, 2014). Hodson et al. (Hodson et al., 2019) report on the co-design of a tool to support adolescents experiencing a mental health crisis. The design work took place across four years, allowing youth design partners to play an active role at every stage of the process: directly contributing to the initial direction of the work as well as the final designed artefact. Ideation drew on the existing understandings and practices of the young people, including strategies for managing mental health crises. Youth creation of design elements was shaped by their own developing concerns and motives and the feedback of others in

their community. This iterative process resulted in the creation of the *Mellow* app (a tool with PI elements: allowing the user to visualize and reflect on their mood). The co-design empowered a vulnerable population to make nuanced and meaningful contributions which reflected their own values. The last chapter suggested that involving teens in discussions around the interpretation of PI data could develop their understanding of PI practices, preparing them to interpret their own PI data more creatively. Extending such a process across a longer time span should enhance these positive outcomes.

7.3 Participants and study context

The design work in this study was framed by the team's involvement in Nesta's Longitude Explorer Prize. The prize encourages "youth-led innovation" in STEM to address real-world problems (Sebba et al., 2009). The 2017 challenge invited young people across the UK to design an Internet of Things product to make people's lives better. Responding to a notice about the chance to enter a STEM competition, students attended a weekly lunchtime club formed by their science teacher to work on their prize entry. I was asked to help run the club in part because students had spoken about participating in my study. The study reported on in Chapter 6 ran concurrently and four club members were also participants. At this stage I had not considered that the work of the club would contribute to my research, and I ran the club in my role as a teacher at the school, rather than as a researcher.

From an initial twenty or so students, around a dozen attended regularly until the submission. Before considering design or existing technologies, the group discussed problems they know people around them face in their everyday lives. A number of problem areas like sedentary lifestyle and junk food were suggested but the group quickly came to a

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consensus around the issue of teen mental health. *"It was just something that came out of organic discussion about what would be best for someone in a situation similar to us."* (Seth). Several club attendees shared experiences of helping friends going through mental health issues. They felt such issues were widespread and that there was a *"health crisis, both physically and mentally, in young people and teenagers and a lack of resources given by public services [to] deal with crisis situations."* (Xian)

After researching existing IoT tools, they came up with *"a smartwatch that could support mental health… [by launching] your personal coping strategies."* (Geordie). The students suggested that adolescents with anxiety may have a specific person, video, or other go-to technique to help manage negative mental health episodes. The conceived smartwatch would launch this strategy during a panic attack. This idea was submitted to the Challenge but did not advance to the next round.

However, some members of the group were keen to keep working on the idea and I continued to run the club for them. The idea developed from a wearable to a self-tracking app *"where you set the variables and kind of get into it without having to fork out a lot of money or do anything special."* (Geordie). The focus on self-tracking came out of student discussions, but was influenced by my own framing of their work as "self-tracking" as part of these discussions. Three of the group members were also participants in the previous study (Chapter 6) and drew on their experiences of existing self-tracking tools such as *Samsung Health* and *Daylio*. Together, these factors framed the design of the *LifeMosaic* app.

The group's work on the app was increasingly interesting and relevant and I discussed the possibility of including it in my research with the university ethics board and acquired an amendment to my ethics to incorporate it in my thesis. Club members joined the study by returning letters of assent and parental consent. Club members could continue attending the club or leave at any time without contributing to the research. Four members of the club joined the study – in the present chapter I call this "the design team". Other students contributed to the design work at various stages but chose not to be involved in the research.

7.3.1 Procedure

This study reports on the design of a personal informatics tool by a group of 14 to 16-year-olds from varied socioeconomic backgrounds. The study focused on a design team of four UK secondary school students (3M, 1F). This chapter uses a case-study design (Creswell & Miller, 2000; Yin, 2017) offering a qualitative account of the design process.

The design work began when participants were in Year 9 and continued through to Year 11, with one younger participant joining the team at the start of Year 10. To examine this long-term course of development, whilst foregrounding the motives, practices and perspectives of the youth participants, I adopt a Vygotskian framework (Veresov, 2014; Vygotsky, 1997). Designed artefacts are evaluated in the context of their role in mediating youth motives, i.e. we focused on how designed artefacts express youth concerns, rather than giving an adult evaluation of design affordances.

Data on the development of the design was collected "on two planes" (Vygotsky, 1997, p. 106): first, through observations of the design work across 20 thirty-minute lunchtime club

sessions; then in a twenty-minute semi-structured summative interview. Interviews took

place outside of the club, during tutor period and asked students to speak retrospectively

about their design work. Each team member was interviewed separately to foreground their

own voice, explicating the concepts and concerns they had personally internalized. Interviews

focused on design goals, rationale behind designed functions, and intended uses for the

app. Sessions were audio-recorded and transcribed. The participants read transcripts of their

own interview and had the chance to amend them. Transcripts, observation notes, and

designed artefacts were thematically analysed (Clarke & Braun, 2014). Emerging themes were

discussed with participants and modified based on feedback (Harvey, 2015). An earlier draft

of the present chapter was shared with participants and their parents.

I explained to participants that they were no longer in a study once the interviews were

complete. No more data was collected after this point, though the design work continued for

a further two years. The design team were keen to participate in research and contributed

paragraphs of text reflecting on their work for an article outside of the present thesis

(Jayman & Potapov, 2021).

The findings of the present chapter quote extensively from the young people in

characterising the design process. This is motivated by study aims of privileging youth

voices. The summative interviews help frame the observational data from the young people's

perspectives.

7.3.2 The co-design process

The work of the design team continued in weekly lunchtime club sessions. Though the framing in the preceding sub-sections should be noted, I made a deliberate effort not to direct the course of design. Design choices were based on the young people's own lived experiences and the ideas that emerged during discussion. The team's decision to focus on teen mental health presented ethical challenges around the sensitivity of the topic. I encouraged the team to frame mental health in more holistic rather than clinical ways and to avoid discussion of their own mental health, focusing instead on hypothetical users like themselves. It was also important to build a good relationship with the team's parents to communicate about concerns and relevant context in the team's lives.

Figure 4: Wireframe for a new feature.

Lunchtime club sessions involved discussions around specific problems and app features. The freeform structure meant that some sessions dealt with abstract concepts like *online bullying* or *progress*, while others dwelt on the position of a button or what to call a menu item. The team often created design fictions for "future versions" or spent weeks on a design feature they later deemed unrealistic or unnecessary. As the work progressed, designed artefacts created between sessions or drawn on mini whiteboards during the session helped mediate the discussion: clarifying ideas and focusing negotiations. I introduced the concept of a *wireframe* and the team experimented with a range of free wireframing tools, but

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preferred to work with paper and pen. Esme, a member of the design team, was passionate about graphic design and used the Adobe suite on a home computer to create higher fidelity designs and the final app elements.

Esme might come to the session with printouts of two wireframes. Xian will ask Esme questions to help her explain what she has done. The team will be sat around two tables with the printouts in front of them. Geordie might ask more critical questions. Seth will jump in with a possible answer. He will offer a scenario in which the user is interacting with this screen. Geordie will raise another problem. Esme will defend her design then ask how she should change it. Geordie will scribble on the wireframe. Xian will start a deeper discussion of the problem, bringing in other concerns and priorities. I will show something that comes to mind on the whiteboard, such as an existing app on the app store with a similar feature. The team will criticise this and try to reach some conclusion about what the design must be able to do. If there's a sense that we are getting nowhere, the debate may be parked for a later session, and a new question introduced.

As the design grew more complicated, I showed the team how to set up a Trello board (Figure 5). This greatly helped the team to structure their design work and added a layer of accountability which did not require my direct intervention. The team assigned tasks to each-other using this board and completed these tasks at home between sessions.

My principal role in the design team was to facilitate discussion: keeping focus and highlighting emerging questions. Here, care was taken to seek clarification or prompt with ideas already in the youth discourse, rather than dismissing contributions or intervening with
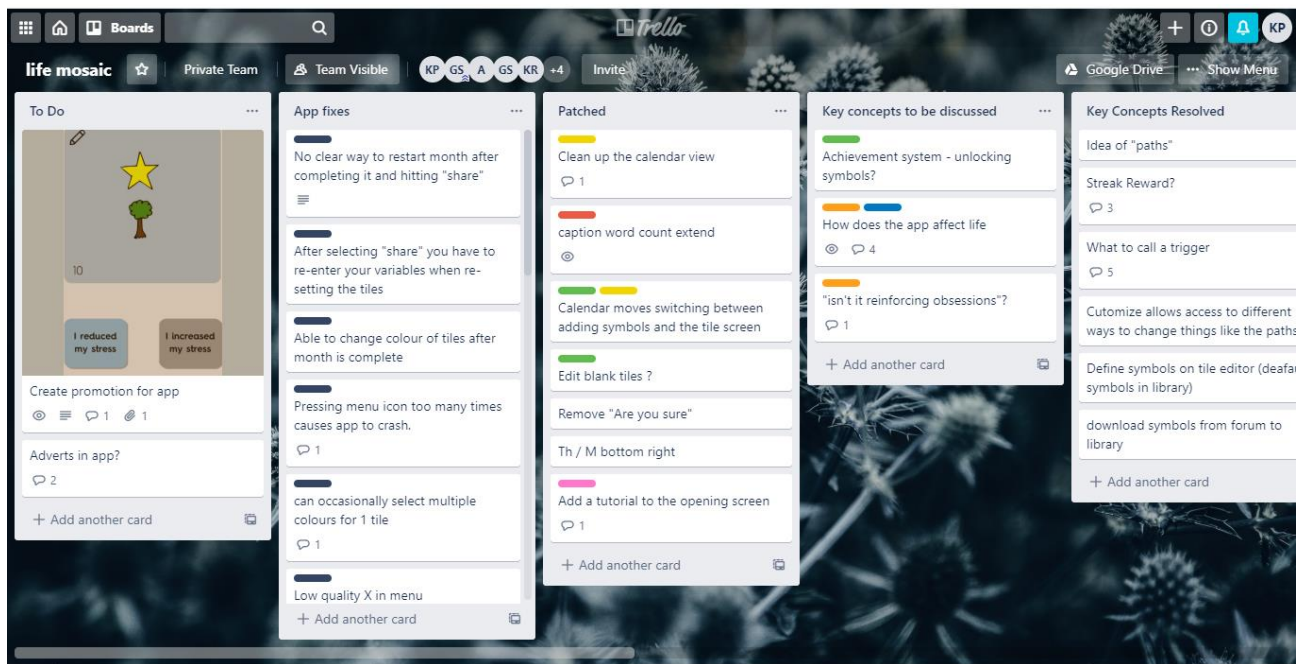
Figure 5: An iteration of the team Trello

new content (Iversen et al., 2012). Once Trello had been introduced, I acted as "minute

keeper", helping the team put their tasks and ideas onto Trello cards (though team members

often rearranged these and added their own between sessions). Having the team Trello on

the interactive whiteboard allowed weekly follow-ups of the assigned tasks, and structured

subsequent discussions. Problems and disagreements could be quoted on a Trello card to be

returned to later. In persisting disagreement or confusion, I could point to the Trello board to

remind the team of key ideas, such as needs of the target audience they had identified, or

limitations of existing apps.

I also managed contacts with external agencies and took on roles that can only be

carried out by an adult: setting up Kickstarter and Upwork accounts; finding and liaising with

professionals for specific consultation, such as graphic designers, start-up founders, and

developers.

As the design developed, local parents offered their support and gave the team workshops in fundraising, branding and app specification writing. The team made use of this valuable advice to publicize the app and take it to a developer. Though the team sought advice and guidance at different stages of the design processes, the designed elements submitted to the app developer were wholly designed by the young people themselves. *LifeMosaic* was built when the team submitted their designed elements, specification and user stories to a freelance developer on Upwork, following a successful crowdfunding campaign supported by the local community.

7.4   The LifeMosaic app

LifeMosaic is a personal informatics smartphone app that lets the user focus on a chosen aspect of their life and log it daily using colours and symbols (*stickers*). The user tracks two opposing actions or qualities, such as "I slept well: I slept badly"; "I made my mood better: I made my mood worse"; "I revised: I went on YouTube" (Figure 6). These are represented on two coloured buttons. The user clicks the button to indicate how many times or to what extent an event has happened. Pressing combinations of the two buttons blends their assigned colours on a *daily tile* (Figure 7). The shade of the daily tile indicates to the user where they are along the spectrum of their chosen focus.

The user can add *stickers* to their daily tile from the sticker library. These symbolize contexts like what triggered an event, what activities the user has done, or how they were feeling. The user can also create their own simple sticker on a sticker design screen.

Figure 6: Setup screen. The user can choose a suggested focus to track or create their own.

Figure 7: Daily tile screen. The user can log events with buttons which tint the tile, and add stickers for context.
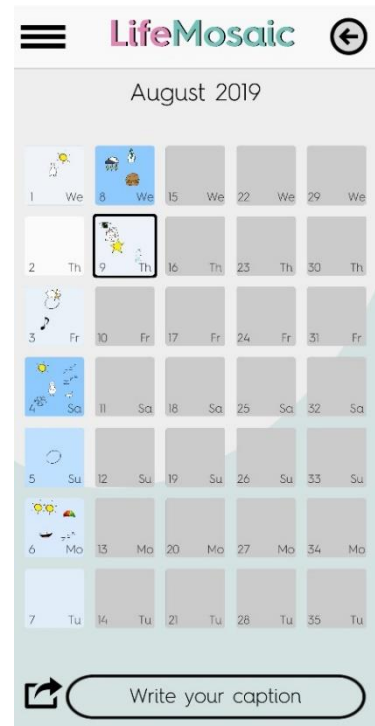
Figure 8: Mosaic screen. The user can see an overview of their month.

The user can view a visualisation of their month (their *mosaic*), composed of their daily tiles and aligned vertically week to week (Figure 8). An image of the *mosaic* can be archived or shared with others.

7.5 **Key motives and design choices**

The primary design goal of supporting teenagers in learning about their own wellbeing permeates the team's discussions of specific app functions. These design choices have been coded into four sub-motives: enabling customization, supporting data interpretations, facilitating conversations, and maximizing privacy. The design team are proud of the end product and agree that *LifeMosaic* captures their intentions and negotiations over the course of the two years of design work. The design crystallizes their practices (Iversen et al., 2013) and the motives, values and contradictions behind them (Ilyenkov, 2013, p.52).

7.5.1 Enabling customization

It was key throughout the design work that as a user you should be able to "*make the app your own*" (Geordie). The team felt that the lives of young people were too varied and fast-changing for the "*rigid*" design of existing PI tools.

> *So, for some people doing an hour's exercise might be ridiculous. So you can say that you've done 10 minutes and still be proud of yourself and still be able to put positive input in and see for yourself that that's something you've done well... or another week just not shutting yourself off in your room is worth recording. (Geordie)*

The PI tool needed to be flexible enough to record potentially subtle and changing factors valued in everyday life activity of the young user.

> *[Other PI tools] defined for you what happy and sad was as opposed to you can say yourself what the behaviours are that are making you happy or sad... or if that's not how you see it: if that's not for you then you can do 'social/antisocial', 'helpful/ unhelpful' for instance. (Seth)*

The team felt it was important for the user to be able to set not only the personal data type they were tracking but also the criteria by which they evaluated that data. In contrast to behaviour change framings of PI systems (in which it is a given, for instance, that a higher step count is of value) the team wanted their PI tool to allow them to define the framing of interpretation as well as the data source: what was qualified as well as what was quantified: *"You can find things that work for you and people who help you but you need to do the work to understand how to make progress."* (Seth). In contrast to adult users, who often acquire PI tools to make progress towards known instrumental ends (Kersten-van Dijk et al., 2017), Seth

wanted his PI tool to be part of wider process of learning about what constitutes progress

for him and within his existing social relations.

On first launching *LifeMosaic* the user sees a setup screen (Figure 6) on which they

choose a "tracking focus" and what it is about that focus that they want to evaluate. This is

represented through two contrasting actions or judgements. Suggested options include "I

was social: I was not social" and "My day went well: My day went badly". The user can also

easily create their own tracking focus. This allows the user to set their own system for

interpreting life factors. For example, the user could focus on mood and evaluate this as "My

day went well", "I had good times" or "I feel positive" or a subfactor like "I felt calm". The user

can use sticker symbols (Figure 7) to separate what they take as data and what as

judgements about that data. For example, they could use the symbols to represent people

they spoke to or activities they've done, and then use the "I was social: I was not social"

buttons to judge/interpret this data. They could also use stickers to represent how they felt

about these social encounters. What was treated as the objective data and what was a

judgement about it was relative to the practice and a function of whether it was used in

more indexical or symbolic ways.

Self-determination and empowerment were key values explored in the design work. The

design was shaped by their motive to empower the user *"to figure out how they can take*

control of their own life" (Geordie). The team felt that giving the user agency in their meaning

making could support wellbeing and self-understanding.

> *A lot of the time we found existing apps were extremely focused and narrow upon some*
> *things such as mental health or losing weight, whereas LifeMosaic aims to put the user*

in control - expressing themselves in a way that's more meaningful to them... so there isn't that kind of pressure, which for teenagers is actually probably what you're trying to avoid. (Xian)

Rather than saying this is how you should change or even this is bad or this is good, the most important thing was how can you understand for yourself and just learn more about yourself every day. (Seth)

The team acknowledged the value of systems and routines for personal growth, but did not want their PI tool to tell them what to do: in part because this would not capture their individual values and in part because it disempowered them along their long and tentative project of self-understanding. For a teen population who are still developing a sense of identity, it was important that the app could support them in learning about themselves whilst giving them room to experiment.

7.5.2 Supporting interpretations

The team wanted to prioritize ease of use and understanding for the user. An early challenge concerned the visualization of the data, with trade-offs discussed between simplifying what the user saw and capturing what was important. As Geordie noted, apps like *RescueTime "can show you a load of stuff [that took] too much effort"* to access and understand. There was a worry that when users are teens, seeing "*a graph might not feel that relevant*" (Esme), prompting abandonment before the user has invested time interpreting potential significance.

Together with the concerns around customization, these motives directed design towards visualizations that were playful (Pousman et al., 2007) rather than technical or scientific and which could be interpreted in multiple ways.

Because [when] it's all about numbers and is more precise data, it kind of restricts what the user can do on the app. And it gives you one answer whereas on LifeMosaic you can have many different answers. (Esme)

Data collection on *LifeMosaic* centred around two buttons, corresponding to the two poles of the tracking focus e.g. "I slept badly: I slept well". The user assigned a colour to each pole and their daily tile visualization was tinted with that colour on each button press (Figure 6). This created a visualization which was expressive rather than precise: the user would not know how many times they pressed each button but the resulting colour would give them a sense of where they were on the gradient between the two poles.

This work helped explicate the values of self-expression and creativity in the design. The team wanted the user to express as much as possible about what was significant for them. The team designed a library of stickers that could be dragged onto the visualization to signify whatever the user wanted it to. These symbols were designed to be whimsical and open to taking on different meanings. This gave the user the flexibility of *"Not having to say, you know, this sticker means I'm happy, but the tree could mean that erm you fell down the stairs. And being able to see, you know if there's quite a lot of trees, you're quite clumsy."* (Geordie) For Geordie, the sticker did not have a fixed representational value; its value was produced through its relation to everyday life activity.

LifeMosaic offers a monthly visualization of the user-created tiles (Figure 8) which let the user look "*back on your day, your month or your week and kind of see what affects you... how things are going*" and potentially notice "*trends*" (Seth) like weeks or days of the week where similar significances were expressed. The process of meaning making was potentially

supported here through the fact that the user had already invested meaning in the data by choosing how to represent it. This addressed the barrier of interpretation through the close correspondence between data collection and interpretation.

Over time, the user could create their own system or "language", using the sticker symbols to convey varying levels of abstraction.

> *"This tile I've drawn a burger with an arrow facing up and a bottle with an arrow facing down because I ate more fast food today and drank less and I put a spanner at the bottom to remind myself it's something I want to work on and I want to fix it." (Xian)*

The personalized creativity here could potentially motivate teen users put off by the onus of interpreting more traditional graphs and visualizations.

7.5.3 **Facilitating conversations**

Much of the play and creativity in the interpretation of PI data visualizations emerged in the design work through the dynamics of discourse and collaboration. After some time experimenting with PI tools, the team wanted to find ways to reproduce such social dynamics for the user. The values driving these concerns related chiefly not to sociability but to support and empowerment. The expressive nature of the data reflected the team's concern for the visualizations to be something that could be shared and talked about (with a friend or mentor). *"So how I can tell Seth about my week on LifeMosaic you can have someone you know you can talk to."* (Geordie) The team hoped this could help the student feel less *"pressure [than seeing a] psychiatrist or a therapist or someone they aren't entirely comfortable sharing it with."* (Geordie). The data was seen as a ticket for meaningful discourse that could support inquiry and self-understanding.

Instagram for instance believes that social desirability and having many friends is the most valuable thing and they use a likes system to represent that, whereas LifeMosaic is purely based around recording and opening discussions… in the end we just aim to facilitate people connecting with other people about who they are. (Xian)

The team had had positive and enlightening experiences on social media and recognized its power but were critical of the token economies of "likes", which they felt got in the way of genuine and meaningful connections. Through this lens, they came to see a PI visualization as a potentially more authentic social media post. At the time of the interviews work had begun on a private forum where users could anonymously post their *mosaic* with a narrative about it. Other users would click "relate" to indicate they felt a connection with something in the post.

It would help you understand that it is not just happening to you and it's happening to lots of other people. So you wouldn't feel as targeted or victimized by powers out of your control. (Esme)

The team recognized a tension between young people's fear of being judged or bullied, and the value of the support of their peers, and tried to mediate this in design. They felt this could best be achieved through careful curation and meaningful partnerships between users.

7.5.4 Maximising privacy

The concern for social sharing was underscored by an equal appreciation of the need to protect users from the risks of their personal data being misused and *"certain stuff being seen by a teacher"* (Geordie) or other unwanted audiences.

So other apps are starting to like become corrupt and their sharing features make it public so your information is a lot less personal and you don't know where it's going… [someone] can steal it or pass it on. (Esme)

It was important for the user of *LifeMosaic* to have full control over who saw their data. The "share" function (Figure 8) took a screenshot of the mosaic but this visualization did not offer any identifying or personal information. The use of abstract symbols could allow the user to develop their own codes, stopping the data from being meaningful to anyone they did not choose to discuss it with.

Users of personal informatics tools may be collecting highly sensitive data, such as information about their physical and mental health, making the consequences of a breach even more severe than with other kinds of personal technology (Lanzing, 2019; Li & Hopfgartner, 2016). Data could be used in peer pressure or bullying or be passed to a third party without the user's direct knowledge (Danaher et al., 2018; Gabriels & Coeckelbergh, 2019). As Neff and Nafus (2016, p.64) suggest, even where the user experiences no direct harm as a result of a data breach, they may still feel uncomfortable or anxious with the idea of their data being misused. These risks are magnified when considering teenage user groups, both because of their increased vulnerability and the need to guide them in making safe decisions (Engen, 2016).

7.6   Discussion

Personal informatics tools have tended to be designed for a narrow demographic of adult users (Spiel et al., 2018), with teen populations rarely considered (Carrion et al., 2015). Prior work bringing PI to youth has tended to focus on particular short-term outcomes

related to behaviour change, health management or knowledge transfer (Garbett et al., 2018). Reporting on youth-led design that did not adopt such a framing, this chapter describes teen uses of PI tools that divert from these norms; these include social connection, identification of personal obstacles and self-expression. These findings contribute to work on PI with youth, suggesting opportunities for PI to support personally significant motives (RO.2).

The findings of this chapter highlight how the motives and responses of teen users may differ from those of adult users. While teen motives are shaped through the institutions in which they participate, they also extend beyond them (Iversen et al., 2013). Prior work has often ignored these motives by restricting teens' activity: the contributions of teen users have tended to be evaluated against a curriculum focus or behavioural outcome. This chapter's findings indicate that teens may benefit from being given a more active role in the development of such criteria. The *LifeMosaic* team wanted to set their own standards for judging their personal data: evaluating whether they were productive, sociable or another quality they felt significant in their everyday lives (RQ.2).

Rather than seeing PI as a behaviour change intervention, the *LifeMosaic* design team considered how their app could be integrated into their existing practices as part of a tentative and ongoing process of self-understanding. They did not want their PI tool to tell them what to do (Seth) or act as an extension of the institutional and social pressures they already faced (Xian). Above all, they valued agency and self-determination and wanted their PI tool to support their own meaning making in spheres of experience beyond the tool interface and beyond the classroom (Peters et al., 2018).

While early work in PI has proposed that self-tracking practices could support student reflection on personal values (Pommeranz et al., 2011), this area remains underexplored. This chapter's findings contribute to this work, suggesting that PI tools can help teens to express and shape personal values in social contexts. Flexibility and self-expression were valued above accuracy and technology-generated interpretations. *LifeMosaic* was focused on *"directly communicating someone's experience of the world"* (Xian). The team felt *LifeMosaic* could empower the user by helping them learn about and express aspects of their fast-changing lives, values and identities (RQ.2). They felt existing tools were too rigid to allow this.

In contrast to traditional personal informatics tools, *LifeMosaic* gives the user an active role in designing their data and constructing its meaning. While prior work has recognised the desire for such flexibility among users (Ayobi et al., 2018; Kim et al., 2019), existing PI tools focused on user agency and customization are often too complex, especially for young users (Kim et al., 2017). Some designers have responded to this limitation by creating PI data visualisations that are expressive and casual (Pousman et al., 2007) rather than precise and rigorous. Storni's *Tag-it-Yourself* app prototype was developed to empower adults with diabetes to record their idiosyncratic and fast-changing concerns and practices, letting users create custom and multimedia tags to log everyday life activities (Storni, 2014). Similarly, Ayobi et al.'s *Trackly* harnesses the practices of bullet journaling and colouring to give users with MS the agency to easily choose what they want to track and how to visualize it (Ayobi et al., 2020). *LifeMosaic* contributes to these efforts, illustrating opportunities for future work to better scaffold customisation without limiting the user's creativity and sense of agency

(RQ.1). Adopting a cultural-historical activity theory lens, one could say that when a user can manipulate an object like a data visualisation through their own actions, this object can come to embody a complex system of values and practices (Ilyenkov, 2013; Kow, 2018).

LifeMosaic supported customisation on multiple levels:

- Iconic: The visualisations were more varied and open textured than classic PI visualisations such as histograms: the shapes and colours could capture different qualities. This more casual presentation of data supported teen experimentation and the eclectic nature of their concerns and experiences. For teen users, it may be particularly important for data to be presented in ways the user finds intuitive and resonant; the familiarity of iconic stickers on *LifeMosaic* like apples and clouds may support this aim.

- Indexical: The design team wanted users to be able to customise *LifeMosaic* to make it more **sensitive** to their lives. The data needed to relate to the teen user's personal motives, context and experiences. As in prior work (Storni, 2014), the *LifeMosaic* user could add stickers to indicate idiosyncratic factors like who they were with or how they felt about an activity. Teen users may particularly value data that feels attuned to them as an individual and able to capture the things that happen in their lives.

- Symbolic: The design team wanted users to be able to customise *LifeMosaic* to make it more **expressive** of their ideas, feelings, and identities. The use of abstract and ambiguous sticker symbols, and the ability to combine stickers in a single daily tile visualisation supported the expression of multiple meanings. Teen users are likely to

value PI tools that let them create or modify the form of their data for different (real or imagined) audiences.

These findings contribute to work on PI with youth examining how personal data visualisations can act as an 'object of inquiry' to support student-led learning and creativity (Chu et al., 2019; Polman, 2018). Rather than seeing the meaning of the data as given by the tool, the design team portrayed it as open to multiple interpretations, through their own (dialectically developing (John-Steiner & Mahn, 1996)) judgements. The collaborative process of co-design allowed the data to become rich and evocative. The data could take on values and motives unique to the user's activity (Vygotsky, 1997, pp. 135 - 140). The *LifeMosaic* user could record *"an art pallet to show I want to create more relationships"* (Xian) and use this act as part of personal exploration, to ask for support or to connect with others (RQ.1). These findings illustrate a potential limitation in prior work in which the meaning of a sign in a PI practice is fixed by an adult before it can be appropriated for a problem by the young person (Veresov, 2014).

Following prior work with adults (Elsden, Nissen, et al., 2016), the findings demonstrate that when personal data is framed as playful and expressive, it can act as a 'ticket-to-talk', helping the user to connect with others and share aspects of their identity. Though schools are inherently social places, prior work with PI in schools has tended to follow the conventions of PI with adult users (Li et al., 2010), treating it as an individual rational activity (Garbett et al., 2018). This chapter's findings address this gap and motivate future work: showing that peer-to-peer interactions could be a powerful tool for supporting and

enriching youth meaning making (RQ.3). These findings echo Freeman & Neff in showing that teens see personal informatics as a fundamentally social activity, not an egotistical one.

The gap in prior work considering youth motives of PI users in schools may relate to the challenge of managing the wide range of voices in a classroom, given the constraints of the school day. Differentiating for the concerns and motives of youth participants may present a barrier for research (Matteucci, 2017). These findings indicate that young people may value such flexibility and collaborate to support each other's activities and learning: a greater degree of agency over the focus of the teen practice may address this limitation.

Whilst the design team valued the support of peers, they recognised the dangers of sharing personal and potentially sensitive details with others. Their design choices prioritized privacy and curation; ideas like that of a private forum attempted to negotiate the tension between supporting social connections and protecting young users from harm. Contributing to prior work (Garbett et al., 2018), *LifeMosaic* explores how youth identities can be anonymised while allowing the data to be shared as a public object of inquiry. The use of ambiguous symbols and personalised systems of evaluation could suggest some further directions for design addressing this important challenge (RQ.1). Future work should consider how youth self-tracked personal data can be curated by the young person and protected from misuse, without restricting its social value.

Design has often ignored the perspectives of end users and this is particularly true in design for young people. Though co-design has proven a powerful method for explicating youth values (Iversen et al., 2012), work here can be limited in the agency afforded to

participants (Bratteteig & Wagner, 2016). The present chapter expands on work in this area by reporting on design with teens whose contribution is higher on the "ladder of participation" (Andersen et al., 2015) than is typical in co-design with young people. These findings demonstrate the value of this approach for gaining insights about teen concerns and characterising opportunities for future research. Following prior work (Coenraad et al., 2019), the findings demonstrate how co-design can empower youth to express personal concerns, motives and identities; breaking away from prescribed norms and curricula.

7.7 Limitations

A limitation of the present study is in its transferability to other school settings. It is not practical for a school to coordinate a process of co-design every time they want to run a PI based intervention. Though the design team suggested a few aspects of intervention which schools could implement, it is still necessary to test such interventions with groups of students who were not involved in the design process. The next two chapters in part aim to address this aim.

The design work was carried out with a single design team at a single school and through serendipitous circumstances. The work was in no small part a product of the rare talent and determination of the particular students involved. Initiating this kind of design with additional design teams could significantly expand the rich data and better ensure that the case studies are representative. Indeed, I initiated similar design processes with three or four other teams of students in my role as a teacher, with results that were positive but less striking in terms of student self-determination and depth of thought behind design choices for the technology.

Finally, I regret that I did not make notes on my own work on the project. A more reflexive approach to how I managed the team could help clarify my own contribution and how my own choices supported or hindered the design process. I largely left it up to the team to tell me when something was not working (such as taking turns to lead discussions) without noting and reflecting on such aspects of the design work. In foregrounding the teens' voices, I have overlooked or understated ways in which the form and content of the work might have been different without my involvement.

7.8 Conclusion

This chapter investigated how the design of PI tools could support teen's PI practices. The teen design team in the study confirmed some of the conclusion from previous chapter. The participants wanted their PI tool to be flexible and customisable: with units of analysis that could change over time. They wanted their data visualisations to be polysemous: casual enough to allow multiple interpretations. Finally, they wanted to share their data with others but in a way that was carefully curated and protected their privacy. (RQ.1) The overriding motive for each of these design choices was a greater sense of agency for the user (RQ.2).

The present chapter placed a greater emphasis on social interaction. While the method of co-design framed the design work as collaboration, the tool which the design team designed also became increasingly collaborative in its intended uses. The team stressed that the most motivating and supportive uses of the *LifeMosaic* app would come about out of interactions between peers in discussing and reflecting on data, whether face to face or on a dedicated forum. The social interaction could be an opportunity to share ideas and advice, ask questions, and make the tool user feel less alone in any problems they were going

through (RQ.3). This kind of sharing was contrasted with the kinds of interactions the team had encountered on platforms like *Instagram*, which they felt were not conducive to supporting their wellbeing.

Another key suggestion from the present chapter concerns implementing PI in schools (RO.3). When the subject is their own everyday lives, teens should have a meaningful say in the criteria, metrics and outcomes within which they are evaluating themselves or about which they are being taught. PI can encourage this kind of personalised learning as well as developing teens' skills of engaging in such negotiations and evaluations.

The next two chapters will investigate how PI can be implemented in schools in practical ways that cohere with their existing practices. Drawing on findings in the last two chapters, these studies will need a training/scaffolding phase to introduce participants to self-tracking and the opportunity for peer collaboration in clarifying self-tracking motives, and in interpreting PI data. Motivated by findings of the preceding chapters, the work in the following chapters aims to develop opportunities for young people to reflect on their emotions as well as everyday life factors like exercise and sleep.

N.B.

The design work continued for a further two years after the present study concluded. The design of *LifeMosaic* expanded to feature avatars and a choice of interactive setting (forest, dessert, ocean) to replace the white tile on the daily tile screen. The team were finalists in the 2021 Longitude Explorer prize.

8 Case study: Learning about sleep hygiene with self-tracking

Parts of this chapter have been published in (Potapov, 2021a).

8.1 Introduction

This thesis has argued that involving personal informatics in wider social practices can support users in drawing personally meaningful insights from their data. Discussing their data with others can support later independent tool use by helping them form relevant concepts for interpreting their data – this is a process Vygotsky called *internalization* (Veresov & Mok, 2018). The preceding chapters characterised the interpretation of PI data in the context of wider social practices, but did not analyse the social interactions involved in such interpretation processes. A number of recent studies have confirmed Vygotsky's suggestion that group-based reasoning improves students' subsequent individual reasoning on a task (Augustinova, 2008; Coppola et al., 2022; Wegerif & Mercer, 2019). Group discussion can also help students develop concepts and frameworks which are useful outside the specific task domain (Reznitskaya et al., 2001; Sedova et al., 2019). These effects can be seen in planned and spontaneous learning across a wide range of contexts (Slavin, 2012).

8.1.1 Social and Emotional Learning

The new 'Relationships & Sex, and Health Education' curriculum in the UK[59] is among the growing number of strategies targeting youth wellbeing and self-determination. Schools in

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[59] RSE has been a part of the broader area of "personal, social and health education" (PSHE) for some time. Though schools could deliver PSHE and RSE concurrently, many are transferring PSHE content to RSE. Citizenship is another curriculum area where there is some possible overlap here. Given the statutory requirements and the extensive reforms for RSE, it's likely that many schools will prioritize this area.

the UK have a statutory requirement to support adolescents in learning how to make good decisions in aspects of their life from friendships to stress management (Emmerson, 2018); however, little is known about how such autonomy can be facilitated in a classroom context (Moynihan et al., 2015). Technology could play a role in the design of such pedagogical strategies. Rubtsova (Rubtsova, 2019; Rubtsova, 2020) reports on studies in which semi-structured technology use offered adolescents a "training platform" on which to enact ideas, values and other aspects of their identity in ways that could be personally insightful and empowering.

Slovak & Fitzpatrick note that a central challenge for social and emotional learning (of skills such as self-awareness, social awareness and responsible decision making) concerns transfer of the learning to real-life contexts (Slovák & Fitzpatrick, 2015). While activities like group discussions, journal writing, and workshops have proven effective with teens, less is known about how the skills can be implicated in everyday life. Technology could both support such boundary crossing (Akkerman & Bakker, 2011), and encourage independence (Fonseca, 2020). Slovak & Fitzpatrick suggest one mechanism for this could be in "presenting ambiguous cues, which can nudge people to engage, interpret, and reflect on their experiences" (ibid.) This is close to how personal informatics has been characterised in preceding chapters.

Sleep is a key aspect of health education for teens, though it is often absent from any particular national curriculum (Elfarsdóttir, 2021; Gruber et al., 2019) The UK relationships & sex, and health education curriculum is perhaps unique in requiring that secondary school students be taught about "the importance of sufficient good quality sleep for good health

and how a lack of sleep can affect weight, mood and ability to learn."[60] That good decisions

around sleep can support adolescents in each of these life areas is now well established

(Peltz et al., 2019). Sleep education has proven an effective strategy in supporting such

decision making (Illingworth et al., 2020; Wolfson et al., 2015). The challenge is to deliver

sleep education which is relevant to adolescents and responsive to the varying external

factors they need to navigate in their everyday lives (Illingworth, 2020). In a very relevant

study, Ploderer et al. (2022) report that teens discussing their own sleep data are able to

make personal insights about healthy and unhealthy decisions around sleep.

The present chapter reports on a study of PI-mediated learning framed around sleep

hygiene. The study investigates whether manually collected data can support the transfer of

concepts from class discussion to everyday life, and vice versa. Discussion of personal sleep

habits in a semi-structured classroom setting could offer a *training platform* (Rubtsova, 2020)

for teens to test out roles and concepts related to sleep. The study addresses RO.3: *To design

classroom interventions that facilitate teen meaning making with self-tracking data*, and is

motivated by the following research questions:

RQ.1: Can personal informatics support curriculum-relevant learning about sleep

hygiene?

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[60]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1019542/Relationships_Education__Re
lationships_and_Sex_Education__RSE__and_Health_Education.pdf

RQ.2: Does discussing personal data with a small group of peers support its interpretation?

RQ.3: Can personal informatics support the transfer of knowledge between home and classroom contexts?

8.2 Methodology

Neil Mercer is a Vygotskian whose *Thinking Together* lab in Cambridge has been studying the many ways in which classroom talk can support learning. *Thinking Together* provides helpful resources and guidelines for facilitating student discussions. Mercer and colleagues (Mercer & Dawes, 2011; Mercer et al., 2019; Mercer & Sams, 2006) ground in educational research many of the findings that have already been discussed earlier in this thesis: they offer a helpful starting point for researchers hoping to carry out similar interventions in other educational contexts. The work focuses on the discussions of groups of 4 – 8 students. Mercer advises that group facilitators hold a session prior to the discussions in which some ground rules are established and students are shown examples of the practices they'll be engaged in (Mercer & Dawes, 2011). This session should stress that it is the reasoning of the young person which will be valued in the discussion. Mercer et al. find that shared attention on a digital technology can support reasoning in discussion and stress that young people should have time to experiment with these technologies in self-directed ways (Mercer et al., 2019).The present study follows Mercer et al.'s guidelines.

8.2.1 Participants and procedure

The research was approved by an institutional research ethics committee and took place at a secondary school in London during weekly 40-minute periods designated for social and

emotional learning and life skills (RSE). Participants were asked to download, use, and discuss data on *LifeMosaic*, a self-tracking app designed by a different group of students in the previous study (Chapter 7). The study was piloted with a group of Year 12 students at the same school. The pilot group could track a focus of their choice on *LifeMosaic* such as "being sociable" or "time management", then discuss the data they collected with the group. The students found this confusing and reflected that they did not value the sessions because they were not learning anything. On this basis, I revised study design so every participant tracked the same topic on the Relationship, Sex & Health Education (RSE) curriculum.

I subsequently arranged a meeting with the two teachers coordinating RSE at the school. I explained my research, sought guidance about delivering the curriculum, and got feedback on study design. We also discussed the possibility of using PI in peer mentoring and agreed on some resources I would create for other teachers to use in RSE sessions (outside of the present thesis). I chose the topic of *sleep* partly as a result of this meeting. One of the teachers suggested that I come to her class when she is scheduled to teach RSE and introduce the class to some topics relevant to my research. We felt this was a good way to recruit participants and a good group of students to work with.

To frame the study, a class of Year 8 students (12 – 13-year-olds) were introduced to digital literacy ideas around personal data, including data privacy and how data could be useful to them. They were introduced to the concept of self-tracking technology and practices of interpreting data visualizations on *LifeMosaic*. This supported students in making informed consent to join the study by helping them to understand the topic, as well as some risks of using technologies that collect personal data. The class was asked if they would like

to take part in a study trialling the app to track their own sleep. Seven participants (3m; 4f) joined the study by returning forms of assent and parental consent.

Participants were invited to a short briefing before the study to review key study information and to clarify my role as a researcher. It was emphasized that they could withdraw now or at any point in the study. All participants completed the study to interview stage. Participants were asked to use the *LifeMosaic* app on their smartphone for a week to log how well they slept and anything they thought was affecting or affected by their sleep. At the end of the week, they met with me and the rest of the group at a classroom in their school to share anything they learned about sleep based on their self-tracking.

Participants were free to uninstall the app at any time, with or without withdrawing from the study. Although I had obtained permission for participants to send me screenshots of their *LifeMosaic* screens to use as study data, it proved tricky for me to request a screenshot from the participant's phone without disturbing the practices of curation promoted throughout this thesis. I chose not to collect this data from the participant's own phone and to instead reconstruct some of the visualisations on my own phone with their help. During the **discussion session**[61] participants sat in a circle and shared anything they found interesting or informative in the data they had collected in the previous week on *LifeMosaic*. Participants could choose when to contribute to the discussion and whether to show their personal data to others. I gave prompts and questions and brought the discussion back to

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[61] This was also referred to as a "workshop" in the transcripts.

the topic of sleep, as well as offering relevant information about sleep when it was appropriate to the participant-led discussion. Participants' comments and queries were allowed to motivate wider discussions without rebuke for error or digression.

Participants involved in the study in Chapter 6 suggested that they would be completely comfortable discussing their sleep data with their peers (more so than topics like *friendships* and *exercise*). Nonetheless, the present study could still elicit discussion of sensitive and upsetting topics, particularly as participants were being asked to reflect on and share details about their own lives. I had experience of teaching RSE and PSHE, as well as wider experience of discussing sensitive topics with teens, and was able to direct the discussion to maintain a safe space. Given the personal nature of participant's contributions it was important to set ground rules at the start of the session, stressing no interruption, mockery, or passive aggression, and modelling how to offer an alternative view constructively. The group agreed that anyone who broke these rules should be asked to leave the discussion and return to their tutor room. I did not need to enforce this consequence.

At the end of this discussion session, participants were encouraged to use the app for a further week, after which they attended a **one-on-one interview** in the same classroom and timetable slot. The interviews focused on whether the participant felt they had gained or learned anything from tracking their sleep and discussing their data. It was also an opportunity to give feedback on the discussion session / workshop, as well as the *LifeMosaic* app. I also summarised what the study had been about and shared some of my initial thoughts from analysis of the recording. I had planned to do more meaningful member checking but was unable to due to Covid-19 lockdown.

8.2.2 **Data collection and analysis**

The discussion session and one-on-one interviews were audio recorded, transcribed and analysed on NVivo together with handwritten notes. Sociocultural discourse analysis (Mercer, 2004) was adopted as an analytic framework. Sociocultural discourse analysis was chosen in order to analyse the social dynamics within study sessions. The framework takes a Vygotskian approach to broadly capture the pragmatics of discourse, rather than focusing on the minutiae of every utterance like some more linguistically oriented approaches to discourse analysis (Martin, 2021). As well as this, Mercer is one of the few researchers to recognise that analysis may need to take place across multiple sessions as learning is a gradual process. (Mercer, 2010). The focus of the analysis here is on how concepts develop between people and over time. I supplement the analysis with some additional Vygotskian concepts, as outlined in Chapter 4, including *signs* and *everyday/scientific concepts*; these are used as heuristics rather than a predetermined topography. In the present context, this approach can improve on traditional discourse analysis by characterising the reasoning of participants as well as the role of technological artefacts within that reasoning. Vignettes from the discussion session are chosen to illustrate social interactions in which personally-relevant learning can be said to have taken place. Two vignettes selected from the discussion are not presented here though they capture dramatic situations. One of these vignettes repeats the same ideas and the other is less relevant to the topic. I also selected a handful of vignettes from interviews but do not include them in the findings because their social dynamics are not comparable to the group discussion. This learning can broadly be labelled as relating to *technology and sleep*, *diet and sleep,* and *emotions and sleep.*

8.3   Findings

8.3.1   Technology and sleep

At the start of the session participants were somewhat reluctant to share what, if anything, they had learned about their sleep in the previous week while using the *LifeMosaic* app, with Chanel commenting, *"I'm not really sure what to say"*. Tom was the first to volunteer a response.

Vignette One

Tom	Yesterday I went to bed pretty early. About ten thirty. But other nights I stayed up, but usually it's fine.	
Me	Is that something you learned with the app?	
Tom	No. Just some days I have good sleep, other days I don't, so you can just track it.	
Me	Okay and on some nights you had good sleep. Why do you think it was good?	
Tom	Because if you go to bed early it's good because then you focus better in lessons.	
Me	Okay and have you found if you go to bed at ten thirty then you focus better?	
Tom	Yeah.	
Me	Is that what you put on LifeMosaic? Can you tell us a bit about your data?	
Tom		*Tom puts his phone flat on his leg so that the LifeMosaic daily tile screen is visible to the group.*
	I put it a bit blue because I'm still tired a bit and then on other days when I went to bed later then I'm obviously more tired.	
Me	Okay. Is there anything else you noticed from your data? Did you use stickers?	
Tom	No.	
Me	That's okay. So on some of those days where you stayed up later, did you notice anything?	
Tom		*Tom picks up his phone and looks through his LifeMosaic data.*

So, Tuesday I put it as dark blue because yeah, I was really tired on that day. Like yeah I was literally falling asleep. Yeah, and I don't even know. I just go on YouTube usually/

Chanel   Yeah same.

Me   That's interesting. How many of you stay up late because of YouTube?

Chanel   Yeah, because you get sucked in. Yeah, so if you watch something and you have certain channels that you follow and then you just watch them.

Tom begins this vignette referring to *sleep* and *tracking* in the abstract, as scientific concepts. In giving "because you focus better in lessons" as a reason for having good sleep, he seems to be trying to offer *the right answer* in his role as student, rather than reflecting on his own experience: he is relying on certain 'internal scripts' (Tchounikine, 2016). While such scripts form an important part of our discourse, they can also suggest limitations to our responsiveness to reasons: displaying habitual stimulus and response structures more than full-fledged reasoning (Seibt, 2009). Tom may be reaching for such scripts because he is not sure how to go on. He is not familiar with conversations about his personal data. Part of what is being negotiated here are the norms of the conversation.

While at first Tom does not refer to his own data or make any inferences from it, being prompted back to the data brings his story line into a new domain. My role as facilitator here is in initiating attention to the data and framing its interpretation. With these semi-structured roles in place, discussing the data broadens its meaning. By the end of the vignette, a data visualisation Tom is looking at on his phone offers a "ticket-to-talk" (Jarusriboonchai et al., 2014; Sacks, 1995) for Tom to expand and personalize his story, seeing new significance in the data. Indexically treating *this data* as significant reframes Tom's understanding.

Once Tom negotiates a role in which he can introduce everyday concepts around sleep habits, this opens opportunities for his peers to be brought into the discourse. They identify with Tom's story, offering their own experience of staying up because they are watching Netflix in bed or are too distracted with their phone to finish homework. In his follow-up interview, Tom proposes that self-tracking can *"give you a different perspective on [sleep]"*. Asked if he now feels differently about his sleep, Tom refers back to his reflection in the discussion session, suggesting *"…if I stay up on my phone I might not stay up as late or I might keep it in mind."* Tom did not initially make inferences about his phone use from his self-tracking data but the process of discussing and justifying the data established this connection. Tom expands his learning by entering a *zone of proximal development* with his peers and the facilitator (Sannino & Engeström, 2017)[62].

The interaction in this vignette led to insights that are helpful and relevant to sleep hygiene as it is described in the RSE curriculum. Later in the session, participants drew on their own experiences and ideas to suggest how healthier habits might improve sleep, such as charging the phone in another room or using a blue light filter (Poppy). This echoes the findings of prior work on the negative impact of technology use on sleep (Amra et al., 2017; Mireku et al., 2019), and how healthier habits might improve sleep (Bartel et al., 2019).

8.3.2 Diet and sleep

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[62] The structures of mutual recognition within the situation support recursive adjustment between teaching and learning, such that the learner is brought into activities in which they are not yet a fully competent participant.

Although Ali had not used the app every day, he was keen to show his data visualizations to the group for the days he had collected it. He had added several stickers to his daily tiles (see previous chapter) and explained the meaning of some of them during the discussion, with the topic of diet becoming prominent.

Vignette Two

Ali	I don't know if it was this one or Friday.	
		Ali holds up his phone to show his LifeMosaic tile on the screen.
Me	Right so the darkness is how tired you were and was there anything else you noticed in terms of your data?	
Ali	So, I put burgers because I went to Sam's [fast food chain].	*Some participants laugh.*
Carly	You always go Sam's.	
Me	Do you think that was related to how you were feeling?	
Ali	Yeah, because if you get stressed you eat.	
Me	That's really interesting, can you explain?	
Ali	Just because you're stressed so you want to buy yourself some chicken.	
Chanel	Can I say?	
Me	OK quickly.	
Chanel	It's called comfort eating because if you feel bad you eat food to give yourself a treat.	
Me	That's really important yeah. Do you think that's a good idea?	
Chanel	Obviously no because it could be unhealthy.	
Ali	In small quantities.	
Me	Right so you can treat yourself to junk food once in a while in small quantities. But do you know actually your sleep does affect what you eat a lot. You're a lot more likely to eat junk food if you sleep badly and if you don't get enough sleep on a regular basis it can really affect you having a healthy weight.	
Dharma	Sir, on mine I actually put a burger on the days I didn't sleep.	*Dharma indicates to her phone but does not show her screen.*
Me	That's really interesting.	
Poppy	I think it affects your self-control.	

Me	Can you explain that?
Dharma	Let's say you don't sleep. Then your brain isn't focusing properly and you can't be bothered to get healthy food.
Poppy	Yeah.

Ali has added a burger on one of his daily logs on *LifeMosaic* to signify Sam's Chicken Restaurant. He does not suggest any association between this and his sleep. Mentioning "Sam's" makes others laugh because of its significance in his peer group: it is a hangout spot for Year 8 boys, as Carly acknowledges. Ali continues in this joking role with his peers in suggesting that he eats chicken when he is stressed, when invited to justify the relevance of his initial assertion. However, when Chanel takes up the role of a student with valuable knowledge about "comfort eating", Ali now genuinely attempts to justify his past activity. Chanel has potentially judged his visit to Sam's as *unhealthy* or *comfort eating* and Ali negotiates his story against this new ideal by saying it is acceptable "In small quantities." Normative boundaries implicit in these practices become visible through the articulation of reasons.

In treating Ali as if he is contributing to a practice of learning about sleep, he and others are able to recognize this role and its wider social value (Sannino & Engeström, 2017). The meaning of the data and of Ali's explanation of it changes through the discourse. The discourse offers positive constraints that expand the learning by bringing Ali's assertions into a new domain. In interviews, Chanel and Ali refer back to the link between diet and sleep, with Ali suggesting he learned about *"...things that affect your sleep, or you don't sleep and then you just want to munch."*

Over the course of the interaction in this vignette, the group expanded their understanding of concepts related to diet and sleep. Though it's unlikely that a correlation between diet and sleep would be visible after a week of tracking in Dharma's data, she casts her own data as showing this correlation. Her suggestion that she *"put burgers on the days [she] didn't sleep"* suggests that these are concepts she could adopt to reflect on her experiences in future. The inter-personal data-mediated dynamic arguably made the participants more receptive to hearing relevant information about sleep hygiene from me, and later helped Poppy to make sophisticated inferences about how low sleep could affect impulsive behaviours.

While my role in the first vignette was to positively constrain the students' understanding by bringing in indexical connections, here the positive constraints I introduced were symbolic. Ali is already employing everyday concepts to describe his data; the limitation here is that such concepts are relatively unreflective. When Chanel introduces the concept of "comfort eating", she can still be said to be enacting a kind of script rather than judging the data. In my extended contribution near the end of the vignette I reframe some of the concepts already in play (linking diet and sleep), emphasizing some of what I take to

Figure 9: Ali used burgers to indicate going to a fast-food place.

be important about them. I reinforce the learning in this zone of proximal development by introducing scientific concepts that are relevant to the discussion. Scientific concepts empower us by giving us that by which we can reason about our own actions (Derry, 2013): they facilitate reflection that lets us stand in a new relation to our experience. For Ali, they allow his data to say something insightful about what is healthy. All the participants switch from talking about Sam's Chicken to talking about the connection between diet and sleep, recognizing that there is more power for them in articulating reasons in the new domain.

Though I introduce the connection between diet and sleep as something that is noteworthy (Gohil & Hannon, 2018), Poppy further expands the group's learning through the connection to self-control. This again is a helpful insight supported by the research literature (Meldrum et al., 2015; Pilcher et al., 2015).

8.3.3 Emotions and sleep

The group discussed factors which affected their sleep as well as factors which were affected by sleep. Stress and emotion were often referred to. Dharma showed the group a visualization of her day and explained what the stickers she has been using signify.

Vignette Three

Dharma	Yeah, like I said if I was out with my friends or I had a lot of homework. That's the book one.	*Dharma is holding her phone up with a LifeMosaic tile on the screen.*
Me	Okay, so you used the book for homework and then another one…	
Dharma	Yeah.	
Me	And do you think those affected your sleep?	

Dharma	Erm, well I think it definitely affects it. Yes, because on Wednesday I had a lot of homework so I stayed up doing that and on a day you have a lot of homework you might stay up because you have to do it.	
Me	Okay, so that's why you were tired on Thursday?	
Dharma	I think so. I sometimes do it in the morning. Or, basically if you have a lot of homework you get stressed because you know you have to do it.	
Me	Definitely. So, you think the stress affected you?	
Dharma	Yeah. I thought it would show like…	*Dharma is looking down at the phone in her hand. She is searching through her LifeMosaic data.*
Me	You thought the data would show it?	
Dharma	Yeah. But I know stress affects me though.	*Dharma puts the phone down on her lap.*
Me	But your data didn't show it?	
Dharma	No. Can I change mine?	
Me	Yeah.	
Dharma	So basically, on Thursday something happened in school so that's why I put stressed and friends. So, I think that affected me and I put that one.	
Me	Okay and then now you don't think homework affected you?	
Dharma	Not affected. No, like obviously if you stay up and you're tired it affects you but not in that way. Like if something happens it's going to affect you more. So, I think friends is more important than homework… If I don't sleep, that is probably why.	
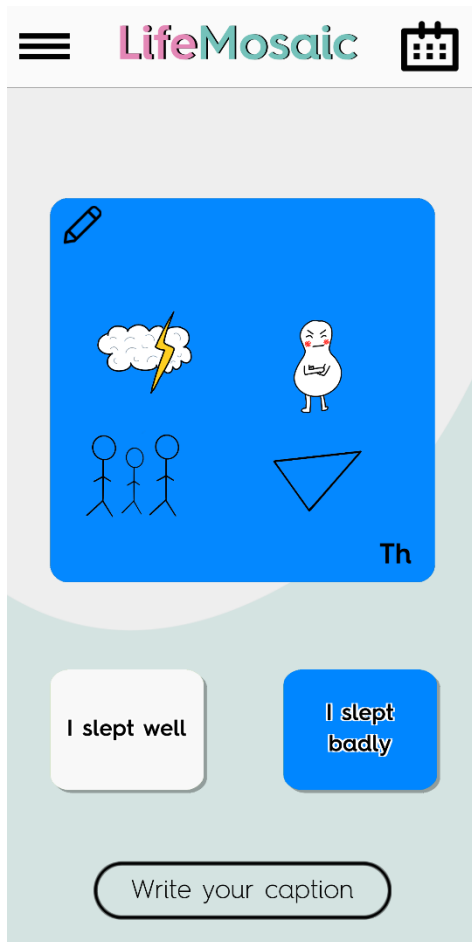
Figure 10: Dharma had bad sleep and felt stressed.

In this vignette Dharma is explaining why her sleep on some nights was much worse than others. Dharma moves from a first-person focus on the particulars of what she was doing to evaluating her actions as conventional or appropriate within a wider system of norms through the perspective of an ideal "you" who comments "you have to do it... you know you have to do it". Though Dharma is keen to clarify and justify her past activity, as she develops her story line, the flow of the narrative is broken when she is unable to use her *LifeMosaic* data to illustrate her point. While in the preceding vignettes I facilitated the interpretation process by constraining the narrative through indexical or symbolic connections, here Dharma is already able to constrain her own narrative by way of her personal data. The data acts as auxiliary signs by which Dharma can orient her own activity (Vygotsky, 2012b, p. 32).

Dharma seems to perceive her role as giving testimony to something she needs permission to "change". The formation of a narrative is helpful in facilitating reflection on personal data as it suggests a level of metacognition while drawing on genres familiar to the participants. Such discourse lets us *"relate to ourselves as if from the sideline"* (ibid., p.16). This

was also the finding of Stornaiuolo (2020) who encouraged teens to form narratives about their data in order to encourage reflection on aspects of their lives like their social status.

The contradiction between the initial story line and the data reveals new layers of complexity: the word "affected", used previously to describe the emotional impact of external factors on sleep, now proves inadequate in expressing this nuance. Dharma now evaluates the significance of disparate aspects of her experience against a broader evaluation of her life. The metonyms of "homework" and "friends" in the narrative correspond to stickers to which she assigned these labels on her app. In her subsequent interview Dharma showed a visualization on LifeMosaic in which these indices participated in a complex system of symbolic meanings:

> I [tracked] sleep but I did like different things, either if it was good, and then [if] it affects you, so I did the sun as well... or on this one it's more dark where I didn't sleep that good and you can see I didn't do that much, and then as well you can see I was stressed.

Dharma is reporting on aspects of her data as they come to mind while she looks at her phone. Although she refers back to concepts from the group discussion like stress and being active, these now seem to operate in a wider domain of personal significance – there is more that she means by noting these concepts. There is clearly still more to unpack in the data Dharma has collected were she to attend another session with her peers. A number of factors are represented in her visualisation which she takes to be related to sleep including sleep quality, mood, and the activities she engages in on the next day. She is keen to monitor the relationship between these dimensions. Though the data visualisation here only features a

sun, triangle and speech bubble on a blue background, Dharma suggests it lets you "see" that she is stressed. She has set up a visual language to communicate these aspects of her experience.

Although the exchange in Vignette Three was between myself as facilitator and one student, another participant (who was reluctant to contribute to the group discussion) appears to have appropriated some of Dharma's concepts into her own practice while collecting her own data independently. The following vignette is taken from interviews, a week after the discussion session.

Vignette Four

Me	Okay and you tracked your sleep? And did you learn anything about your sleep?
Sarah	Like stress. If you don't sleep you feel stressed.
Me	Okay and is that something you noticed or was it from the last workshop?
Sarah	Yeah workshop.
Me	And do you think it's relevant to you?
Sarah	Yeah, if I don't sleep, I put a cloud because I feel stressed or lightning, or yeah.
Me	Great and those were things on *LifeMosaic* about stress?
Sarah	Yeah, and I put friends and like I tried to use different ones [stickers on *LifeMosaic*].
Me	OK and the symbols mean you're stressed?
Sarah	I just do it for how I feel depending on sleep or like anything.
Me	And the different stickers are different feelings?
Sarah	Yeah.

When Dharma made the insight that "friends are more important than homework" in Vignette Three, there was a sense of recognition from other participants. Participants

205
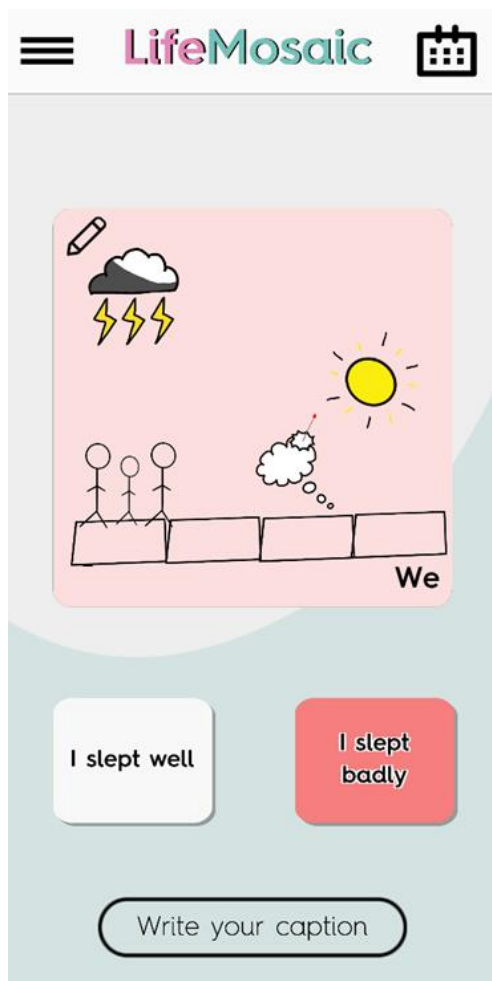
Figure 11: Sarah used the weather to represent mood.

referred to "friends" multiple times in the antecedent discussion, as a factor affecting sleep and wellbeing. It is also noteworthy that while Sarah's interview answers are fairly limited and she is reluctant to take on the kind of storytelling role adopted by Dharma, Sarah can nonetheless use her data to express a complex and nuanced set of personal experiences: noting differences from day to day through her choice of stickers, and sometimes combinations of stickers. The stickers in Sarah's visualisation express aspects of her experience which she may be finding it hard to articulate into words. Dharma's stories may have helped model this complexity for Sarah and others. Prior work has suggested that exploring the connections between social conflicts, stress, and sleep may be beneficial for adolescents (Dahl & Lewin, 2002) and the self-tracking practices Sarah and Dharma engaged in proved helpful in scaffolding such exploration.

8.4 Discussion

The case study analysed in this chapter explored young people's use of the *LifeMosaic* app to investigate whether practices mediated by this technology could support social and emotional learning skills, including self-awareness, social awareness and responsible decision making. The findings suggest that self-tracking technologies and practices may help young

people to reflect on their everyday experiences and to make personally relevant insights, which could support decision making. The process of collecting and discussing personal data may contribute to the development of skills and strategies for self and social awareness and problem solving. Echoing Splichal et al. (2018), this study demonstrates that computer supported collaborative learning can support students' reasoning and reflection on personally relevant topics.

While prior work bringing self-tracking technology to the classroom has often focused on the transfer of specific curriculum content, the discursive nature of the present study blended adult instruction with youth exploration of concepts the participants themselves found valuable or intriguing. Though the study focused on the topic of sleep, participants also reflected on other curriculum-relevant topics such as diet and stress. Future work could investigate this pedagogical approach with other kinds of self-tracking e.g., mood, physical activity, or even metrics relating to arguments the young people got into. From a pedagogical perspective, the approach in this study challenges the traditional top-down delivery of content in social and emotional learning curricula (Long, 2018). Personal informatics practices supported a bottom-up approach which better addressed relationship & sex and health education's objective of empowering young people to make their own informed decisions in managing their physical and mental health. There is a challenge here in that not all students in a class would consent to downloading a PI app and it is vital that staff respect and emphasize this autonomy. However, this chapter's findings suggest that having just a couple of students in a group who have engaged in self-tracking can be enough to stimulate discussion and facilitate learning for the whole group.

It should be noted that the concepts offered by participants in the one-on-one interviews are limited in the extent to which they can be called *spontaneous.* That participants referred to themes from the discussion session of a week earlier is not adequate to establish whether they had integrated this knowledge into their everyday practice. This is not a major limitation as the focus of the study was on learning rather than development. Where the study activities did appear to aid development was in students' abilities to form cogent self-narratives involving knowledge about sleep. The impact of such learning on broader development within the adolescents' everyday life practices is a topic for future work.

In interviews, participants did not simply regurgitate the knowledge imparted by me as the facilitator but explained what they learned, contextualizing it in their own experience. Some now challenged rather than reaffirming the concepts introduced in the group discussion; for instance, Dharma suggested that she would continue using her phone in bed if it could help her feel less stressed before sleep. Abstracted concepts like "If you go to bed early it's good because then you focus better in lessons" had expanded into a wider system of related and personally relevant concepts, which the young person evaluated against their sense of identity/personality as a whole. Following Ploderer et al. (2022), I argue that such reflection can support teens in making healthy decisions around sleep.

One limitation suggested by Tom here was in the fact that it was sometimes a challenge to see the data visualisations a participant was showing on their smartphone. In pilot studies we tried sending a screenshot of a visualisation to a mentor/facilitator prior to discussion, but this spoiled the dynamic nature of sharing data as part of the emerging discourse. A

better solution may be for students to be able to put their phone under a visualiser (a small camera on a flexible stand found in many classrooms).

The findings in this chapter illustrate some general principles for orchestrating the interpretation of personal data in the classroom. Most insights about data happened not when the participants were asked to explain their data but when they were explaining something about their everyday life and were prompted back to the data. Here, the data either specified a concrete situation they could explain or contradicted their narration, forcing them to offer alternative justifications. Following Mercer (2010), the main focus for the facilitator here is to ask questions or elicit reasons rather than challenging or offering their own interpretations. There is a balance here between asking teens to explain their experience and framing these explanations through the positive constraints offered by the data i.e. bringing them into a domain relevant to the learning objectives. For example, in the second vignette, the visualisation allowed for everyday talk between peers about a fast food place to be treated as contributing to valued discourses about diet and sleep. As a student offers their interpretation, the data visualisation could be treated indexically ("Is that what this data shows?") or symbolically ("How else could we interpret this?"). What is being reinforced here is that the same data can have multiple interpretations and can mean different things to different people. This was also a key part of the scaffolding session prior to the study (In which the class were introduced to the concepts of self-tracking technology and personal data).

Personal informatics data is well placed to make discourse either more formal and objective or more personal and subjective depending on how it is appropriated in social

practice. Though an argument of the present thesis is that *any* data can play this role, the practices of personal informatics are particularly pertinent here. PI can be contrasted both with something more impersonal like business informatics and something more subjective like a diary entry. It can speak with both an informal and a formal voice: it can express a feeling or ground what's true.

Self-tracking visualizations have affordances that make them publicly available in ways that can contradict the interpretations of their user. This prompted participants, including Tom in Vignette One and Dharma in Vignette Three into a process of justification and clarification which expanded their learning. As Vygotsky argues, while everyday concepts make learning personally meaningful, scientific concepts give us agency by organizing everyday concepts and the experiences they're embedded in (Vygotsky, 1987b). Yet what was at stake here was not just curriculum learning but their whole identity: their social roles and the coherence of their past experiences. Returning to MacIntyre may be helpful here:

> *Reflective agents increasingly understand themselves and others in terms of a certain kind of narrative, a story in which they as agents direct themselves or fail to direct themselves toward a final end, the nature of which they initially apprehend in and through their activities as rational agents. Progress toward that final end is marked by slowly and unevenly increasing self-awareness and self-knowledge, so that agents become better able to understand what in their past has gone well and what has gone badly in their own lives and in the lives of others with whom they have interacted and why.* (MacIntyre, 2016, p.54)

By collecting data about themselves for the purpose of later reflection, on their own and with others, participants framed the data, and thus their own activities, in particular ways. The data scaffolded adolescents' reflections by acting as memory cues as well as expressions of what they judged to be significant in their everyday lives. The act of sharing their data with others prompted them to experiment with roles in which they could make sense of their past and create narratives to explain their decisions. The fact that the data were shared objects of inquiry meant that the narratives could be contested or reinterpreted by others, prompting the storyteller to offer further justifications. This led to some richer and more concrete learning experiences than is typically found in learning instruction for social and emotional learning in secondary schools (Formby & Wolstenholme, 2012). Participants were keen to exercise skills relevant to the development of their identities. Through its appropriation in social practices of interpretation, personal data on the *LifeMosaic* app took on new meanings which could allow future reflection to happen with greater levels of granularity.

8.5 Limitations

The study took place during Covid-19 lockdowns. There was a lot of uncertainty around who would be in school and when, and schools were subsequently shut for an extended period of time. This restricted study design in a number of ways. Interviews took place one week after the discussion so felt a little forced and artificial. Having limited time for some of the interviews and multiple questions "to get through" left little opportunity to fully explore what participants had learned. With more time, I would have liked to have held a later session and explored methods other than interview for formatively assessing learning and promoting reflection on the experience. A related limitation was that the work was carried

out with a single group of students. Carrying out the intervention with other groups and perhaps other discussion topics would have presented new peer social dynamics and offered more data from which to draw vignettes and identify challenges and opportunities of working in this context. There were initial plans to run the study at my other school, but given the precarious situation, I did not want to push on this.

It may be difficult to generalise about the value of the intervention or best practice for carrying out with facilitators lacking my dual experience in teaching and HCI. I designed a couple of lessons for the school RSE curriculum but did not have the time or make plans for investigating whether these resources were used and how they were received. The group size in the study was limited by the process of returning consent forms and future work could interview teachers of larger groups. This could also explore the extent to which being participants in a study contributed to the drama represented in the vignettes.

8.6 Conclusion

While the last two chapters explored teens' motives in self-determined uses of personal informatics tools, this chapter considered how such uses can be harnessed by schools. The study reported on an intervention that could be embedded into the practices of most secondary schools in the UK, namely as part of statutory relationship, sex and health education. Most of the participants in this small case study made comments which suggested they had understood ideas relevant to sleep hygiene (RQ.1) – indeed each of the areas named in the RSE curriculum was mentioned: "How a lack of sleep can affect weight,

mood and ability to learn"[63]. More importantly, participants were able to demonstrate the overarching objective that "should be well equipped to make decisions for themselves about how to live their own lives, whilst respecting the right of others to make their own decisions and hold their own beliefs".[64] Discussing their personal data gave teens the opportunity to explore minutiae of their lives which they would not usually have a chance to articulate with others. They were the experts on aspects of their own experience and were able to draw on their expertise to listen to, relate to and advise others. The data visualisation acted as a boundary object (Akkerman & Bakker, 2011), speaking to discourses that were part of the participants' home lives as well as their lives in the classroom. In interview sessions, all participants explained something they had learned in the workshop and four had internalized these concepts as a lens they could apply to new experiences in their everyday life (RQ.3). Although the *official knowledge* (Hess, 2009) or curriculum content was emphasised by me at a few points in the discussion, there was a sense that teen participants could contest and renegotiate it. They were empowered to do this in constructive ways partly because it was *their* data that was at stake.

There was a complex dynamic of mediation between data and discourse. Participants' initial interpretations of their own data change over the course of discussion. Though the

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[63] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1019542/Relationships_Education__Relationships_and_Sex_Education__RSE__and_Health_Education.pdf p.34

[64] Ibid., p.26

data alone could not result in meaningful learning, discussion alone would not have had the positive constraints and shared focus that allowed myself and peers to ask for reasons. The fact that meaning developed dynamically between participants in the study allowed it to serve as a model for individual participants' future independent self-tracking and reflection (RQ.2). Vygotsky would describe the study setting as a situation of *drama* (Veresov, 2016): the activity within the study was not just publicly visible to the participants, it was felt to matter to them and was punctuated by its own problems and conflicts. The data took on meaning by being implicated into the drama. Such drama is arguably missing from the kinds of individualistic uses for which PI tools tend to be designed (Lupton, 2014).

9 Case study: Self-tracking in pastoral and academic mentoring

9.1 Introduction

The last chapter presented one way in which PI may be integrated into the practices of schools to support student learning. We saw that participants reflecting on their personal data with peers exercised skills and reached insights that aligned with the RSE curriculum for social and emotional learning in the UK. PI could scaffold a series of two of three lessons in which students reflect on and discuss an area like sleep, diet, or exercise. The present chapter extends the objectives of the last chapter, focusing on a different school context. It explores how PI can be implemented in an existing school mentoring programme.

Though they can both be said to contribute to social and emotional learning, there are several differences between the delivery of RSE and related curricula, and mentoring programmes. Most relevant to the present thesis is the difference of social dynamics within group and within pair interactions. That the mentor-mentee interaction is dyadic has a significant impact on the processes of meaning making it could involve. For example, by encouraging more reference to personal identity and experience (Schwarz, 2021); allowing for more differentiated scaffolding (Bearman et al., 2007); supporting relationship building (Noam et al., 2013), and empowering mentees to voice personal opinions (Ren & Deakin Crick, 2013). Peer mentoring in particular could help teens co-construct knowledge about their everyday lives and support their self-determination (Dantzer & Perry, 2023). What such dyadic relationships potentially lose (cf. 8.3) is the freedom and creativity in the drama of larger peer groups.

Personal informatics tools could add to a mentor's toolbox and could be easy to implement in a wide variety of educational settings. They could add structure to mentoring, make it more motivating, offer data points on otherwise hard to measure targets, and encourage mentees to continue thinking about their targets outside of mentoring sessions. For example, a student with poor punctuality could track the time they leave their house or even their route to school. A student who is struggling socially could track who they start conversations with. But would such data practices support or limit the students' self-determination (cf. 3.2)?

The study addresses RO.3: *To design classroom interventions that facilitate teen meaning making with self-tracking data*, and is motivated by the following research questions:

RQ.1: Can self-tracking tools support target setting in a school mentoring programme?

RQ.2: What meanings do teens draw from their data and how are these meanings changed in the mentoring practice?

RQ.3: Does self-tracking in a mentoring context contribute to social and emotional learning or self-determination?

9.2 Methodology

9.2.1 Participants and procedure

The study was approved by an institutional research ethics committee and took place at a secondary school in the context of an existing academic mentoring programme for students who are underachieving, disengaged from reading, or new to the school or country.

These students were judged receptive to mentoring by their head of year and did not have

additional needs or vulnerabilities. 6th form students mentored students in Key Stage 3 (aged

11-14). The programme took place in a school library and was overseen by a deputy head.

The aim of the programme was to give younger students a positive role model and someone

they could check in with. As part of the programme, mentors were given a brief training

session but could conduct mentoring however they wanted. They were encouraged to keep

track of SMART targets[65] agreed with the mentee using a form. One target was often focused

around reading habits. A mentoring session could also include paired reading or reviewing

homework. Mentors worked with the same students for six to twelve weeks.

I discussed the study with the deputy head in charge overseeing the mentoring

programme and we explored ways in which PI could be integrated without disturbing the

course of the programme. I initially piloted the integration of PI into mentoring with a group

of Year 13 students. I introduced students to PI in shortened version of the introduction from

prior chapters. They then attended six mentoring sessions. The students took turns to

mentor each-other in pairs. They then fed back on the mentoring practice to the group and

discussed what could make it better. They spent the rest of the sessions developing

scaffolding that could support this process. This could take the form of planned questions,

exercises, phrases, or PI apps they had found. They would test these in subsequent

mentoring of their pilot group peer. Examples of scaffolding included an exercise in which a

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[65] https://youthworkinit.com/create-a-smart-plan-for-your-youth-work/

mentee creates a visualisation of their "perfect day" and general strategies like "get them to focus on what they can do rather than their problems". I gave critical feedback on this scaffolding and offered my own suggestions based on learning from prior studies. The scaffolding itself is not analysed in this thesis but strongly (if implicitly) informs the mentoring practices reported on in this chapter and appears in condensed form in Chapter 10.4.

Mentors were recruited in 6th form assembly and joined the study by staying behind at the end to collect information sheets and consent forms and returning these to me. Two mentors from the pilot group and one from outside it joined the study, one mentor withdrew in the early stages due to other commitments. Subsequently, myself and two members of the pilot group acted as mentors in this this study.

I introduced the study to mentees during a mentoring session by briefly explaining what self-tracking is and giving examples, then suggesting why it might be interesting to experiment with in their mentoring. There was an ethical challenge here around indicating to certain students that this opportunity was not appropriate for them; for example, because of their level of English competence. I addressed this by individually speaking to every student who expressed interest about what the study would involve, checking for their understanding and motives for joining. There was an additional ethical challenge here in that mentor and mentee might feel pressured by one-another to stay in the study. It was important to stress that both mentor and mentee could withdraw without reason and either continue mentoring as normal or discuss alternative activities. It was common to swap out

mentors and mentees when the mentoring relationship was not working, and this was prioritised over participation in the study.

Six mentees joined the study by returning forms of parental consent and personal assent. One participant joined a couple of weeks later after speaking to a friend about the study. Participants tended to be those who were more motivated and had used self-tracking apps in the past. They came from a variety of socioeconomic backgrounds.

I and the two mentors mentored two students each over six 20-minute sessions. Mentors talked briefly after each session to discuss any issues that had come up, any challenges, and any strategies that had worked well. Mentors were given some recommendations of apps which a mentee can download on their own phone, and were also free to find their own. Mentees were reminded that they could withdraw from the study or stop self-tracking at any point. Mentoring sessions were audio recorded and I listened back to recordings on the same day and made notes on what it seemed was and was not working well. I occasionally discussed these with a mentor before the next mentoring session.

On listening back to a recording of a mentoring session, I recognised that one of the participants presented with needs that were not well addressed in the current mentoring arrangement. I discussed this with the mentee and they agreed that they would benefit from some additional pastoral support. They received this support and did not attend subsequent mentoring sessions.

9.2.2   Data collection and analysis

The mentoring sessions were audio recorded, transcribed and analysed on NVivo together with handwritten notes. Sociocultural discourse analysis (Mercer, 2004) was adopted as an analytic framework and supplemented with theoretical concepts from Chapter 4, including *motive*, *scaffolding,* and *everyday/scientific concepts*. The mentoring sessions explored targets and themes unrelated to PI. Only vignettes explicitly involving the interpretation of PI data or practices were selected. Once each case study was analysed separately, some common factors were identified across case studies – these are included in the discussion. Mentors had already met some mentees when data collection began. I call "Session 1" the first session in which the target setting form to determining the focus of mentoring was completed.

Participants' tracked data is not collected for the research. The figures in this chapter are reconstructed from notes for illustrative purposes.

9.3   Findings

Each participant engaged with PI in idiosyncratic ways and the case studies attempt to capture these variations. For some participants, PI proved consistently insightful, for others, occasionally so or not at all. In some cases, it was reflecting with mentors that provided insights and subsequent sessions showed how changed understanding affected practice or thought.

9.3.1   Tamzin

In Session 1, Tamzin suggested that one reason she was below target in various school subjects is that she didn't do enough work at home and was selective about which subjects she completed work for. Her mentor suggested that she could track how long she spent on

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her revision and reading using a self-tracking app like *Toggl*. *Toggl* displays simple stop-start

timers which show cumulatively how long has been spent on a particular task or project. In

Session 2, Tamzin suggested she had forgotten to track her work. In Session 3 Tamzin

explained that she still hadn't tried using the *Toggl* self-tracking app.

<div align="center">Vignette 1, Session 3</div>

M	Was there any particular reason you didn't track?
TAMZIN	I just didn't.
M	It's fine, I'm not having a go. Just curious if you had any reason.
TAMZIN	Well, I'm not exactly going to do it every single time I am reading a book or I'm doing homework.
M	Why not?
TAMZIN	Have to get my phone out and open it and click it and it's just long.
M	So it takes too many clicks to start to start the timer?
TAMZIN	Yeah.
M	That's interesting. So do you think the design is to blame?
TAMZIN	Not really. I just don't want to do it.
M	Would you want to try one that does it automatically on your computer or on your phone? So it can monitor what type of websites or software you go on. I can show you what it looks like.
TAMZIN	But I don't really use computer that much for work, or what if I'm doing it at school?
M	Yeah ok. Could we try tracking it with something completely different? Maybe you could rate from one to five stars after you finish your homework and it will record that. You'd be rating how well you think the work went. Would that be better?
TAMZIN	It might be better.
M	We can have a look at that. What are you thinking?
TAMZIN	I think having an app, it's just not going to be that beneficial for me. I don't really see the point of having an app. I can tell you about my homework. I can show you my book. So that's all.

Tamzin is initially reluctant to offer reasons for not using the PI tool, perhaps because of

unease around having to explain why she did not follow expectations of the practice. Her

comments in the vignette suggest that since initially planning to use the app in Session 1,

she has thought through what the practice would involve and changed her mind. That it is "not really" the design which is at issue here, could again imply that the issue is with the practice of using the app and integrating this with her wider everyday practices. By the end of the vignette, Tamzin frames this in wider terms to suggest that she is not the kind of person to use this kind of technology. She understands that an app could potentially support the process of mentoring by letting her share data about her work with her mentor, but suggests that her exercise book is already a record of this kind, so an app is superfluous. Through justifying her non-use, Tamzin has made explicit a range of reasons for her choices. While the mentor here focuses on the technology itself, she refocuses on the "point" or motive it was intended to support. Though she abandons the app, the exchange in this vignette could have given her an opportunity to reflect critically and develop reasoned opinions about this kind of technology.

9.3.2 Stefan

At the start of mentoring, Stefan found it difficult to identify an area he wanted to work on. Finding a suitable target was framed in broad terms, with the mentor asking "*What kind of areas could we work on that will help you feel like you're making progress; and that could also be... physically and mentally?*" Stefan found this hard to answer, but brainstormed different possible factors with his mentor. Out of these, Stefan selected five he thought
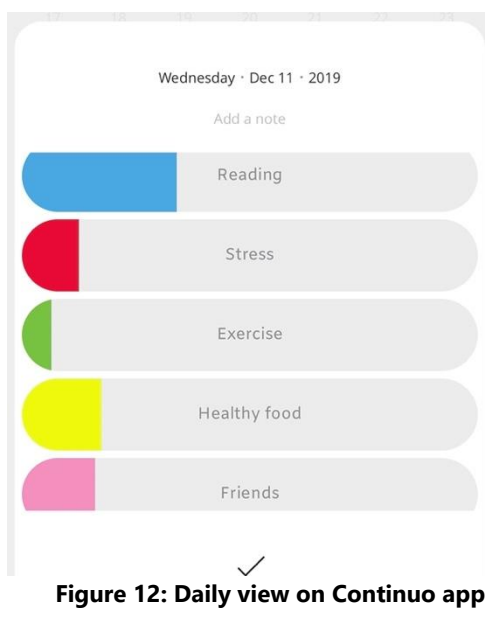
Figure 12: Daily view on Continuo app

were most relevant to him: *reading, stress, exercise, healthy food & friends.*

The *Continuo* app was selected to track these concurrently. The *Continuo* app and widget lets the user slide their finger across a sliding scale, like the bars of a bar chart, to manually log the extent of factors set by the user (Figure 1). The user can view daily charts together in a calendar view (Figure 2).

In Session 2, Stefan had tried *Continuo* "a bit", but did not want to show his data. In Session 3, Stefan had only logged two days that week but was keen to talk about his data.

Vignette 1, Session 3

M	What does this show? Talk me through this data.
STEFAN	A lot of reading. Not gonna lie, I actually read so much.
M	Was that at home?
STEFAN	Library.
M	Yeah wow. So looking at this, stress looks quite low as well.
STEFAN	Yeah.
M	So maybe reading a lot is good for your stress.
STEFAN	Unlikely. It's just because I know I have to fix up my reading.
M	It could also show that maybe you need quite low stress to focus on reading.
STEFAN	Oh yeah yeah.
M	And what about the food? Quite healthy but not that healthy.
STEFAN	I don't remember.
M	Is it connected? No. No, probably not connected. Exercise?
STEFAN	No.
M	OK and friends?
STEFAN	A bit, if they're talking.
M	You put friends quite low, so is that good then?
STEFAN	For reading, and not good in other areas.
M	You don't feel like you did a lot with your friend that day?
STEFAN	No.
M	That's fine, and was that something that worries you? Did you want to do more with your friends?

STEFAN   It's fine.

Figure 13: Calendar view on Continuo

In this vignette, Stefan waits for the mentor to ask him about his data to communicate that he has read a lot. Since *Continuo* relies on manual logging without any absolute scale, it is interesting that Stefan wanted the visualisation (Figure 1) to act as a shared object of attention before explaining the simple fact that he had been reading. Prior to this vignette, he does not seem to have made any links between reading and the other factor he is tracking. The visualisation then acts as validation or a ticket-to-talk, as well as scaffolding for the mentor and mentee to make additional logical connections. Although Stefan does not make this inference independently, his data allows him to reason with his mentor about a link between reading and stress.

While the lack of an absolute scale gives *Continuo* more flexibility and expressivity, it also poses limitations. Can we compare *a lot* of reading with *a lot* of friends? Perhaps this limitation would diminish over time as the user becomes sensitive to the relations between factors. Stefan's reasoning about "friends" illuminates some further issues. The meaning of the data depends on its object. Though "friends" is low, this is interpreted as good in the context of reading but bad in other contexts. But what was the object of the data when it was collected: the episode in the library or the day as a whole? While the ambiguity proves productive to the mentoring here, it could also lead to confusion. Later in the session Stefan is asked to explain his "healthy food" data. He suggests that it does not mean anything and

is not important to him, explaining, *"I eat, I don't know, I eat whatever like at school and then at home it's the same."* Perhaps factors over which Stefan has less agency prove less meaningful to him.

9.3.3 Toby

In the first session Toby decides on targets related to maths and also plans to track his mood, though there is no explicit target here. The role of PI in the mentoring practice is instructive here insofar as it largely fails to lead to any meaningful insights for the mentee. Toby chooses *Mooda* to keep a daily log of his mood by selecting one of nine face icons (Figure 9).

Vignette 1, Session 3

M	How's it been going for you over the last week?	
TOBY	It's been fine. It's been same.	
M	Same? OK. Anything that stood out last week?	
TOBY	Not really.	
M	Oh. So an average week again like last time.	
TOBY	Yeah. You can look over but it's pretty much the same. See, average!	*Shows calendar view Mooda visualisation.*
M	A lot of average faces. A lot of straight faces. And then a sort of... is that excited?	*Pointing at one face on the visualisation.*
TOBY	Yeah. I like doing the little faces.	
M	Sounds like you've really got into a sort of routine. Any stories to tell from the past week? Any excitements?	
TOBY	Err, not really...	

The discussion in this vignette is not contextualised within a particular practice and both mentor and mentee struggle to find a common frame to interpret the data. The mentor tries strategies to prompt interpretation, such as asking for "stories", but Toby struggles to share

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any. Such strategies might have proven more helpful if they related to particular practices and motives with which Toby identified. Toby interprets the norms here as entailing that he work "on the tracking", rather than as implementing self-tracking within wider practices. Throughout the vignette, the tracking itself is the object of the discussion: what Sharon & Zandbergen (2017) call "data fetishism".

Vignette 2, Session 4

TOBY	I have them.	*Toby shows his Mooda data.*
M	What have we got here. Mainly just normal again and is that a bit of anger near the end of the week? So perhaps a stressful end to the week?	*Studying the visualisation.*
TOBY	Not really. It's been pretty good.	
M	So what's that about then?	*Pointing at the angry face.*
TOBY	Well, I think at that exact time I just was a little frustrated because, it's a long story, but my mum said I moved something out of my sister's room. It wasn't a big deal.	
M	So that face was just capturing an argument you had there?	
TOBY	Yeah.	
M	And the rest, just normal?	
TOBY	Yeah, just kind of the same.	
M	You were saying last time you were going to go to Winter Wonderland?	
TOBY	Yeah. Yeah.	
M	So how was that?	
TOBY	Was really good thanks. Winter Wonderland was just really really fun. I got money for my birthday so it was a really great day.	
M	Excellent! So is that something you recorded? You put your feelings as mostly normal. Is that the same on that day then?	
TOBY	I guess that one is excited. I can change it.	*They pause while Toby clicks the 'normal' face and changes it to 'excited'.*

M	Yes, with these you're really trying to notice anything that changes in your life. So if things go up and down then you're recording it down. So that one was excited. Could there be any other ones that we could change?	
TOBY	Well, that one could do sad because obviously, obviously then I already went to Winter Wonderland and just had to go to school. So it's a bit of an anti-climax.	*Referring to the following day on the visualisation.*
M	Good yes. Let's make that one sad and anything else?	
TOBY	I think then the other ones are just normal because I wasn't really doing anything.	

Figure 14: Calendar view on Mooda

The discourse in this vignette is more constructive and fluent than Vignette 1. Instead of awkward pauses, there is some elaboration and negotiation throughout. At the start of the vignette the mentor uses the PI data indexically to suggest a contradiction with Toby's account of events. Toby's justification helps to contextualise the data in a domain relating to his homelife. The detail here is more granular than what Toby has shared earlier in the session. That is, the object of the signs is more stable and clear, and thus somewhat more motivating for Toby to articulate. This opens a route for conversation which the mentor can return to later. In the middle of the vignette, the mentor again uses the data to suggest a contradiction, by asking if it captured a trip to Winter Wonderland. This prompts Toby to revise his assessment of a day in his data. He is able to do the same for the day after without much prompting. He could be learning to make his PI data more sensitive to everyday events and values. The PI data is being treated as something live and negotiable, rather than immutable, as it arguably is in most prior work.

Across the sessions, PI fails to lead to any personal insights for Toby, perhaps because he has not identified motives against which data could be judged good or relevant. The design of his tool may have contributed to his fetishistic engagement. While *Mooda* offers a fun interface, the design makes it difficult to identify days or trends by placing five rather than seven days in a row.

9.3.4 Alyssa

Alyssa decided to track her sleep using *Android Sleep* alongside two academic targets. *Android Sleep* displays graphs of sleep cycles based on your movement in bed. Her case provides some helpful contrasts to Toby's. By linking the data to Alyssa's motives, the mentor helped her to see greater significance in it over time.

Session 3 had the clearest instance in the study data of a participant making a personally relevant insight based on their PI data, though caveats will have to be made here.

Vignette 1, Session 3

M	Let's move onto sleep now then. Should we have a look at your data now?	
ALYSSA	Yeah hold on. Shall I show you on here?	*Alyssa points to her phone.*
M	Did you generally sleep well this week?	
ALYSSA	Yeah, I have got it. Wait.	*Alyssa is searching through her phone, not looking up.*
M	That's OK.	
ALYSSA	Yeah, so I tracked it every day.	
M	That's good.	
ALYSSA	Yeah I'm doing it.	
M	And have you been sleeping well?	
ALYSSA	Yeah. So I've been sleeping fine though.	

M	Anything interesting you noticed in your data?
ALYSSA	Yeah, I'm not going to lie.
M	Yeah?
ALYSSA	Nah, what is this? So like, hold on.
M	What's wrong with it?
ALYSSA	Wait.
M	Is it not…
ALYSSA	No this is actually funny. I'm just going to show you. I just wanted to show you the graph on it. OK, so can I show you?
M	Yep yep.
ALYSSA	Right, it says I slept four and half hours on Wednesday. So when I looked at that I was baffled. I went bed like normal. Because here… I'm asleep not that late but then I wake up then here and then it's, I don't know. I don't remember that at all.
M	But you didn't feel tired?
ALYSSA	I was a bit tired.
M	That's OK. Maybe you went to the toilet.
ALYSSA	But what if I was sleepwalking? That's what I'm saying now, I'm prang [?] because I've done that before.
M	If you weren't that tired then it doesn't really matter does it?
ALYSSA	No, I don't know.
M	On Thursday we were talking about it. You had a good Geography lesson and there weren't any problems were there? It's probably just an error.
ALYSSA	Wednesday. Oh yeah no, yeah.
M	So it didn't really affect you and it was fine before you noticed it.
ALYSSA	But if I'm sleepwalking that's a bit scary.
M	If you were saying you are sleeping well that's the most important thing. It might not be accurate data. Maybe your phone fell somewhere or it wasn't picking it up. Shall we see if it happens again next week?
ALYSSA	Yeah, I think it's the app because sometimes it's not that accurate. If it's like one or two hours just sleepwalking I would wake up or I would wake someone up.

Alyssa is still looking at her phone.

Alyssa shows her Android Sleep visualisation, pointing at the sleep graph.

In this vignette Alyssa responds dramatically to the discovery that she slept less than she thought she would have: she built up to the revelation of her discovery to her mentor. What strikes Alyssa as remarkable about her data is not necessarily that this sleep length is unhealthy, but the contradiction between this data and what she expected to find. Alyssa engages with different parts of her visualisation to try to interpret or articulate the significance here. Alyssa's interpretation that she had been sleepwalking is fitting for the dramatic situation but not judged productive in the context of the mentoring practice. The mentor redirects her to what is good and relevant in the mentoring practice: working towards targets.

Alyssa may have little familiarity with sleep as a *scientific concept* (Derry, 2013, 21): as a subject of deliberation, but she selects sleepwalking as a salient concept given her existing knowledge. The mentor attempts to relate her insight back to its implications for her everyday life by asking whether she was tired. She quickly assents that she was, before returning attention to the apparent sleepwalking. Alyssa's insight seems to have changed her memory of her own experience, as the mentor is able to point out to her. Together, they adopt a more critical stance on the data and Alyssa agrees that it is more likely to have been a fault with the app or tracking. Though Alyssa's insight about sleepwalking is deflated, the process of negotiation here may help her develop skills for practices into which the PI tool is implicated. In subsequent sessions, Alyssa is able to adopt a more critical stance and question her data's accuracy when relevant.

Vignette 2, Session 4

ALYSSA   Yeah OK so in my thing. I got it yeah. I didn't do it every day.
M   That's OK. Is it going well?

ALYSSA	I think it's actually good. It can just make your sleep better. Like if you know you need to sleep, it can help you.
M	That's really good, so what would you say you are doing differently?
ALYSSA	I don't know. If I want to stay up or I'm just on my phone then I'm not going to do that because it'll be bait [blatant].
M	So it's more just having it in mind? Can you think of anything else?
ALYSSA	It could be anything. Say someone posted something quite late and then you can think you have to go bed, so you like don't reply straight away. So it can just help you out.
M	So you're putting some things off until the morning so you can sleep better?
ALYSSA	Yeah.
M	That's a really good habit. If you have to do something, whether that's for school or something socially then you can do it the next day and that way you are sleeping well and you're not staying up stressing about things.
ALYSSA	Yeah, that's what I'm saying.
M	And that's something, you're just reflecting on that now? I think it would be good to add that on.
ALYSSA	Just because I remembered it.
M	So we can add it onto your target.

Although Alyssa does not explicitly suggest that her PI tool caused behaviour change, this vignette shows that she sees it as a resource she could draw on should she want to change her sleep habits. The reason for this appears to be something like the "borrowed authority" described in Chapter 3. Alyssa suggests that poor sleep habits like staying up on her phone will lead to sleep data that will expose this behaviour. She takes the app or mentor to be holding her accountable for this "bad" behaviour. Her description of a situation in which *Android Sleep* would be helpful suggests she has reflected both on the aspects of her sleep practice that may be leading to bad sleep and on the role that PI could play in supporting better sleep. The mentor makes explicit that rescheduling things for the next day is a helpful way to improve sleep, thus helping to shape everyday concepts into scientific concepts. Alyssa may learn that this is a strategy she has available to her.

Later in the session, Alyssa decides to talk her mentor through some of her PI data. Though the exchange is brief, it could demonstrate learning from previous sessions.

Vignette 3, Session 4

ALYSSA   Tuesday I went to bed or I fell asleep at 10:47. Wednesday is pretty late. Wednesday is like 12:15 so I don't know why that is.

M   Do you think that's accurate?

ALYSSA   It might not be that accurate. Thursday, because Thursday I was fine. We have PE and I went out as well, so...

M   You don't always feel it if you don't get good sleep.

ALYSSA   I can't really remember. I've been trying to go bed early so I don't know. I think if I stayed up I'd remember though.

M   I think it doesn't matter too much as long as overall you're still sticking to your target and you think it's going well.

ALYSSA   Yeah I think so. I think it's not accurate. Thursday after school I went out on my bike and then Thursday night was good.

M   OK.

In this vignette the mentor prompted with the concept of *data accuracy* and Alyssa appropriated the concept to explain a seeming data anomaly. There is a clear contrast in how she deals with the contradiction here compared to Vignette 1. She evaluates the data by considering the impact that poor sleep would have on the next day's activities – something her mentor scaffolded for her in Vignette 1. She both expresses confidence in challenging her data and grounds this in justifications with increasing depth of detail from her everyday experiences. Alyssa uses this concept of *accuracy* again in her final session, though its meaning has now expanded.

Vignette 4, Session 6

M   Shall we have a look at your sleep?
ALYSSA   I didn't really do it that much.

M	You haven't been tracking?
ALYSSA	Yeah, I haven't really been doing it.
M	That's fine. Is there a particular reason you decided to stop?
ALYSSA	I did it on some days. I think I did it like... Yeah, so I did it on some days. I did it on Monday and I did it yesterday.
M	Were those days OK then?
ALYSSA	It's low on that but that isn't really accurate and yesterday is fine so that's fine.
M	So you're not tracking it as much but you're still tracking it.
ALYSSA	Yeah.
M	So what are you thinking about the Monday?
ALYSSA	It's just fine, like my sleep is fine.
M	And you think it's not accurate because it's quite low there?
ALYSSA	It's not an issue so it isn't really showing me that or it's not that relevant.
M	So you don't really want to talk about the sleep.
ALYSSA	Not really.
M	That's fine, but would you say you met the target?
ALYSSA	Yeah, I met it.

Alyssa unlocks her phone and looks through her app data.

In this vignette "accuracy" seems to relate not only to the function of the app but also to its relevance to Alyssa's motives. She is not concerned by her sleep duration because she has finished her exams for the term and feels she has met her targets. Her data is not "accurate" because it is not resonant with her motives. Her understanding of the role of PI in her own practices can be clarified through an exchange from Session 5.

Vignette 5, Session 5

ALYSSA	I think it's good to track it and to keep it in mind but if you get obsessive over it then some people might actually have a bad effect.
M	It's definitely very important to have your own sort of free time. Do you think having the app, has it been more helping you or not helping you, overall?
ALYSSA	For me, I use it in a way where it can tell you something if you know that OK now I need to sleep but if you don't need to then it's not really that harsh. Like it's just fine.
M	So you don't always have to take it that seriously.

ALYSSA	It can be serious or it can be not that much, depending on the situation.
M	What kind of situation?
ALYSSA	Like if you have an exam the next day or in a few days, or if you have important lessons.

Alyssa has developed a critical appreciation of her data, including recognising its potential risks. She is aware that she can draw on her PI tool in specific situations, but that in other situations (such as in her leisure time) it is unnecessary.

9.3.5 Elias

Although Elias was enthusiastic about using the *LifeMosaic* app over the course of his sessions, he was initially fairly sporadic and unsystematic in the way he logged his data; for example, using a cat sticker to represent his cat on one day of the week although he saw his cat every day and could not explain what made this instance significant. The focus of his tracking was on the extent to which he was productive or unproductive, since he felt he was wasting a lot of his time on activities he didn't value. The discourse in his mentoring practice helps to scaffold for Elias the kinds of meanings that his data can and ought to take on.

Vignette 2, Session 3

M	Can you go to the other one again?
ELIAS	Monday?
M	I just wanted you to explain the lightning.
ELIAS	I am using lightning for energy. If you have no energy then you don't do a thing but you have too much energy and you are too hyper, so it is a balance. Two lightnings is just perfect for me but as we can see it is four here and that is very disruptive.
M	And on Sunday?
ELIAS	Yeah.
M	It's still a lot of lightning. So a lot of energy but looks like it's more pale than Monday in terms of productivity.

ELIAS   On Monday I was studying and my sister was trying to study as well and it was very very clear, because I am trying to put time into my science, it just wasn't going to happen. It was just going to be YouTube from now on.

M   So was it the energy or did the YouTube distract you?

ELIAS   It's a chicken and egg situation. I am distracted and then I go on YouTube and it distracts me even more or I go on YouTube and then I become distracted.

M   Have you tried just telling yourself that you won't go on YouTube? Just as an experiment, could try it.

ELIAS   But for a lot of these days with three or four lightning it is completely unrelated to YouTube and I am not on it. I don't think it's a important factor for me.

M   So why did you put these lightnings for Sunday?

ELIAS   Sunday we went to Westfield so that's that.

M   And why were you hyper?

ELIAS   I was high energy because I was with my friends and quite likely having a lot of bubble tea has something to do with it.

M   The speech bubble is friends?

ELIAS   Yeah.

M   So did you find it hard to focus like on the conversation or?

ELIAS   Not, no. It was very enjoyable which is why I put it as quite productive because the aim was to relax, have a good time, look for some games and yeah.

Compared to previous sessions, in this vignette Elias is more fluent in narrating an interpretation of his data. The app has allowed him to externalise a conceptual system related to his energy level. Instead of being led by the mentor, Elias now gladly takes on the role of explaining his data and he is adept at tying his PI system to concrete everyday experiences. As well as explaining the meaning of a particular visualisation, Elias also evaluates his data on a meta level: noting that while distraction on this visualisation was related to YouTube, this was not an "important factor" for him, as justified by other data points: YouTube did not tend to be the reason behind his low productivity. The change between this session and earlier sessions may be partly due to his feeling more invested in the PI practice, having had the agency to define and demonstrate its parameters.

A contradiction arises between the meaning of having multiple lightning stickers on two consecutive days. They are judged as bad (contributing to being unproductive) on Monday and as good on Sunday. The mentor does not explicitly pose this as a contradiction but drawing Elias's attention to it helps him to explain how the meaning changes in different situations. Elias explains that in the context of spending time with friends, high energy is good because it coheres with his motives; he represents this in his data as being "more productive". Here again, conventional terms can take on new meanings as a PI practice develops – this is partly captured in the distinction Elias makes from being "hyper" to being "high energy". On this occasion, Elias connects food with a positive experience of energy and having a good day.

The normative evaluation of the concept of energy in different situations is discussed explicitly in Session 4.

Vignette 3, Session 4

ELIAS	Yesterday I had a lot of energy but I just did a few press ups and that's pretty much it.
M	And is that OK?
ELIAS	It's a bit disappointing.
M	OK. It sounds like sometimes energy has a good impact and sometimes it has a bad impact so maybe there are many different kinds of energy and it depends on the situation.
ELIAS	Yes, so for example, if you are mentally very focused and calm this can be good if you want to do coding, or you go to a party, you are responding to people and being a good friend then that's totally different.
M	Great point. I think that's really interesting. So you're saying being calm like that isn't as helpful at a party?
ELIAS	It also completely depends on what time of day it is. If you have just woken up then for some people that is going to be a very different kind of energy from the middle of the day or later.
M	Yeah, it definitely changes like that as well. Is that something we could track? The different kinds of energy? I'm not sure how we could do it to show the time of day.

ELIAS   Maybe a sun? You could have a sun in different positions or sun and moon.

M   As different parts of the tile?

ELIAS   Yeah.

M   Could try it. I think the main thing is just the different kinds of energy and what kind of impact they have.

ELIAS   OK.

Elias is bringing in many different dimensions across which someone may evaluate their energy level. At this stage in his mentoring, he demonstrates an appreciation both of salient details of everyday practices which may be implicated in his self-tracking and of the affordances of his PI tool. Although it would be challenging to sustain a PI practice that involves the kinds of tracking Elias is suggesting, it is an innovative appropriation of the symbols Elias has been interacting with in *LifeMosaic*. Indeed, by the next session Elias has come up with a sustainable practice that fluently represents some of the distinctions discussed in this and previous vignettes: he uses the number of lightning bolts to represent how much energy he had and a black lightning bolt to express that it was "bad" rather than "good" energy i.e. that it caused hyperactivity discordant with his own motives.

9.3.6 Roxana

When asked to think of issues with her school subjects or things that were often on her mind, Roxana suggested that her "incompetence" was the issue with her subjects. Her mentor suggests that this is likely untrue and asks whether Roxana can think of anything that can be turned into a "measurable target". She decides to track the times in her day she felt competent or incompetent. She used *Daily Counter*[66] to log instances of

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[66] A simple tallying app, presenting defined values in a bar graph

competence/incompetence and to generate bar graphs of the daily frequency of each. The discussion section will raise questions about the suitability of this kind of tracking focus. In Session 2, Roxana logged a couple of instances of "incompetent" every day with no instances of "competent". In discussing this data with her mentor it became clear that she was expressing general frustration with how things were going. By Session 3, Roxana was better able to explain the meaning of her data by relating details of her everyday practice.

Vignette 1, Session 3

M	How have you been tracking it?
ROXANA	I've been tracking it like "Oh, I feel incompetent, add 1"
M	What does that make you feel then? How is that feeling?
ROXANA	It was an experience. I was very self-aware. And I was aware of my actions.
M	So you felt more aware in the situation. Did that help you feel control, or calmness?
ROXANA	It helped me feel control.
M	OK, and how was that? Can you elaborate one of your days?
ROXANA	Erm. Yeah, like the 7th. Look.
M	Oo unlucky. Ouch!
ROXANA	Yeah. So on that day I felt a bit lost. Because to be honest I understand history but I didn't really understand what everyone else spoke about. So everyone around me was talking but I still felt quite incompetent because I couldn't understand so many things. But at the same time I did do quite well in the test. But I missed some days and I may be behind in many of my school subjects. So maybe I am in the boundary between competent and incompetent.
M	Though you didn't put any competent on here. Do you feel like that awareness of balance is new to you or arises with everything?
ROXANA	It's quite new.

Though she suggests her self-tracking consists of simply tallying instances of competence and incompetence, Roxana offers a narrative about data heavily skewed to "incompetent", and comes to reinterpret her experience as "between" the two categories she

has been tracking. It is also interesting to consider why she selected this particular

visualization from her data in response to the request for elaboration. The mentor nudged

Roxana to frame self-tracking as helping her feel in control, but she chose a day with a

particularly high level of "incompetence". The implications Roxana draws from the request or

the concept of "feeling control" are not made explicit here. These concepts are reorganised

in subsequent sessions.

Roxana is asked to consider the kinds of thoughts that are going through her head when

she feels incompetent in history. Later in the session Roxana suggests that some of her

"incompetence" comes from anxiety about an upcoming visit from her extended family.

Vignette 2, Session 3

M	What's the thought that you keep having in these cases?
ROXANA	I'm not good enough. I need to be better.
M	That's a very dramatic statement. Let's try to quantify that. On the 4th you are very competent and that's very good and then the next day it drops right down.
ROXANA	Yeah.
M	But you're the same person aren't you? How could you lose all of your competence like that? And you've got the grades you've got now so you can't really be better performing there. So what are we going to do, considering they're not bad grades for where you are, surely.
ROXANA	I don't know. I don't think there's anything.
M	Where are the expectations coming from for you for all these strains which you're feeling?
ROXANA	My family.
M	So your family. Not anything to do with your competence. What about yourself? Do believe those expectations are really important?
ROXANA	Yes. I guess I believe they're fine. They could be better but they are not bad. But there is no reason for them to believe that as well.
	[...]
M	So what would you like next week to happen? What should we set as a target?
ROXANA	I would like to feel more competent about my grades.

M	So we can still notice the times you are feeling incompetent about grades but this time you can record it and then we can think if that's accurate: is that about you, or is it something you can't really control and just external pressure. Does that sound good?
ROXANA	Yeah it sounds good.

At the start of the vignette the mentor judges Roxana's calm explanation of her thoughts as "dramatic". His proposal to "quantify that" seems to itself play a dramatic role. Here, to "quantify" seems to mean to manage the "dramatic" meaning by offering a new interpretation of the same data. The mentor challenges Roxana's interpretation by returning to the idea from a previous session that it is not reasonable for levels of incompetence to be significantly different on two consecutive days. Roxana remains unconvinced.

Later in this vignette Roxana recognises that while her reports of being incompetent are related to her grades, it was her family's judgement that gave them this value. This supports a transition in the mentoring practice from framing incompetence as relating to Roxana's actions and situation to relating it to her *attitude* towards them. The mentor suggests ways that Roxana can reframe her self-tracking to integrate this more critical stance. Here again "accuracy" is related to normative evaluation rather than the technical functions of the self-tracking tool. This could be a formulation of the concept of accuracy the mentor developed with Alyssa.

Vignette 3, Session 4

M	Has the app helped you at all to feel in control?	
ROXANA	I'm not sure. There is a day here.	*Roxana looks at her data then points to a particular day.*

M	OK. A bit of a mix. Tell me about about this then.
ROXANA	I was feeling very incompetent because I did not start my homework, because I was helping with something in the house and then when I did start it I realised I could just do some of it in school or after school, so I did not need to feel stressed and then I felt a bit competent.
M	So at first you could not do the work and it was something out of your control that meant that. And then you got a bit of control because you could choose your own time to do it.
ROXANA	Yeah.
M	So that's a really clear pattern there isn't it? And let's see the next day.
ROXANA	It's higher.
M	So more competent on that day. So you were in control and you did the work. Yes. That's good. And then what went wrong?
ROXANA	I got more homework.
M	It's just homework? Talk me through some of these. What about the 11th?
ROXANA	I started feeling incompetent about my exams again.
M	Was that because of family pressure?
ROXANA	Probably.
M	That's good, so that was our target wasn't it. You noticed those feelings.
ROXANA	Yeah.
M	And what did you do then?
ROXANA	What do you mean?
M	When you're feeling like that, what do you do?
ROXANA	Rock back and forward?
M	Ha, OK. That is one thing. And does that help?
ROXANA	A bit.
M	So we were saying when you feel incompetent you don't feel like you have a lot of control and then when you feel competent you have control. So what could you do there? What choice could you take?
ROXANA	I'm not sure.
M	You can focus on the 11th. What are some of the things that were going through your head?

Roxana shows the competent/incompetent count for the following day.

Roxana looks at her data again.

ROXANA	I'm not sure.
M	So... we're talking about how you put incompetent for some of these times. Where were you when you're feeling this?
ROXANA	In my room.
M	And is there anything you could do differently? Is there something you could choose to do?
ROXANA	I could go for a walk?
M	That's great yeah. A walk would be something you can choose. Let me note that down straight away because we can try that. We can test that next week.
ROXANA	OK.

In this vignette the mentor is strongly reinforcing the frame of control and self-determination. Roxana offers a nuanced justification for her data but initially finds it difficult to identify opportunities for self-determination. The mentor attempts to formulate this frame in a number of ways until Roxana finally independently thinks of a suitable action. The mentor supports this in part by drawing Roxana's attention to a particular data point and details of the everyday situations it represents. When initially asked about her choices, Roxana quips that she could "*rock back and forward*". Roxana is communicating her lack of agency in the situation. The data can prompt reflection about options for action, but can also reveal the ways in which such choices are limited. The mentor returns to these concepts again later in the session when discussing another day's data.

Vignette 4, Session 4

M	So for most of the day you were feeling quite competent? Why was that?
ROXANA	I think it was quite easy in all my subjects.
M	That sounds like you felt really competent.
ROXANA	Yeah.
M	But you still have more incompetent than competent.
ROXANA	I think I felt quite bad. I think it was balanced.
M	After dinner? So even if you mostly feel competent it doesn't actually balance out the incompetence. What does that show you?

ROXANA	Sometimes it does and sometimes it doesn't.
M	It could also show that you're focusing a lot more on the negatives. Why might that be a bad thing, to have this one so high?
ROXANA	Because I'm always thinking about how incompetent I am?
M	Exactly. Because that's the problem isn't it?
ROXANA	Yeah.
M	We should think about this. What do you think we can do to change it? If you're always labelling as incompetent?
ROXANA	To label more as competent.
M	Yes, that could be a help. We could do that. But what about if we change the labels? You mentioned control so what about if we change it to "in control" and "not in control"? How would that... would that be good?
ROXANA	Yeah that's good. Do you mean on the app?
M	Yeah.

In this vignette, the mentor emphasises some possible distortions or unfair standards in the way that Roxana has been collecting and interpreting her data. The discourse here is still led by the mentor but may help Roxana for form a more critical assessment of her data. The mentor tries to make explicit something that was perhaps already explored implicitly in past sessions: that the "problem" here was not "incompetence" but *labelling* oneself incompetent (as in Theory A / Theory B shifts within CBT (Sighvatsson et al., 2021; Wells, 2011). By changing the tracked parameters of a PI practice over which Roxana has already gained some mastery, the focus changes from Roxana's "incompetence" to her degree of control in the situation, potentially shifting her away from personal blame.

In Session 5 Roxana logged events with much less frequency because she *"didn't really know what to do"*. There were not many times she thought of herself as in control or not because she was not yet attuned to what counted as experiences appropriate to these

concepts. In this session there seemed to be evidence that Roxana had internalized some of

the concepts introduced in previous sessions.

Vignette 5, Session 5

M	Would you say you could see a connection between feeling competent and feeling in control.
ROXANA	Yeah.
M	So tell me about that. Was there a time here you are feeling in control?
ROXANA	I went for a walk to the park.
M	Great, so you did that, and you felt in control?
ROXANA	Yes, and then also walking around the park and then buying a snack.
M	You counted those as different?
ROXANA	Yes. I did it if I was choosing different things.
M	Because you're making choices. And those were different choices you were making? So going for a walk can actually present different possibilities. And did that have a positive impact?
ROXANA	I think it was quite calming. It was good.
M	That was a good day then. Any other days? This one you did a few. Were these anything?
ROXANA	I think just work. Finishing work.
M	Quite high: "in control" is high and "not in control" only one. So feeling far more in control? Feeling better overall?
ROXANA	Not really.
M	You weren't feeling better overall? OK.
ROXANA	I just didn't do as many [logs of "not in control"] of that one. I wasn't sure what to put.
M	So you think there might have been other examples of feeling not in control but you weren't really sure of them.
ROXANA	Yeah.
M	OK no worries. Is your homework from last night on here? Is that represented at all?
ROXANA	Not really.
M	Why don't you add that. Is that "in control" or "not in control"?
ROXANA	Probably both.
M	So the same task can be both. And does it have an overall feel? How are you thinking about it right now?

ROXANA   Right now I think in control.

Roxana reports meeting her agreed weekly target of going for a walk, and explicitly describes her practice as "choosing different things" and splits the practice up according to such choices. She associates these choices with feeling calm.

Earlier in the session Roxana discussed her feeling of being overwhelmed by some homework, and her mentor suggests that this ought to be represented in her data. As in Vignette 2 of Toby's case study, the data here is seen as something live and negotiable. It is something that ought to be updated to be better attuned to Roxana's concrete experience. The process of updating the data here involves first evaluating her past experience through the norms developed in the mentoring practice. There is an implicit recognition that while "right now" she evaluates herself as in "in control", this interpretation could change if she returned to the data on another occasion.

9.4   Discussion

9.4.1   Focusing on motives

This chapter's findings demonstrate the vast differences in the ways young people interact with personal informatics given their personality, contexts and motives. The dynamics of teens' experiences of their environment (their *perezhivanie*) affected every stage of the process of PI data collection and interpretation and became more explicit as the study progressed.

Although PI at times and for some participants proved a distraction from mentoring, there were many occasions where it formed the focus of mentoring and supported the aims of mentoring i.e. by helping the participant set targets, assess whether they were working towards them and evaluate whether the targets had been met.

Following previous studies in this thesis, and as stressed in activity theory (Edwards, 2016), an appreciation of participants' motives was crucial both to the understanding of practices and their maintenance. The introduction of self-tracking into mentoring proved less successful where the participants did not have good reasons to track: where there was nothing beyond the tracking practice they felt motivated to pursue. While it was important to be open about the motives that a mentee could have, without orienting to particular problems (Jaeggi, 2018, 134 - 138) at the level of everyday life, the mentoring lacked a common frame or knowledge domain to motivate and evaluate tracking. Where a common frame was not found, the mentor often led the discussion. Though self-tracking could support self-determination, it was still constrained by the roles, norms and expectations of the school context. At times, mentees adopted and reappropriated frames introduced by the mentor, at other times they rejected these frames, or assented to them without elaboration.

Managing multiple foci at once on an PI tool also proved challenging. Given their narrative structure, mentoring practices worked best when meaning could be judged as relevant to a central motive. At the same time, it was important not to prejudge what is valid material within the discourse. Some of the clearest examples of personally relevant insights came from the connections participants made between the leading motive and an initially trivial or irrelevant detail such as eating crisps or annoying a sister. The key was to evaluate

these unanticipated and tangential details in terms of a particular wider practice and its goods.

As in prior work with adults (Coşkun & Karahanoğlu, 2022), self-tracking practices proved engaging and meaningful when they represented factors over which the user had agency. Some of the most impactful insights in the study data involved the mentee reflecting on the options for action that were open to them in a particular type of situation. This process supported their self-determination.

Past chapters noted how the ambiguity of data visualisations could let data act as a polysemous interlocutor, rather than a sage speaking truth. Data that was open to multiple interpretations led to the most valued insights. But the findings in the present chapter suggest that ambiguity is not sufficient here. Early in their mentoring, Toby and Elias played with their data and saw it as open to their own interpretations, but still failed to gain any insights from it. What proved more helpful was *responsive ambiguity*: participants could better interpret their data when it was tied to particular aspects of their concrete experience. They could then treat the data as sensitive to their everyday choices, values, and problems. This responsiveness involved a development in sensitivity of the tool to the participant as well as of the participant to the tool.

9.4.2 **Developing practices**

Running the study across six sessions gave time for the mentoring practice to develop. The mentor as well as the mentee improved in their ability to appropriate and interpret data over the course of mentoring. The mentees who made valued insights through self-tracking, did not seem to do so until the third session of mentoring. As they built a relationship with

the mentor and the practice, the data interpretations implicated a wider range of aspects of everyday life. As in prior work (Clegg et al., 2017), participants at times initially struggled to derive any meaning from their data but the semi-structured setting helped to dynamically develop scaffolding that supported them here. There was clear evidence of participants applying skills and concepts learned in earlier sessions, for example in distinguishing between different kinds of personal energy (Elias).

Self-tracking tools are not usually designed for the tracking parameters to be adjusted over time. This proved to be a limitation in the study, though having a mentor managed its impact. The challenge for design is in how to best manage transitions to new parameters when the user wants to track a new or additional factor. There seems to be a trade-off between flexibility and respecting what the user has invested in tracking. The loss of previously valued structure involved in resetting the app to change the tracking focus seemed to lead to abandonment.

Although participants tended to lose interest in the PI tool by the sixth session, giving them this time was still valuable: the mentee had the time to explore the tool and agency over when they stopped using it. As Epstein et al. (2016) note, lapses in the use of self-tracking tools are the norm and may involve a wider maintenance process in which the tool again becomes relevant as users' motives change.

9.4.3 Mediating creative collaboration

Meaning making was a truly collaborative process, with a concept introduced by a mentee in one session sometimes picked up by the mentor to introduce to a different mentee in another session. Although these are not reported on, the informal chats between

mentors after each session also allowed concepts and strategies to be shared. Having the

mentor as an audience, both in sessions and in mind when tracking independently,

supported the process of collection and interpretation. Data interpretation could be a kind of

performance. Participants often did not reflect on their data until the session and norms

around "discovering" something in the data helped to engage them in the mentoring and

contributed to its narrative structure. Data was something offered and solicited as part of the

social practice – it mediated drama (Veresov, 2014). Nonetheless, the moments of drama

were rarer in one-to-one mentoring than they were in group contexts (cf. 7.4.3, 8.3), perhaps

because in larger groups peers could adopt multiple roles and appropriate others' motives

and problems (or decline to do so). The partially predetermined roles and power dynamics of

mentoring made it easier to fall into scripts and shallow responses. As in traditional

mentoring (Davis & McQuillin, 2022), the mentee simply went along with a mentor's

suggestions as often as they expressed their autonomy and collaborated with them.

Prompting mentees to be more creative with their collection and interpretation offered a

welcome challenge for some. Participants enjoyed coming up with theories and systems to

make sense of their data. Elias felt motivated to continue this kind of theorizing on his own

after the session. The tool helps to externalise and organise these concepts by letting him

play with different ways of representing factors related to his productivity. But equally, such

elaboration was only possible through the process of giving and asking for reasons in the

mentoring practice. While self-tracking data has often been treated as an immutable source

of objectivity (Pantzar & Ruckenstein, 2017), the data in this study could be treated as live

and negotiable: not only did the interpretations of data change through discourse, but the

data itself could be revised based on reinterpretation. Following previous studies in this thesis and conventions of activity theory, a key strategy for eliciting such reinterpretation was to suggest contradictions that arose in the participants' activity and between their activity and later evaluations of it (Engestrom, 2000). Here the data was given a "borrowed authority" (Weiner et al., 2017), which could in turn be questioned through further justification.

9.4.4 Becoming critical data users

Although there was a lot of variation in what and how much participants learned across their mentoring sessions, there was nonetheless a strong theme of developing a critical stance to personal data. Even participants who chose to abandon their tool, like Tamzin, benefitted from the opportunity to articulate good reasons for doing so. Teens will be met with personal data technologies throughout their lives and reflecting on their own attitudes towards such data and the choices resulting from these attitudes could help to prepare and empower them here. This process was supported by actively making self-tracking data and practices something that was up for debate and on which multiple opinions were valid.

As in prior work (Freeman & Neff, 2021), some participants noted potential risks of self-tracking; for example, in fuelling obsession. For others, becoming critical was not about rejecting the tool outright, but developing a more nuanced understanding of its affordances in their practice, and when it was more or less appropriate to use. For example, tracking may no longer be deemed necessary during leisure time or after the exam period in a term was over.

There was evidence that the PI mediated mentoring could help Roxana to adopt a critical stance not on her self-tracking tool but the objects of her self-tracking practice. Over the

course of tracking her "incompetence" she formed an understanding with her mentor that always looking for examples of her own incompetence was itself part of the problem. This echoes the kinds of ironic insights made in a range of prior work, such as the participant in Cox et al. (2013) for whom tracking productivity supported the "epiphany" that they were worrying too much about their productivity. Representing everyday concepts and experiences in data visualizations allowed them to be examined *as if from the sideline* (Vygotsky, 2012b, p. 16) to support the development of a new stance to the situations in which they arose.

Some risks should however be noted here. While the connotations of "insight" and "epiphany" are positive, and this is the framing encouraged by the mentor, the user may reach interpretations that are unhelpful or challenging. Letting mentees choose any concepts or concerns they want to track could help them work through them with the support of the mentor, but it could also prompt or exacerbate rumination. It may be helpful to steer mentees to SMART targets focused on tangible activities[67], as was the case for Tamzin, Stefan, Elias and Alyssa. Though Roxana herself was well supported outside study sessions, it is easy to imagine how discussions of this kind could have a negative impact on mentor or mentee. Though the study was motivated in part by the fact that students were more likely to share personal details in this setting, these findings suggest that this could actually be a limitation. As part of the ethical considerations of working with this user group, it is

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[67] https://youthworkinit.com/create-a-smart-plan-for-your-youth-work/

important for researchers to have strategies in place to manage "insights" teen users find upsetting or troubling. In this case, this was done by catching up with the student after the session.

Participants developed their appreciation of the ways in which the same kind of data may have different meanings in the different everyday situations it implicates. Talking to friends or having high energy could be judged good or bad depending on whether it was in a library or in a shopping centre. Contrary to dominant approaches in personal informatics (Rapp & Tirassa, 2017), it was not left to the tool to judge what was good or bad; participants did not accept that the data speaks (Dourish & Gómez Cruz, 2018): that its meaning is objective and given. Here, the data's "accuracy" could be tied to its appropriateness to the user's existing knowledge and motives. Negotiating the meaning of data positioned it as negotiable.

As in previous studies, discussing personal data led to reflection on wider everyday practices, experiences and aspects of identity. For example, reflecting on sleep data could lead to reflection on how a mentee had been spending their free time. Mood tracking could prompt reflection on how the mentee had dealt with an argument with a family member. There were signs that this kind of reflection could extend to deeper discussion of wider social forces structuring teens' practices and experiences, like school rules and sexism (cf. Stornaiuolo, 2020).

9.5   Limitations

Negotiating with school leaders and embedding interventions in existing practice posed some limitations to study design. The emphasis on SMART targets may have restricted

mentoring discussions and added a layer of artificiality to their course. It also reinforced norms and power dynamics around quantification and behaviour change critiqued earlier in the thesis. These are critical reflections I only make retrospectively and more could have been done at the time to support mentors and mentees to themselves have a more critical relationship to such targets. Future work could explore PI in mentoring that does not involve target setting. Following theoretical commitments discussed earlier in this thesis (cf. MacIntyre, 2013), such mentoring could focus less on management and more on the practices themselves and the goods internal to them; for instance, in another iteration of the programme mentors would check in with mentees while doing homework together. The research was carried out with particularly emotionally intelligent, motivated, and reflexive mentors and it may be important to consider how this intervention would work with mentors who have less time or will to engage in the reflexive processes contributing to the practices reported here.

9.6 Conclusion

This work reported on a case of self-tracking with teens in the context of existing and common school practices. The results suggest self-tracking could be successfully integrated into a one-to-one school mentoring programme. Self-tracking could make target setting more engaging and tangible. However, questions remain as to whether implementing self-tracking into mentoring has a positive or detrimental effect. Self-tracking can help mentors and mentees to collaboratively set and review targets, but it can also distract from mentoring, making the tool the focus of discussion (RQ.1).

Mentees were often initially confused about what their data could mean or how to collect it. Mentors scaffolded and modelled data interpretation, through prompting, questioning and brainstorming. Over time, mentees were able to offer creative and fitting insights. This could help teens in developing concepts by which to make sense of their experience. Mentees reflected critically on concepts which they themselves found salient in their lives, challenging, modifying, and developing their data-mediated interpretations over the course of the practice. These everyday concepts and personal narratives were given legitimacy and positioned as *scientific concepts* within the mentoring (RQ.2).

This process could support self-determination: helping them explicate reasons for their activity and options for acting, but it could also contribute to their estrangement: reinforcing institutional norms and expectations that they do not identify with (RQ.3).

10 General Discussion

The present thesis pursued three research objectives:

RO.1: to develop and apply a philosophical and methodological framework to reconceptualize personal data interpretation in self-tracking as it applies to learning.

Chapter Three criticised dominant approaches to social practice in HCI and contrasted these with the activity theory approach. This brought into sharper relief certain limitations in these approaches such as the neglect of learning and agency. Chapter Four proposed a new framework for HCI by returning to the work of Vygotsky and subsequent thinkers sharing his German Enlightenment influences. The chapter framed self-tracking in terms of key Vygotskian concepts like *sign mediation* and *perezhivanie*. Subsequent chapters drew on these concepts in the analysis of empirical data, showing the utility of the Vygotskian framework for exploring learning and social practice in the interpretation of PI data.

RO.2: to investigate the feasibility of teen-led self-tracking, including whether teens choose to engage with the tools, how they choose to use them and the meaning they draw from these uses.

Chapter Five explored how teens use self-tracking technologies when they are free to pursue their own motives and choose their own tools. Teens proved creative and versatile users of self-tracking technologies, appropriating them for a range of motives from anxiety management to motivation for schoolwork. There was also variation in how often and for how long teens engaged with these tools, with some quickly abandoning them because they did not align with their interests and sense of the kind of person they were. The uses to

which teens in the study put the tools had not obviously been anticipated by designers and at times design was incongruent with teen motives; for instance, the activity categories on *RescueTime* seemed to assume a user who worked "*in an office*".

Chapter Six explored the co-design of a self-tracking tool for teens. This design was strongly led by the teen design team members in order for teen motives to crystallize in design choices. This work suggested that teens may value design that privileged customization, self-expression, social sharing, and privacy. Teen interpretations of PI data visualisations went beyond what was initially "given" by the data to the wider everyday practices it mediated.

Chapters Seven and Eight offered specific examples of the kinds of meanings teens made in the process of discussing their data. These meanings could at times constitute insights about themselves and their lives, potentially helping them to develop a more critical relationship to aspects of their everyday life and the systems and institutions they participate in.

RO.3: to design classroom interventions to facilitate teen meaning making with self-tracking data.

Chapter Seven reported on an intervention involving self-tracking data by initiating a small discussion group in which teens independently collected data on their sleep and its impact, and then fed back their findings to peers. The data encouraged teens to offer details about their own sleep, and evaluate these in justifying their own choices. By directing attention from the data to themes and objectives of the PSHE/RSE curriculum, this semi-

structured discourse could support relevant learning, without constricting teen meaning making.

Chapter Eight evaluated the integration of self-tracking technology into one-to-one mentoring interventions. PI data was implicated into the setting and evaluation of academic and pastoral targets and supported the mentoring process with varying success and levels of engagement. Mentor and mentee were free to bring in discussion of PI data at any point in any mentoring session and this process could support mentors in scaffolding how mentees evaluated factors like their reading practices and productivity.

Throughout the studies, the meaning of data changed in the process of discussing it, and participants could be supported in gaining insights by bringing their attention to such changes and ambiguities. The rest of this chapter explores these themes in greater detail, considers their wider implications, and offers specific recommendations for researchers and educators.

10.1 Teen insights in social practice

I develop a mobile app with access to all your data. Your movements, heart rate, playlists, breakfasts, public fracas, and secret crushes are all at the disposal of the app's algorithms. It is a psychoanalysis app that can save you months of therapy. You input a problem like "I feel anxious about the future" and hit the INSIGHT button. The app integrates your data, searches for patterns, analyses trends: a small wheel spins. You get an alert when it's generated the insight: *you hate your father*.

In this thesis I have argued that we should not view the personal informatics tool as an insight delivery system. I draw on Sellars (McDowell, 2008) to contend that the meaning of data cannot be "given" by the tool. Prior work on supporting reflection in personal informatics has often focused on how insights can be "triggered" through tool interactions (Baumer, 2015; Cho et al., 2022; Pirzadeh et al., 2013). But an insight need not hit us like the head flying off Heidegger's hammer. Learning is a slow and tentative process better understood at the level of practices than interactions. In this thesis I have understood "insights" in terms of how learning is enacted in dramatic situations, and then tied into the user's understanding of their experiences. As Elsden, Kirk, et al. (2016) emphasise, the insights we draw from our data are formed for audiences in narratives in particular social contexts. They argue, "Quantified Self data should be designed not only as objective facts but also something for people to talk about and use in creative ways."

The moral of the design fiction at the start of this section is of course that you have to *do the work* to find any meaning in your data. Elsden, Kirk, et al. (2016) define *data work* in terms of the "language and work that is necessary to qualify and make sense of one's data". The present thesis has offered a finer-grained analysis of such qualifications and negotiations. This literature can more broadly be situated in "lived informatics" accounts of self-tracking (Epstein, Ping, et al., 2015; Rooksby et al., 2014). This work echoes my criticism of personal informatics as decontextualised insight delivery, and instead focuses on the everyday contexts in which tool are really used and understood. Beyond personal informatics, Taylor et al. (2015) emphasize how the places in which data are appropriated can structure and ground the interpretation process. They describe data as entangled in existing

forms of life in the context of which they come to matter. Despite the emphasis on social contexts, sociality is still often undertheorized in "lived informatics", in favour of a more eclectic view of *social-material assemblages*. The present thesis extends work in this tradition by theorising the *space of reasons* in which the meaning of data is formed by interlocutors in a practice, and the ways in which material objects can figure in this practice i.e., as signs and environments.

While there is now a plethora of work on "lived informatics" in HCI, very few studies have adopted such theorisations to understand the practices of young people. The present thesis addresses this gap to consider the "lived informatics" of groups of teens. Such work is increasingly important as a majority of teens use PI tools (Rich et al., 2020) and personal data technologies become ubiquitous in their lives. This thesis supports the findings that teens are already choosing to engage in self-tracking of their own accord and that they can competently do so without adult guidance, adapting choice of PI tool and practices of use to their own needs and interests.

Prior work with young people has tended to follow Li et al.'s (2010) traditional framing of personal informatics as leading to a discrete pre-defined outcome (Li et al., 2010). I group this work into two strands: the first strand treats PI as part of a behaviour change intervention; the second treats it as a STEM curriculum resource. The participants in the studies in this thesis reacted to implicit norms within both strands. They often reacted against tools and systems that told them what to do (e.g., what to eat or how much to exercise). They valued behaviour acceptance and learning as well as behaviour change. Though many participants did at times approach PI tools with something like the "self-

improvement hypothesis" typical of adult users (Kersten-van Dijk, 2017), this rarely led to actual behaviour change. The change it supported was unlikely to be seen at the level of individual interactions or behavioural patterns in an intervention study. It involved developing a more fine-grained understanding of their activity and of its role in their lives as a whole; for example, by noticing connections between their diet and sleep, or reflecting on their feelings about a friend moving to another school. This was best understood at the level of social practices rather than behaviours or interactions.

The abandonment of PI tools is also best understood at the level of practices rather than interactions. Participants abandoned their PI tool when they felt they could not embed it in their existing practices and align it with the motives they held in such practices; for example, because their Fitbit told them to do more steps when they felt they had exercised enough, or their Toggl gave them data on revision they were not worried about spending time on. However, it was not enough for PI to merely cohere with or supplement existing practices. The data the tool provided was seen as "trivial" unless it mediated practices in ways that scaffolded dynamic activity. The data had to relate to current drama or to things the user found challenging or valued learning more about (Bruner, 2004).

Viewing tool use at the level of practices also let me characterise the rich variety of such practices. Teens were, unsurprisingly, more creative and versatile in their use of technologies than has been appreciated in studies where tool use and outcomes were prescribed by adults.

10.2 Personal expression through data

Adolescence is a time marked by confusion, experimentation, and emotional intensity (Somerville, 2013). Personal informatics has the potential to turn the "ambiguity and messiness into something manageable" (Pantzar & Ruckenstein, 2017). This thesis has explored this potential and considered how it could be supported. At the heart of this exploration has been teens' talk about their own data.

This thesis' findings suggest that PI can offer teens a "ticket-to-talk" in a range of contexts. It is a "ticket-to-talk" in Sacks' (1995) sense of an excuse to start talking, especially in an emotionally involved way i.e. as a way to navigate social norms. But it is also a "ticket-to-talk" in the more fundamental way of entitling me to make specific assertions (Brandom, 2007). For example, the lightning icons on the *LifeMosaic* data of Elias in Chapter 9 allowed his mentor to ask him why he had less energy on one day than on another. This was mediated by the PI data both in the sense that it is not a subject that is usually easy to broach within this kind of social relationship, and because "energy" only became available as a concept as a result of the data being shared in this interaction.

One of the defining characteristics of adolescence is the importance of social relationships and social recognition in teens' lives (Bell, 2016). The social practices reported on in this thesis suggest that PI could play a role in mediating social interactions could offer a space for teens to experiment with different roles and develop their own identities. Elsden et al. (2017) contrast the short-term and outcome-oriented focus of traditional PI with *documentary informatics* as longer term PI practices that allow identity to be constructed and curated. They propose that framing PI as documenting past experiences can foreground its incomplete nature and openness to interpretation and therein make it a less egotistic and

more sociable activity. The present thesis demonstrates documentary informatics in the context of a school mentoring program in which students documented significant occurrences in their everyday lives and reflected on them with their mentor from week to week. Given the salience of these social dimensions and the permeability of teen identities, teens could experience others' evaluations of their data (for instance, in suggesting they were not healthy) as particularly resonant and significant. In contrast to the participants in Elsden et al.'s (2017) study, the teens in this thesis often did not merely reflect on their thoughts and feelings about what was implicated in their data, but experienced this meaning as directly evocative and dramatic. Expressing emotions is an important skill to develop in adolescence: it is positively associated with emotion regulation and decision making (Zeman et al., 2006). Emotion and emotional learning became a focus for the present thesis because the participants in our studies were so enthused by the opportunity to talk about their emotion. In being asked to offer an interpretation of their data (be it sleep data or productivity data), participants often spoke about their mood and emotions. The concepts and practices developed as part of the self-tracking they were asked to experiment with directly supported this process. Participants appropriated signs and concepts from their PI practice to help understand their experiences. Some explicitly reported that this supported their emotion regulation. The was a process of what Vygotsky calls *sign mediation*:

> *The creation of a sign, such as 'I am angry' allows an individual to reflect upon the feeling process and modify it. Through the use of signs, feelings can therefore be re-contextualised and redirected, and take on other meanings in a hierarchical dynamics that gathers momentum over time. (Muller Mirza, 2016)*

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The strength of the PI tool here was in making such signs tangible and publicly accessible i.e. in iconically grounding them. The semi-structured process of discussing their data with an adult and with peers gave teens the chance to weigh up the significance of current as well as past experiences. The data could offer "evidence" to themselves and others that what they were doing was appropriate and good. Although keeping a paper journal has been found to lead to similar benefits for adolescents (Utley & Garza, 2011) a journal entry is in some ways less open to reinterpretation than PI data. As in prior work (Elsden et al., 2017), PI allows for the past to be recast in light of new insights or values. Some of our participants went back and edited past data following its interpretation, in a way they are unlikely to do with a journal. A personal journal is arguably also less suitable for sharing with others.

Prior work has tended to treat PI as an independent system where "the data speaks" directly to the user (Bode & Kristensen, 2015). The rhetorical power of the data is invisible here and it tends to be thought of solely in terms of what it indexes. The PI system could at times be treated as an agent with "borrowed authority" (Weiner et al., 2017), and at other times, as a prop in an unfolding drama – to make a joke, share a preference, or express something else tied to the young person's developing identity.

Following prior work (Elsden, Kirk, et al., 2016; Fleck et al., 2020), I suggest that when data became part of the dynamics of face-to-face social interaction, it became polysemous: it could be seem as open to multiple interpretations. This was one way in which the data's "own" voice of authority could be challenged. Teens live in a world where their voice is often undervalued, and the rules and norms of adults are imposed on them. Once social practices developed that could support negotiation over the meaning of data, data interpretations

often played out the contradictions between norms imposed by adults and those of teens and their social groups.

The findings in the present thesis suggest that PI tools designed for teens should allow customisation and flexibility – so that they can respond to the fast-changing contexts, motives, and interests of teen users. This could involve customisable units of analysis for tracking, context tagging, and integration of new data types into the same system. Though customisation has been a design focus in PI for some time, current solutions like *OmniTrack* (Kim et al., 2017) are likely too complex and labour intensive for teen users. Our design of *LifeMosaic* offers some potential directions for future work to address this gap. *LifeMosaic* uses symbol stickers and colours to involve knowledge and genres already familiar to adolescents.

I want to suggest that personal informatics data need *responsive ambiguity* to support interpretation – they should be symbolically open and indexically closed: although it was important for the data to be open to multiple interpretations, it was also important for it to be tied to (i.e., covariant with) salient aspects of the environment. PI data then should be less like a Rorschach ink stain and more like an expressionist painting. The data represents something insofar as it is sensitive to the user's concrete practice. Even playful data, like a chicken drumstick icon on *LifeMosaic* took on meaning in discourse because it could be treated as revealing concrete particulars, in terms of which interlocutors could retrospectively recollect their experience e.g., by surmising that choices to eat junk food had been affected by sleep habits. This is a dialectic in which data is both *objective* and *subjective*.

That customisation can support self-determination and meaning making has long been established in PI research (Storni, 2014; Ayobi 2018). The present thesis extends this contribution by offering a finer grained understanding of the motives and activities by which customisation can support such effects. With Vygotsky (4.3.1), we might say that customisation allows me to develop signs to change my relationship to my environment, expressing opportunities to transform it. *Responsive ambiguity* stresses the tentative and uncertain nature of this process. Drawing on the work of the *LifeMosaic* design team as well as the philosophical framework of Chapter 4, I offer recommendations for design for *responsive ambiguity*. I draw out some collateral commitments of the concept model them across two dimensions[68]:
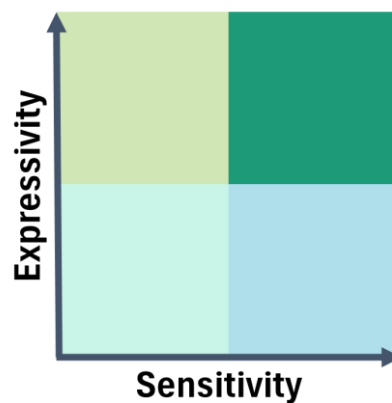
Figure 15: Design for responsive ambiguity model

When Elias (9.3.5) begins to use *LifeMosaic*, the app can be plotted in the top left quadrant. It allows him to express things he personally values, such as his cat and how

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[68] This model is necessarily a reductive recasting of the "Janus-faced" nature of sign use (Potapov, 2021b).

productive he feels, but he finds it difficult to tie these signs back to everyday experience to draw out their implications in his own concrete practice. The data here has low **sensitivity** because it is abstracted and severed from what is occurring in Elias's life activity. Ali (8.3.2) added a burger symbol to his daily log on *LifeMosaic* to index eating fried chicken / going to a chicken shop. Though this did not limit the meaning making in the situation, a wider range of food stickers could give Ali greater granularity in future reflection on his diet. At the same time, prioritization of iconic representation of specific foods could limit the **expressivity** of the data by reducing its ambiguity.

Meanwhile, Stefan's (9.2.3) use of the Continuo app can be plotted in the bottom right quadrant. Stefan can use the data to explain just how much reading he has done – the data is sensitive in adequately capturing his everyday experience and proving resonant for him and in the mentoring practice. But the app is less helpful in scaffolding meaning making beyond the practice in its present form (4.2.3). The data serves as an initial cue or ticket for talk, then quickly gets left behind in the course of the mentoring. This is fine and good from the perspective of the mentoring practice, but with a focus on design, we can note where the tool fails to meet user needs. The data visualisation has low expressivity in the sense that when the mentor points to it in the discourse, it does not support Stefan's reasoning. Arguably, Continuo's flat and uniform bar graphs did not provide a rich texture for drawing determinations or offer gaps and ambiguities to invest with meaning, thus limiting the extent to which the data's significance could be negotiated; alternative explanations offered and justifications solicited. For instance, the app could better support Stefan in expressing connections between reading and other scientific concepts he represented on the app, like

exercise – perhaps by presenting the data in a single radar chart. Alternatively, the app could be redesigned with a focus on symbolic representation, letting Stefan draw these connections on more ambiguous or "metaphorical" (Winterburn et al., 2016) visualisations, such as the root system of mushrooms of different types and sizes.

"Sensitivity" here is not synonymous with "accuracy". As Alyssa (9.3.4) and others demonstrated, *accuracy* is better understood as what corresponds to the user's motives and practices. Apps like *RescueTime* could provide minute-by-minute accuracy about the activities of the user, but this did not tend to support meaning making because it was not attuned to their own understanding or resonant with their experience. To return to the Vygotskian framing (4.3), it is sensitivity to the *environment* not in absolute terms, but as it is refracted through the personality of the individual.

Design should centre on the user's motives for customisation. The user may want to customise their tool to be more sensitive to their needs, capabilities, activities, life contexts, and level of understanding[69]. Alternatively, they may want to customize to express their identity, values, meanings, and relationships. Of course, these motives may overlap and be clarified through tool use. The theoretical framework offered here could extend to other design work exploring how data can be embodied to promote creative reflections and "data stories" (Desjardins & Biggs, 2021; Desjardins & Tihanyi, 2019; Odom & Duel, 2018).

10.3 Meaning making with data

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[69] This also aligns with what Elsden, Kirk et al., (2016) call "verisimilitude".

This thesis has focused on meaning making as a mechanism for learning. I follow Vygotsky and Sellars to argue that the meaning developed between participants in a situation can be internalised, constituting learning that can apply to other contexts. Meaning making at micro-level can support more gradual macro-level learning, progressively expanding concepts and capacities. I emphasise the role of shared signs implicated into a social practice in mediating this learning: allowing participants to orient one-another to an ideal form of what is right and relevant. I focus on how such learning is catalysed by dramatic situations, which contribute to how we cast our lives as a whole and our relation to our world. These multiple temporalities, and these semantic and affective dimensions are an inseparable part of the learning and development of teens. I have characterised these dynamics in terms of teens' *perezhivanie*, but they are also implied by the multiple meanings of "meaningful".

As Mekler and Hornbæk (2019) argue, designing for the experience of meaning is an important but undertheorized objective in HCI. Making interactions personally meaningful is an important part of making design ethical and supportive of user well-being. The objectives of the present thesis have involved investigating how teens draw meaning from their use of PI tools (RO.2) and how such meaning making can be theorised (RO.1). This section describes how the discussions and findings in the present thesis can contribute to the research agenda of designing meaningful experiences with technology. I first address a common strand of criticism of personal informatics and its ethical implications, and then offer a positive account of the potential benefits of personal informatics in schools as part of a process of meaning making.

10.3.1 Alienation

In an ethnographic study of the Crow nation in Montana, Jonathan Lear describes how the Crow way of life fell apart as a result of colonialism. The same words and acts no longer held any meaning because the concrete practices of which they were a part no longer existed. Asked about his experience of life after the buffalo were wiped out by Europeans, Crow chief Plenty Coups says, "*You know that part of my life as well as I do*" (Lear, 2006, p.2). He has no narrative to offer that would not be covered by a 3rd person description that the white man could give. Plenty Coups' relation to the world may be described as one of extreme *alienation*.

As data encroaches on ever more aspects of our lives, there are growing worries about how it may contribute to our alienation. Self-tracking and the Quantified Self movement are often targets of these critiques.

> *'Quantified Self' transforms the body into a control-and-surveillance screen… [it] dissolves the body into data, makes it data-compatible… The transparent body is no longer the narrative scene of the imagination. Rather, it is a sum of data or partial objects. (Han, 2017, p.25)*

Data can pose a 3rd person perspective on our practices which can disempower us through its abstractions – reducing what is unique, felt, and meaningful to prescribed models. In schools, data forms the bulwark for regimes of accountability that try to "teacher-proof teaching", instead of treating it as a developing social practice or craft (Dunne, 1997, p. 35). But it is possible to go too far in this criticism. This thesis has recommended treating data as signs. To reject data *in toto* is to reject signification; which (as argued in Chapter 4) is

to reject rationality and self-consciousness. It is worthwhile therefore to separate some common weak criticisms from those I argue are valid and important.

One line of criticism holds that self-tracking omits important aspects of our experience, or prevents us from adopting more authentic or intuitive ways of knowing (Juchniewicz & Wieczorek, 2022; Wright, 2014). Treating data as signs makes the weakness of this criticism clear. As Vygotsky and Ilyenkov suggest, every use of a word (or of any symbolic sign) involves reification (Ilyenkov, Forthcoming; Vygotsky, 2017, p. 489) but this is just to say that it plays a function in a particular practice. Calling something a "ginger cat" certainly omits things about the cat, but it is only by this determinate negation that it can mean anything at all (Brandom, 2019 p. 58). As I have argued, there are no unmediated ways of knowing.

The worry here seems to be that self-tracking technologies will *distort* my experience. Out hiking in the Kent Downs, I look at my Fitbit to see how many steps I have walked. To the critics, this degrades or constrains my experience. But if we reject the dualism of embodied skilful coping versus disembodied rationality (McDowell, 2013), there is no difference in kind between these experiences. I check my steps, note on a road sign that Canterbury is 5 ½ miles away, then my eye wanders to a foxglove on the side of the road. Multiple non-overlapping experiences and systems of values can be part of my hiking. Far from unweaving the rainbow, they can enrich my practice. As Sharon (2017) argues, it is best to think of values like *empowerment* and *alienation* not in absolute terms but in the context of the self-tracking practices in which they are enacted.

Though users of PI tools can indeed experience "the alienating and disembodying nature of the devices" (Gardner & Jenkins, 2016), this is a function of their relation to our habits, not of their nature qua technologies. In a study of EEG and ECG data visualisation, Gardner & Jenkins report that this sense of alienation can dissipate as the data becomes implicated in users' richer processes of meaning making. Eva Kappler et al. (2018) similarly report that participants can appropriate seemingly alienating PI tools to make them resonant with their lives and personalities. The participants discussed in the present thesis often found their data initially confusing or meaningless (e.g. Elias in Chapter 9), or closely tied to existing rules and expectations (e.g. Tom in Chapter 8) but came to draw on such data in ways that were imaginative and expanded their self-understanding. Contra Han (2017), this thesis illustrates how self-tracking practices can very much be a "narrative scene of the imagination". A single burger icon can unfold into a narrative about visiting a chicken shop and staying healthy (8.3.2). My daily step count can mean I'm sick and my wakeup time can frame what a bad day I've had (6.3.4). I characterise this as a process in which learning supports self-determination.

This thesis aligns with Hegelian Marxist conceptions of alienation (Ilyenkov, 2023). Alienation for Marx involves finding that the world, as it forms the material conditions of my practice, is not my own; it is beyond my control, though it controls me. This leads to and is led by the disruption of my social relations and the power involved in these relationships (Marx, 2013). The lives of teens are full of power structures, many of which are not rationally or practically mutable. While many authors have emphasised how PI can reproduce or exacerbate power imbalances in the workplace (Moore & Robinson, 2016), adolescents' forms of life differ here and need to be considered separately. Our participants were aware

of the ways that teachers and parents could misuse their power in relation to personal informatics by

a) Forcing them to use the tool
b) Accessing their information without consent
c) Using information coercively e.g., saying they cannot go out because their productivity score is too low

No actual instances of such misuses of power were reported by participants in this thesis. I would recommend that while schools should notify parents that their child will be using self-tracking tools, the agency of the teen must be preserved. In our studies we supported this by paying careful attention to how the design of tools and the norms of practices supported curation of personal data i.e. allowing teens to decide which data they shared and with who. As has been widely reported in work with adult users (Wieczorek et al., 2022), some participants also expressed concerns about companies using their data without their knowledge.

As in prior work (Freeman & Neff, 2021), it was not only power relations between teens and adults that were important here. While I have argued that sharing and talking about data brings a wide range of benefits, it can also lead to unhealthy social comparisons or to teasing between peers. The design team of *LifeMosaic* addressed this challenge by making data ambiguous. Manually tracked casual data is arguably far less likely to be exploited within the different systems of power described above.

10.3.2 Appropriation and self-determination

As Schulz (2016) argues, while PI can be a tool of exploitative alienation, it can also help users to become more aware of these external powers, or in better wielding their own power within exploitative social relations e.g. by more distinctly carving out what is free time from work time (as recommended by Cecchinato et al. (2015)). Self-tracking helped participants in this thesis to become conscious of the ways their activity was being valorised by extrinsic standards beyond their control and could potentially help them challenge such standards or find alternatives. This could be in the form of a reaction against the tool itself (e.g. in its injunction to walk 10,000 steps) or against school or family rules. Where it was the tool that "told" participants what to do, this could open up critical discussions about the wider social norms this reinforced. The classroom practices described in this thesis also supported youth in critically challenging authority by prioritising youth knowledge and lived experience. But it is also important to note forms of power which were rationally scrutable were often welcomed by teens. This will be discussed more fully below.

While many authors have characterised alienation as alienation from an authentic self or personality (Nardelli, 2022; Rapp & Tirassa, 2017), I have followed Vygotsky in viewing personality as dynamic and porous. The personality of the teens in this thesis' studies became manifest through negotiation in discourses. Personal informatics offered additional resources for these discourses. Jaeggi (2014, p.68) contends that alienation involves the inability to adequately articulate oneself within a social role. For Vygotsky, adolescence is a time of experimenting with social roles and learning to be sensitive to their associated norms (Rubtsova, 2020). Part of what supported the social and emotional learning I report on in this thesis was the opportunity teens were given to experiment with social roles in articulating

aspects of their everyday experience. As Rubtsova (ibid.) argues, technology can help mediate such opportunities by creating spaces for playing with rules.

Marx writes that the alienated person "does not confirm himself in his work, but denies himself, feels miserable and not happy, does not develop free mental and physical energy" (Marx, 2013). What is it to *confirm* myself in my activity or act on *free energy*? While this negation of alienation is usually referred to as *appropriation*, in this thesis, I have followed Vygotsky in calling it *self-determination*. I suggest that this involves:

1. The selection of possible actions
2. In pursuit of a course of action and
3. The recognition of the action and its motive as one's own

Self-tracking supported self-determination when it contributed to a "basic consciousness of the possibility of choice" (Jaeggi, 2014, p.65). In this thesis, participants found their data most meaningful when it explicated choices that were open to them. Some appreciated just knowing that these choices were open to them (like P6 in Chapter 6) while others acted on such insights (like P9 in Chapter 6 and Roxana in Chapter 9). Identifying with the choice of action as coherent with their motives or as confirming who they are was important here. In Chapter 6, reflecting on his data led P16 to realise that he had been sad for a number of days, but he described this experience as good and important because it showed that he valued his friend. He connected this to choices like going to the cinema.

Both alienation and self-determination involve externalisation: finding some aspect of our will embodied in something separate to us. Some participants literally characterised their data as an authority separate to them. Yet they found this authority empowering in that they

could appropriate its dynamics back into their own practice, for example, in holding themselves accountable to bedtimes or times on social media, which, through a wider evaluation of their lives, they judge as good.

Development occurs in dialectical phases of alienation and self-determination[70]. Whether something is alienation or self-actualisation can often only be determined in hindsight (Brassier, 2019). One key determinant here is whether this external object was shaped by and shaped my capabilities. Drawing on the "capability approach" in the Marxian ethical framework of Amartya Sen, Pendse et al. (2021) report on users of online suicide prevention services. Users who search for suicide methods are often given search results for suicide prevention services at the top of the search. This is a traditional nudge, seemingly countering the user's own motives, yet a participant in the study describes it as having given him agency after he called one of the services recommended. He can see the choices he made as aligned with and supportive of his capabilities in his life as a narrative whole. Technology supporting self-determination cannot focus solely on the task a user is trying to achieve but must consider the wider practices, stances and experiences (*perezhivanie*) in which they are embedded – designers must consider multiple spheres of experience (Peters et al., 2018).

PI data often supported participants in the present thesis in viewing their own activity "as if from the sideline" (Vygotsky, 2012b, p. 16), but this was only meaningful when the

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[70] In Chapter 3 I criticize Foucault and Garfinkel for their rejection of scientific naturalism. Di Paolo et al. offer a more integrated cross-disciplinary approach, grounding the dialectic I sketch here in dynamical systems theory, theoretical biology, and psychology (Di Paolo, 2019; Di Paolo et al., 2017, p.243).

participant could reappropriate the data to reflect on activities under their own control. When such choices were not valued; for example, when a participant did not see how they used their phone (P12 in Chapter 6; Tamzin in Chapter 9) or exercised (P10 in Chapter 6) as relevant to their identity, the data became meaningless or even alienating.

Participants appropriated data by engaging with it and seeing how its meaning changed through their engagement. Even rejecting some data as irrelevant supported self-determination in helping them see their own role in giving meaning to the world they engaged in (Jaeggi, 151). Some participants used the concept of their data as "relevant" to evaluate its practical value.

This picture of technology-mediated progress may seem to affirm the "self-improvement hypothesis" (Kersten-van Dijk, 2017) of traditional PI, and the neoliberal ideologies that produce it (En & Pöll, 2016). Though this is a valid criticism, I want to contrast this individualist focus on personal deficit with a focus on problems that arise within social practices (Jaeggi, 2018), the latter of which I endorse and see as the goal of Vygotsky's work. Such a focus should be seen as a part of a wider project of improving the practices and institutions constituting our forms of life through collective activity and reflection.[71] The sleep hygiene practices described in Chapter 8 were expansive of social practices in that it was the goods of sleep as a practice which were the focus here and because these goods

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[71] An implication for design here is that it would be hard for a chatbot integrated into a PI tool to sustain this kind of discourse because it relies on how things mutually matter to interlocutors (MacIntyre, 1999).

were in part constituted through deliberation on what good sleep is. These goods were dynamic and could be contributed to or contested by any participant, though not fixed by or in any participant. They were recognised as good insofar as they could be confirmed in participants' own concrete practice, and the problems or drama they faced. Such a dynamic was easier to attain within the varied relations in a small peer group context than it was in a mentoring context in which a teen was already interpellated as a "mentee".

10.4 Orchestrating the interpretation of personal informatics data with teens

In this thesis, I synthesize the work of Vygotsky and related thinkers to make a theoretical contribution to the study of teen meaning making with data technology. Cultural historical activity theory (CHAT) studies phenomena in their development rather than their behavioural fossils. I have studied teens as they exist in dynamic creative practices the outcomes of which have not yet been determined, and through which their identity is externalised, curated, and created (cf. Elsen & Kirk, 2016). I have bolstered the currently dominant CHAT approach by reintroducing a granular account of meaning and experience in development. I have traced the role that signs and sign systems play in scaffolding this development. Signs do not merely index the way things are, they determine how they could be - they help us see possible action and to reflect on what is good and right. Signs create a social space that lets us orient one-another to our thoughts, wills, and creative powers. As we become sensitive to these ideal forms, we build new ways to relate to our present environments. As we interpret data about the life we experience, we form a new view of the forces that have constituted it: "what results is a certain form of activity which then becomes a child's internal asset, his property and a function of his personality (Vygotsky, 1994b, pp. 338 - 354)". The present

section draws from these theoretical commitments to recommend ways in which young people can be helped in this process of critical reconstruction and self-determination. What is most particular to the lives of teenagers is the centrality of the social realm: the immediate way in which teens' social relations form their development and the goods towards which it is directed. My framework seeks to help researchers investigate these social-affective contexts and the dialectical role of tools within them. Teens' tools can reify histories of affect and practice, as well as constructing their future.

The present section brings together recommendations of methods and principles for educators and researchers interested in facilitating social practices in which adolescents interpret personal informatics data. These recommendations are based on the theoretical and empirical findings of the thesis as a whole, as well as critical reflections on how I ran studies. They are also the product of co-construction with my study participants, they are informed by the tools, strategies, practices, and feedback which participants developed with me over the course of the studies. These recommendations are intended as speculative reflections on the work of this thesis and as directions for future work. Future work could test these recommendations in different school contexts.

Integrating personal informatics into classroom practice could:

a) Allow students to see diversity as well as convergence between their experiences and those of their peers (cf. 8.3.2).
b) Help students feel invested in the learning and give them opportunities to draw on their own values and experiences (Engen, 2016).
c) Provide boundary objects to help educators and peers negotiate beliefs and values (Polman, 2018).

d) Support differentiation, letting a mentor or teacher see what kind of guidance an individual student needs (cf. 9.3.2).

e) Encourage students to continue learning at home (cf. 9.3.5). Targets set during mentoring are usually quickly forgotten, and there is rarely homework associated with social and emotional learning (Foster, 2001).

Personal informatics research and design has tended to either "[show the user] a graph and hope" (Kay, 2014), or else to heavily prescribe tool use. This thesis promotes a semi-structured approach, which moves through phases of freedom and constraint.

10.4.1 Contexts for personal informatics in schools

This thesis has argued that PI could form part of a school's strategy for social and emotional learning, as in the curriculum for RSE in the UK or other PSHE programmes. I examined two types of classroom practice where PI could play a positive role. In the context of one-to-one mentoring, PI tools can be introduced as and when they might be helpful for setting or reviewing mentoring targets, or conversely as an alternative to target setting: offering a structure that is more playful and discursive. The mentee might stop or resume self-tracking at different points in the mentoring.

PI can also be helpful for exploring specific topics on curricula for social and emotional learning. This could include issues of digital literacy like data privacy and online communication, personal health topics like sleep and mood, or even social topics like managing conflicts. One potential barrier here is that if this is a topic explored by the whole class, only a proportion of students will choose to use a PI tool. It is important to not attach extrinsic rewards or punishments to tool use to preserve self-determination: this is partly to avoid creating "token-economies" in which student motives are subordinated to those of the

teacher or researcher (see 2.2.3). My findings suggest that having a few students who are willing to collect data and talk about it to their peers may be enough, as other students can still engage in discussion around these interpretations (cf. 8.4). It may be that more students will be comfortable to collect and share in pairs or groups of three. There are undoubtedly school contexts in which PI could support such talk which have not been explored in this thesis.

Rich et al. (2020) report that more than half of UK adolescents have used a PI tool without adult supervision. This number likely increased during the covid-19 lockdowns as young people sought structure they had lost in no longer attending school (Freeman & Neff, 2023). While this can help teens feel empowered to learn more about their health, it can also pose significant risks, particularly around healthy diet. Food tracking apps like *MyFitnessPal* can have a direct impact on eating disorders (Hahn et al., 2022). Where young people are already using such apps, discussions in classroom settings may prove more effective than prohibition in helping to create critical distance from such risky behaviours. Therefore, while it's important to give young people agency in choosing how they track the things that concern them, I would recommend tracking of more qualitative and subjective dimensions here. A student tracking her calories could be encouraged to track the extent to which she feels she ate well instead. On the whole, manual tracking is better suited to the aims described in this thesis. Simple commercially available tools like *Track & Analyze, Ubermind* or *Best Life Health Diary* allow for customisable data collection and simple visualisation, while also lacking black-boxed algorithms which might pressure the user or constrain interpretation. If a student chooses an automatic tracking tool like *RescueTime*, it's important

to explore with them how they can modify what is tracked, and what would be visible if they showed their data to someone else e.g. by modifying the category of certain activities and deleting logs they don't want in their data (cf. 6.3.4). Whichever tools are chosen, the aim is to build a playful and critical relationship to the data.

10.4.2 Scaffolding and orientation session

Young people have few prior frames of reference or models for how to talk about personal data. Framing what personal informatics was for teen participants had a significant impact on their subsequent independent use of PI tools. Though most participants were aware of PI tools, they had not considered them together in a wider category or done much to reflect on their past experiences. Starting the studies with at least one scaffolding and orientation session prepared participants for high quality self-tracking (cf. 6.2.2). These sessions had a number of components that proved helpful:

1. **Framing the domain of self-tracking**. Showing some existing examples of self-tracking practices and data visualisations helped to clarify the focus of the study and frame some productive ways of thinking about data. This could involve a wider discussion of the role of data in our society (cf. 8.2.2).

2. **Demonstrating that the same data can mean different things** to different people in different situations. This could start with asking for as many as possible interpretations of a visualisation (e.g. heart rate, pages read, time on types of app, then showing how knowing the user's motives and context can help us slightly

narrow what the data could mean e.g. if the user was with their child, had a big argument that morning, or an important exam next week (cf. 6.2.2).

3. **Scaffolding the process** by which each participant decides on a motive which self-tracking could help learn about. This could be related to what affects or is affected by a particular focus like having arguments with friends or sleep (cf. 8.3.3). Participants could make some predictions and plan how they'll carry out their investigation. Following Byrne et al., (2018) I have found that it is best to create or modify scaffolding with the participants in the session (cf. 7.2.1; 9.3.6). Scaffolding could involve:

   a) Offering prompts and questions during discussion (cf. 8.3).
   b) Modelling examples of practices and motives, illustrated on the board or on cards
   c) Asking participants to write down what they're going to do and how (including which app they will use and when)
   d) Asking peers in a pair or group to evaluate whether a plan is reasonable and realistic
   e) Creating a bank of sentence starters or vocabulary that could be helpful when giving a data interpretation[72].

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[72] I only did this loosely with a whiteboard marker (cf. 6.2.2), noting down interesting points and phrases when a participant interpreted a visualization during discussion feedback.

4. **Setting ground rules.** Following Mercer & Dawes (2011), classroom practices involving group work need to also frame how participants will talk to each other. First, this involves establishing that this classroom context is a safe space where it is not appropriate to laugh at someone's contribution, and where the focus must be on supporting rather than criticising peers. Second, this involves making it clear that participants should only share what they feel comfortable sharing and that it is fine to share nothing. Third, this involves stressing that participants will need to give reasons to justify what they say. Instead of agreeing or dismissing, they need to explain how or why they've formed an opinion or interpretation and to ask others for their reasons.

10.4.3 Interpreting in groups

Following Lipman (2011), I suggest students sit in a circle with a teacher or facilitator part of the circle. This is a democratic process with everyone equally entitled to speak. Whether students split off to work in small groups or work as a large group, it is important to think carefully about group composition. Students should feel comfortable sharing and listening to others' ideas and experiences. If working in one large group, a visualiser can be used to project a visualisation from a student phone screen to the board. The student should put their phone under the visualiser themselves (cf. 8.4). The session or sessions should have a specific focus beyond the self-tracking tool, such as sleep, stress, or friendship.

10.4.4 Interpreting with a mentor

It is important to consider whether introducing PI into one-to-one mentoring is appropriate in a specific school context. It may be best to leave pastoral mentoring to school

staff with relevant training and other staff and peers for tangible academic mentoring, focusing on specific targets like time spent on Spanish work or video games. The mentee can start and stop using a self-tracking tool at any point during the mentoring, and should only start using it if it is relevant to their targets and motives (cf. 9.3.3). If the mentee is already using a self-tracking tool, it may be helpful to explore their motives for doing so and to help them develop a critical stance to their tracking during mentoring (cf. 9.4.4). Some may find target setting restrictive or reductive: targets can reinforce one-way relationships of accountability (cf. 9.3.6). PI can replace target setting to provide some structure and common focus while potentially mediating a more creative and democratic mentoring relationship.

I recommend four to six separate sessions for the mentee to develop a PI practice they can draw insights from (cf. 9.4.2). The self-tracking tool should not be the focus of mentoring. Once students have been introduced to self-tracking, the focus should be on finding goods of a practice (cf. 3.4/5) that mentees understand, value, and agree to pursue. This will involve an ongoing discussion e.g., of what it means to get good in Spanish, or be a good friend. It can then be decided whether self-tracking can support understanding or pursuing these goods. There could then be a discussion of how doing well, making progress, or reaching the target might be represented in the data. The motives of the practice will form and develop through doing the practice so it is likely that adjustments will have to be made along the way. (cf. 9.4.1).

10.4.5 Using discourse to support interpretation

This thesis has followed prior work (Agapie et al., 2016; Fleck et al., 2020) to argue that talking about personal informatics data helps to interpret this data and to have personal

insights based on it. While prior work has demonstrated that such discourse is helpful in healthcare settings (Chung et al., 2016), such settings (and the norms and motives within them) differ in important ways from educational settings. My starting principle in the context of education is that a teacher asking a child to share their thinking out loud helps them to reflect on their own thinking and to bring it into a system of other concepts)(Vygotsky, 2012a, p.71). This section breaks this process down into some practical tips at the micro-level of discourse.

Forming a space of reasons:

- Teens should lead the interpretation. Questions rather than statements should be used where possible (Lipman, 2011).
- Ask if there is anything interesting in the data or anything they learned while collecting it. Try to find something in what they say that can lead to a story or a justification. The data is a springboard for talking about everyday life and the session topic (cf. 8.1).
- Ask if the data is good or bad, then seek justifications and challenges. Relate this back to the practice: "What would a good study session look like?", "How can you make it better?" (cf. 6.3.4) Elicit choices the student made and could make. Are they good or bad choices? Explore whether what they see as bad could be good and vice versa (MacIntyre, 2016, p.54).
- Ask if the data is accurate, adequate, and relevant. Rejecting the data still involves interpretation and supports a more critical stance (Jaeggi, 2014, p. 65).
- Ask for alternative explanations (perhaps offering some examples). "What else could this show us? How might someone else interpret this?" (cf. 7.4.3; 8.3.2)

Developing everyday and scientific concepts:

- The facilitator can help the student bring their everyday concepts into a domain of scientific concepts, e.g., by writing their phrase down or asking how we can relate it to the main topic. These kinds of connections are likely to lead to the best insights (Vygotsky, 1987b). Make it clear that the knowledge students bring from home is valued.

- It may be helpful to note contradictions between a student's narrative and their data to positively constrain it or prompt justification (Sannino & Engeström, 2017), e.g., "Is that what your data shows? Did you catch that in your data?".

- Suggest patterns. Tagging activities or events can help to connect them or to question the connection: "You've said on Monday and Wednesday you were unproductive. Was there anything you did on both days?" (cf. 7.4.2)

- Point out how what the data signifies changes over time: "Earlier you said the sun symbol meant you were focused, but now you said it means you were motivated. Has the meaning changed?" (cf. 9.3.5)

- As Peirce suggests, interpretation involves "mooring our words by certain applications and letting them change their meaning as our conception of the things to which we have applied them progress" (Short, 2007, p.264) Highlight words and phrases which proved insightful in the discourse or were returned to. Ask for elaboration on these words or note how their meaning changes over time and in different situations (cf. 9.3.4).

10.5 **Further Directions for Future Work**

Design has often focused on practices that are mundane and orderly. The present thesis instead focused on practices in drama and flux: a state far more representative of the fast-changing and provisional worlds of teenagers. I have argued that it is in these dramatic situations that our tools become meaningful, and that we must grasp these meanings in their particularity to guide design. To reach these conclusions I have traced how meanings develop at the micro-level of discourse. This contrasts with both the macro-level analyses of Foucauldian understandings of practice, and with ethnomethodological accounts in which everything meaningful is taken to be observable on the surface. I have suggested that it is at this macro level that we can observe how users' agency determines the course of practice and the form of tool use within it. The use of a tool develops tentatively and unevenly across different contexts and temporalities. HCI has tended to overlook how users (and particularly teens) learn to use tools and adapt their use over time. If design is to support this kind of learning, it will need to engage with and scaffold rather than circumvent the meaning making that directs it. This focus on the micro-level should not overlook the ways in which our whole lives and identities can become implicated in meaning making. The two senses in which something is "meaningful" to us are moments of the same dynamic. Design must be sensitive to this dynamic affective fabric, while empowering users to express their own course of action within it.

The sole focus on personal informatics in this thesis has potentially curtailed grasp of the dynamics I have theorised here. Personal informatics data visualisations are designed to be behavioural fossils rather than a live component of practice (e.g., contra Byrne et al., (2018)).

Participants in Chapter 9 attempted to perform live reformulations of their data but were not well supported in this by the tool. Ultimately, personal informatics tools are designed such that one Fitbit user is as good as another; few would or could recognise goods of becoming better at Fitbit. It is for future work to explore if the same is true in longer term use of tools that better support responsive ambiguity – applying the framework I present in Chapters 3.4 & 4 to designs like Ayobi et al.'s (2020) *Trackly* may be fruitful here. The broader implication is that future work should design for meaning making with technologies that teens can use in more directly pursuing the goods of a practice, such as an artistic practice or sport. Design-led approaches have begun to explore ways in which data can be meaningfully situated in such social contexts (Menheere et al., 2021), as well as supporting development of sign-meaning across wider temporalities (White et al., 2020).

This thesis has followed traditions of cultural-historical and pragmatist philosophy in focusing less on replication and generalisation, and more on intervention, transformation, and representation (Hacking, 1983, pp. 220 - 244). This tends to involve small-scale studies in which the particular is taken to demonstrate the general by way of theory (Vygotsky, 1987a, p. 307). Within this framing, there are still limitations to note here. The work in this thesis was performed at only two schools and this could limit how well the dynamics explored can be understood and how well they can be transferred to a new context.

Though my role as a teacher in one of the study schools offered many advantages for the present thesis: supporting the ecological validity of the design and analysis, it also poses some limitations. Future work could explore how easily the findings and recommendations in this thesis could be picked up and implemented by teachers who are not already familiar

with the work or with PI. The mentors who assisted me in the mentoring study described in Chapter Nine are far from ordinary students: they were passionate about mentoring and have gone on to pursue related courses of study at top universities. Future work here would test whether the principles of PI promoted in this thesis would be understood and found convincing by a wider range of mentors and school staff.

The contexts for the use of PI presented in Chapters Eight and Nine each posed their own limitations. Discussing data in class to explore a topic like sleep may not give enough time for students to develop and test concepts, and may not give time or the ideal conditions for everyone to participate fully. Introducing PI into one-to-one mentoring could allow for more sustained exploration of a topic and better conditions for students to feel safe and confident to discuss their own lives. However, the mentoring relationship may reproduce restrictive norms that limit the freedom of the mentee or make them feel pressured to take on certain stances. The mentor-mentee dyad could also preserve an individualistic focus on the deficits of the mentee rather than supporting the kind of dynamic and democratic meaning making that has been promoted in this thesis. What is clear is that small changes to the orchestration of a practice can transform the motives and concerns into which PI is implicated in them. Future work could investigate other social arrangements such as mentoring three students at once. This could support the mentoring group in better considering what personal information they share and the multiple perspectives someone may have on it.

Many of the practices described in this thesis could pose risks to young people with mental health needs. For example, it is likely inadvisable to promote mood tracking to

someone with major depression or food tracking to someone with an eating disorder. Nonetheless, the participants often suggested that PI could have a positive impact on their wellbeing. Future work could further explore the role that personal informatics can have in interventions to support student wellbeing, if not in clinical counselling, then in less formal contexts with pastoral professionals; for example, a group withdrawn to work on aggression, attention, or managing positive relationships.

The participants in my studies often used technology in serendipitous and intermittent ways. There are design challenges here around designing for occasional use, or conversely, supporting the development of intrinsically motivated habits of more sustained use. This also poses logistical and pedagogical problems since (though this is generally true of whole-class use of any technology) many students will forget or choose not to use the tool and will find it hard to maintain a practice.

11 **Conclusion**

Adolescence can be a disorienting time. As adolescents try to understand their own emotions and place in the world, they may seek advice and support from different sources. Some of these strategies will prove helpful and others not. Schools are increasingly interested in supporting young people through these phases of development and equipping them to deal with problems that arise. Self-tracking technologies could help support this kind of learning, acting as a bridge between home and school.

I have framed personal informatics as a developing and tentative process, the outcomes of which are hard to anticipate. This thesis facilitated teens in pursuing their own motives and interests while collecting personal informatics data. I chose methods that respected teens as experts on their own lives. Arguing that currently dominant methodologies do not adequately appreciate agency and meaning making, I introduced a theoretical framework largely novel to HCI. This framework helped to characterise the idiosyncratic situations in which teens can appropriate PI tools, based on their evolving motives.

Teens are aware that many of the interactions they have with technology are unhelpful or even detrimental to their wellbeing. The classroom practices with PI tools described in this thesis could give teens a supportive space for drama and experimentation. While their data interpretations were often initially shallow or superficial, over time they developed a critical voice. They were able to become more aware of some of the social norms salient in their lives and to justify or challenge these norms for themselves. Data visualisations could take on symbolic roles here to make such explorations more tangible and shareable.

This thesis offers fine-grained analysis of how discussing PI data with others supports teens in making personally relevant insights. Classroom practices which framed discussions rather than predetermining their outcomes allowed teens to test out their ideas and to situate them in wider knowledge domains. Discourse offers teens positive constraints to orient their interpretations. PI data was most impactful here when it could support a plurality of interpretations. To this end, teens wanted flexible, customisable self-tracking tools that reflected the flux and complexity of their lives.

Personal informatics that supported responsive ambiguity proved conducive to social and emotional learning both in the context of small group discussion and that of one-to-one mentoring. It supported the RSE objectives of helping teens to "make decisions for themselves about how to live their own lives" by helping them reflect on their choices. Self-tracking could help teens develop concepts relevant to other aspects of their lives. At its best, self-tracking contributed to young people's self-determination beyond their tool use, in their lives as a whole.

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13 Appendices

A. Information sheets

UCL Interaction Centre
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Information Sheet (child)
Self-tracking toolkit workshop
This study has been approved by the UCL Research Ethics Committee [Project ID number]: 10269/002

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Participating in this study is totally voluntary. Please read about the study below. Feel free to ask questions about anything that you do not understand before deciding if you want to be in the study. A researcher or your teacher will be around to answer your questions.

Why are we doing this?

1.   We want to get your opinions and your help designing a toolkit for other students like you. The tookit will be made up of apps that you think might be useful for learning and advice on how to use the apps (based on your own experiments). We are focusing on self-tracking apps: apps that give you information about yourself. We think that getting information about yourself could help you do things in your day more effectively.

What will you do?
You will work as a group of ten or in groups of three and have short discussions as well as doing some design work to develop new ideas.

1) You will be shown different apps and told about how people use them.

2) You will choose one of the apps, download it onto your phone or your home computer and track something about yourself for a week or two.

3) You will feed back on how it went to the rest of the group and discuss how we could use it better.

4) You will design new ways of presenting what the information you collected shows you

5) You will put all your ideas into a feedback form for future schools/students to use

Worries that you might have

2.   You might be worried about collecting data about yourself. You don't need to worry because we will only choose apps that agree never to share your data. You won't ever be asked to share your data with a teacher or researcher or anyone else. We won't know what you tracked unless you tell us about it. The only information we will collect about you are recordings of your feedback and worksheets / diagrams you do. If you don't want to do the tracking, you can drop out of the study at any time by just letting the researcher or your tutor know.

3.   You might be worried about sharing personal experiences. You will only be asked to share comments about how you found using the app. You can share as much or as little as you want and we will only ever take feedback from students who put their hand up. Again, you can drop out at any time, including after the study is done (if you don't want the study to use information you already shared).

4.   **Will you gain anything?**

We believe that these tools could make you more productive and help you to meet your own goals. You would also be helping other students and teachers who can learn from your experience.

5.   **What if you have any questions?**

You can ask questions any time. You can talk to whoever you like about this study. If you want to contact the researcher you can use the email or number at the top of this letter.

6.   **Do you have to be in the study?**

You do not have to be in the study. If you don't want to take part any more you just need to tell your tutor or the researcher. If you drop out of the study nobody will tell you off or ask why. It is your right to drop out at any time and to choose how you contribute.

7.   Signing this document means that you understand what you just read about and that you would like to be in the study.

☐   I agree that Mr Potapov can record my voice during the workshop

☐   I agree that Mr Potapov can use these voice recordings, the worksheets I fill in and any illustrations/diagrams I create and analyse them for the study

☐   I agree that Mr Potapov can store the information (scripts of the voice recordings, photos of the illustrations) he collects (with my name and personal information removed) to use in future

☐   I understand that I can leave the study when I want to

_____   _____   _____

Signature of Student   Participant   Date

_____

Printed Name of Student Participant

_____   _____

Signature of   Researcher   Date

_____

Printed Name of Researcher

UCL Interaction Centre
University College London,

Information Sheet: Self-tracking toolkit workshop

This study has been approved by the UCL Research Ethics Committee [Project ID number]: 10269/002

Research team:
Kyrill Potapov and Paul Marshall

Telephone:

Email: kyrill.potapov.16@ucl.ac.uk; paul.marshall@ucl.ac.uk

Dear Parent / Guardian,

We would like to invite your child to take part in a research study. Before you decide, we'd like you to understand why the research is being done and what it would involve for your child. Please take time to read the following information carefully. Talk to others about the study if you wish. This information sheet tells you about the purpose of the study and what will happen if your child takes part.

If you are interested in your child taking part after reading about the study, we will ask you to complete a formal consent form. Once we have received this we will meet with your child and other participating students to explain the study and carry out the first session.

Please note that since this study relies on the use of technology, we regret that your child is only eligible if they have a personal computer and/or smartphone.

Purpose of the study

Many people use self-tracking tools like Fitbit and Sleep by Android to collect data about their own daily activity. These tools could prompt reflection and improve how effective we are at meeting our goals. This study wants to explore the potential of self-tracking tools for improving learning.

By collecting the opinions and experiences of young people we hope to build up a toolkit of useful tools and advice for students wanting to troubleshoot their learning.

Why has my child been invited to take part?
We are writing to you because your child attends ___ school. They have been identified as eligible for the study by staff at the school.

Please note that no one outside the education teams at your child school has had access to your personal details in preparing this invitation. Only members of the school team who work with your child directly, or researchers who are supervising this project will have access to personal details as part of your participation in this study.

What would participation involve?
If you are willing for your child to take part in the study, we will ask them to attend six sessions during tutor periods at their own school. They will be introduced to a wide range of self-tracking tools and some of their innovative uses. They will then work as a group of ten students or in smaller groups to explore the tools in more depth, focusing on their potential for the educational context.

After this introductory session, they will be invited to carry out a week or two of self-tracking. For example, they might track how long they spend on social media or how many times they unlock their phones and when. They will be asked to talk about their experience of tracking but will never be asked to share their personal data.

At the end of the study, they will design a new way of presenting their personal data and give overall feedback on how students might use these kinds of tools. If your child is interested in the process of research and development of technology, they will be invited to attend a lunchtime club focused on extending this process.

What data/information will be collected?

Though your child will collect data about themselves (e.g. how long they spend on Instagram), nobody but them will have access to this data and we will not request access. Your child may bring data with them to our sessions to help inform discussion but this data will not be recorded.

Every session will be recorded on a voice recorder. These recording will be transcribed. The transcription of what your child and others said in the session will be analysed as part of the study. We will also collect worksheets or diagrams created by your child or their group during workshops. Photographs will be taken of this work but not of your child. Your child's name will be changed in all transcripts and references throughout the research.

Your child will be invited to attend a debriefing session explaining the findings, including the toolkit they have been designing.

Will you photograph and/or video record my child?
No.

Does my child have to take part?
It is up to you to decide. If, after reading this information sheet, you decide that your child can take part in the study we ask that you return the consent form by asking your child to take it back to school and give it to _____. We will schedule the first session once we have enough consent forms back. Your child may not be eligible if you are not able to return a consent form by Monday 6th November.

If I agree to take part what will happen if I decide not to carry on?
It is important that you are aware that your participation in this study is strictly voluntary. You or your child are free to withdraw your consent at any time without giving a reason. Withdrawing your consent will not affect your child's care.

Will taking part be kept confidential?
Yes. We will follow ethical and legal practice and all information about your child will be handled in confidence. All data will be collected and stored in accordance with the Data Protection Act 1998.

What will happen to the results of the study?
The results will be interpreted by the student researcher who will write up the study as part of a thesis for completion of a PhD degree.

Who is organising the research?
The study is being carried out as part of a PhD research degree, Interaction Centre, University College London. The student researcher is also an experienced English teacher.

Who has reviewed the study?
This research study has been looked at by an independent group of people called a Research Ethics Committee to protect your safety, rights, wellbeing and dignity.

What if I have questions about the study?
Please do not hesitate to contact Kyrill Potapov on 079 kyrill.potapov.16@ucl.ac.uk if there is anything that is not clear, or if you would like more information.

What if I have a problem with the study?
Any complaint about the way you have been dealt with during the research, or any possible harm you might suffer will be addressed. Every care will be taken in the course of this study, however in the unlikely event that you or your child is injured by taking part, compensation may be available. If you suspect that the injury is the result of the Sponsor's (University College London) negligence then you may be able to claim compensation. After discussing with the research team, please make the claim in writing to Dr Paul Marshall who is the Chief Investigator for the research and is based at the UCL

Interaction Centre, UCL School of Engineering, Gower St, Bloomsbury, London WC1E 6BT. The Chief Investigator will then pass the claim to the Sponsor's Insurers, via the Sponsor's office. You may have to bear the costs of the legal action initially, and you should consult a lawyer about this. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been approached or treated by members of staff or about any side effects (adverse events) you may have experienced due to your participation in the research, the normal University College London complaints mechanisms are available to you. Please ask members of the research team if you would like more information on this.

What next?
After you have had an opportunity to read this information and are happy to participate in the study please sign and return the consent form to school in the envelope provided. In the meantime, if you have any concerns or queries please telephone or email Kyrill Potapov (079/ kyrill.potapov.16@ucl.ac.uk). Once we have received your consent form we will arrange a time to see your child and other participants.

Best wishes
Kyrill Potapov
Student researcher

<h1 align="center"><u>Participant Information Sheet For Student Participant</u></h1>

<p align="center">UCL Research Ethics Committee Approval ID Number: 10269/002</p>

<h2 align="center">YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET</h2>

REFLECTING ON DESIGN OF A SELF-TRACKING APP
Department: UCL Interaction Centre
Name and Contact Details of the Researcher: Kyrill Potapov   kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall   paul.marshall@ucl.ac.uk

1. **Invitation Paragraph**
    You are being invited to take part in a research project. Before you decide to take part, it is important for you to understand why the research is being done and what taking part will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. This study is being done as part of PhD research at UCL. Thank you for reading this.

2. **What is the project's purpose?**
    You have been working on the design of a smartphone app at school. Although you did this in a club rather than for any research, your design is really interesting and we'd like to include it in the PhD research of your teacher. The PhD is examining how young people can use self-tracking apps to learn about themselves and so your self-tracking app is really relevant.

3. **Why have I been chosen?**
    Your school has agreed for the study to happen and you were chosen because you were a part of the team that designed the app we are interested in learning more about.

4. **Do I have to take part?**
    It is up to you to decide whether or not you want to take part. If you do decide to take part you will be given this information sheet to keep (and be asked to sign a consent form from you and your parent to return to your teacher). You can drop out of the study at any time without giving a reason and without any penalty, punishment or other consequences. If you decide to drop out of the study, you will be asked what you wish to happen to the audio recordings of sessions or any images or design elements you've already given us. For example, we could delete the images or leave your contribution out when writing down what was said in the session.

    If you choose not to take part, you can still attend the club as normal and contribute to the designs and discussions. If you decide to take part, you can drop out later and stop attending the club, or keep attending without taking part in the research.

5. **What will happen to me if I take part?**
    Over the next few weeks the researcher (Mr Potapov) will be including the work you're doing in app design club in a research study. He will be making notes on how the design is going. With your permission, he will collect things you've designed, such as app screens, to use in his research.

    You and the other students who designed the app will then be invited to a twenty-minute interview at your school. You will be asked about what the app does and why you chose to design it in the way you did. These will be one to one interviews with each team member. After the interviews, this study will finish and the things you do and say at the club will no longer be part of the research.

6. **Will I be recorded and how will the recorded media be used?**
    The normal club sessions will not be recorded. The interviews will be audio recorded. The recording will be transcribed (written down), analysed and direct quotes of what you said will be used in conference presentations and research papers. This will also be the case for the images or other

things you designed that you share with us. You do not need to share your designs and images if you don't want to. No other use will be made of them without your written permission, and no one outside the project will be allowed access to the original recordings.

You will be part of the process for analysing this research. We will discuss what images and other materials to include and which parts of the interview help to explain the design. You'll also get a draft of the analysis with the images and quotes in it and have a chance to suggest changes.

7. **What are the possible disadvantages and risks of taking part?**
You have asked us to use your first name which could put you at risk if you share personal or sensitive information, if someone can identify you. You will not be asked for information like this in the interview. You'll be asked to focus on your design. I will check with you that you are happy with the quotes we are using before I share or publish them anywhere. You can also choose for us not to use your real name if you let us know within four weeks of the interview.

8. **What are the possible benefits of taking part?**
There are no benefits to participating but you will be contributing to research about your app. If you choose not to take part, you'll still get the exact same acknowledgement for the app and there won't be any negative consequences for not taking part.

9. **What if something goes wrong?**
If you have a complaint about some part of the study how you were treated or the conduct of the researcher, please contact the researcher's supervisor, Paul Marshall (paul.marshall@ucl.ac.uk) If something serious occurred during or following participation in the study or if you do not feel your complain was adequately dealt with, you can contact the Chair of the UCL Research Ethics Committee – ethics@ucl.ac.uk

10. **Will my taking part in this project be kept confidential?**
All the information that we collect during the course of the research will be kept strictly confidential. You will not be able to be identified in any ensuing reports or publications. Audio recordings will be stored securely and deleted at the completion of the research. Transcripts will be edited to use pseudonyms and with identifying information not recorded. If you share a screenshot from your phone, any identifying information will be edited out.

11. **Limits to confidentiality**
- Please note that if you disclose something that poses a risk of harm yourself or others, the school's safeguarding policies will be followed and the school's safeguarding team notified.
- Please note that it will not be possible to anonymize the quotations that we include in reports / presentations because of the small group size. Written quotes of what you say will be used but we will remove any sensitive or personal information from them.

12. **What will happen to the results of the research project?**
The data collected from this research will be presented within a PhD thesis and may be published in articles or presented at conferences. It will not be possible to keep the quotes anonymous but we will not include anything personal or sensitive that you say. Recordings of sessions and screenshots will be stored on a secure laptop and UCL's "data haven" safe storage facility. Recordings will be deleted at the completion of the PhD (By 2022).

We will conclude what we have found in the last session but you or your parent can email the researcher if you want a copy of the completed thesis or any publications: kyrill.potapov.16@ucl.ac.uk or indicate it on the consent form

The transcripts and screenshots may also be used for subsequent research.

13. **Data Protection Privacy Notice**

The controller for this project will be University College London (UCL). The UCL Data Protection Officer provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk

This 'local' privacy notice sets out the information that applies to this particular study. Further information on how UCL uses participant information can be found in our 'general' privacy notice:

https://www.ucl.ac.uk/legal-services/privacy/ucl-general-research-participant-privacy-notice
The information that is required to be provided to participants under data protection legislation (GDPR and DPA 2018) is provided across both the 'local' and 'general' privacy notices.

The categories of personal data used will be as follows:

Name

The lawful basis that would be used to process your *personal data* will be performance of a task in the public interest.

The lawful basis used to process *special category personal data* will be for scientific and historical research or statistical purposes.

Your personal data will be processed so long as it is required for the research project. If we are able to anonymise or pseudonymise the personal data you provide we will undertake this, and will endeavour to minimise the processing of personal data wherever possible.

If you are concerned about how your personal data is being processed, or if you would like to contact us about your rights, please contact UCL in the first instance at data-protection@ucl.ac.uk.

14. **Contact for further information**
Kyrill Potapov
[ ]

You will be given a copy of this information sheet and a consent form.

Thank you for reading this information sheet and for considering to take part in this research study.

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<u>**Participant Information Sheet For Parent of Participants**</u>
UCL Research Ethics Committee Approval ID Number: 10269/002

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

REFLECTING ON DESIGN OF A SELF-TRACKING APP
Department: UCL Interaction Centre
Name and Contact Details of the Researcher(s): Kyrill Potapov   kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall   paul.marshall@ucl.ac.uk

14. **Invitation Paragraph**
    Your child is being invited to take part in a research project. Before you decide if they can take part, it is important for you to understand why the research is being done and what taking part will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish your child to take part. This study is being done as part of PhD research at UCL. Thank you for reading this.

15. **What is the project's purpose?**
    Over the past two years your child has been working on the design of a smartphone app during a lunchtime club. They did not attend the club as part of this PhD research but the app they designed is very relevant to its aims. The PhD is examining how young people can use self-tracking apps to learn about themselves and so the self-tracking app designed by your child is particularly interesting.

16. **Why has my child been chosen?**
    Your child's school has agreed for this research to be conducted. Your child became involved in the design of an app at a lunchtime club. I (the lead researcher) assisted in their design in my capacity as a teacher at the school. I would like to write about the design they have been working on in my PhD research. Your child has suggested they are interested in contributing to such research.

17. **Does my child have to take part?**
    It is up to you to decide whether or not you want your child to take part. If you do decide for your child to take part you will be given this information sheet to keep (and be asked to sign a consent form to return). Your child can withdraw at any time without giving a reason and without any penalty or loss of benefit. If your child decides to withdraw they will be asked what they wish to happen to the data they have provided up that point. The data will take the form of audio recordings of sessions and any app screenshot your child might choose to share.

18. **What will happen to my child if they take part?**
    I will make written notes on some of the weekly club sessions that your child is already attending at their school. During these sessions, they will continue to design the app as they have already been doing. After a few weeks, I will discuss with your child and the other design team members what images they would like to include in the research to demonstrate their designs.

    Your child and the other students who designed the app will be invited to a short interview. This will take place at tutor time. They will be asked about what their app does and why they chose to design it in the way they did. These will be one to one interviews with each team member.

19. **Will I be recorded and how will the recorded media be used?**
    Direct quotes from transcripts of the interview will be used only for analysis and for illustration in conference presentations and research papers. The same applies to any image or element of the design shared by your child. No other use will be made of them without your written permission, and no one outside the project will be allowed access to the original recordings.

I (the lead researcher) will discuss with your child the images and materials chosen for the research and share the quotation of their interview responses that will be used in the research. I will also share a draft of the analysis and give them the opportunity to make revisions.

20. **What are the possible disadvantages and risks of taking part?**
Your child has asked that I use their first name in order to credit them for their work when I report on my findings. This has the potential risk of them sharing personal data about themselves that is identifiable. For this reason, all sensitive and identifiable data will be removed from audio transcripts and not reported on. The interviews will focus on the design of the app and why they made the design choices they did. You can also choose for us not to use your child's real first name if you let us know within four weeks of the interview.

21. **What are the possible benefits of taking part?**
There are no direct benefits from participating but your child would be contributing to research involving the app they've been working on. Participating in the study will not affect how they are acknowledged for the app or lead to any other costs or consequences.

22. **What if something goes wrong?**
If you have a complaint about some part of the study, the treatment of your child or the conduct of the researcher, please contact the researcher's supervisor, Paul Marshall (paul.marshall@ucl.ac.uk) If something serious occurred during or following participation in the study or if you do not feel your complain was adequately dealt with, you can contact the Chair of the UCL Research Ethics Committee – ethics@ucl.ac.uk

23. **Will my taking part in this project be kept confidential?**
All the information that we collect about your child during the course of the research will be kept strictly confidential. You will not be able to be identified in any ensuing reports or publications. Audio recordings will be stored securely and deleted at the completion of the research. Transcripts will be edited to use pseudonyms and with identifying information not recorded. If your child shares a screenshot from their phone, any identifying information will be edited out.

24. **Limits to confidentiality**
- Please note that if your child discloses something that poses a risk of harm themselves or others, the school's safeguarding policies will be followed and the school's safeguarding team notified.
- Please note that it will not be possible to anonymize quotations taken from written transcripts of what your child says because of the small group size. These will be included in reports / presentations. Written quotes of what your child says will be used but we will remove any sensitive or personal information from them.

25. **What will happen to the results of the research project?**
The data collected from this research will be presented within a PhD thesis and may be published in articles or presented at conferences. It will not be possible to anonymize participants due to the small participant group size but personal and sensitive data will not be published. Recordings of sessions and screenshots will be stored on a secure laptop and UCL's "data haven" safe storage facility. Recordings will be deleted at the completion of the PhD (By 2022).

Preliminary conclusions of the study will be shared verbally with participants. If you would like to obtain a copy of the completed thesis or any publications, please send your email to the researcher at kyrill.potapov.16@ucl.ac.uk or indicate it on the consent form

The transcripts and screenshots may also be used for subsequent research.

26. **Data Protection Privacy Notice**

Notice:

The controller for this project will be University College London (UCL). The UCL Data Protection Officer provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk

This 'local' privacy notice sets out the information that applies to this particular study. Further information on how UCL uses participant information can be found in our 'general' privacy notice:

https://www.ucl.ac.uk/legal-services/privacy/ucl-general-research-participant-privacy-notice
The information that is required to be provided to participants under data protection legislation (GDPR and DPA 2018) is provided across both the 'local' and 'general' privacy notices.

The categories of personal data used will be as follows:

Name

The lawful basis that would be used to process your *personal data* will be performance of a task in the public interest.

The lawful basis used to process *special category personal data* will be for scientific and historical research or statistical purposes.

Your personal data will be processed so long as it is required for the research project. If we are able to anonymise or pseudonymise the personal data you provide we will undertake this, and will endeavour to minimise the processing of personal data wherever possible.

If you are concerned about how your personal data is being processed, or if you would like to contact us about your rights, please contact UCL in the first instance at data-protection@ucl.ac.uk.

14. **Contact for further information**
Kyrill Potapov
[ ]

You will be given a copy of this information sheet and a consent form.

Thank you for reading this information sheet and for considering to take part in this research study.

UCL Research Ethics Committee Approval ID Number: 10269/002

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

DISCUSSING SELF-TRACKED DATA WITH PEERS
Department: UCL Interaction Centre
Name and Contact Details of the Researcher: Kyrill Potapov   kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall   paul.marshall@ucl.ac.uk

27. **Invitation Paragraph**
    You are being invited to take part in a research project. Before you decide to take part, it is important for you to understand why the research is being done and what taking part will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. This study is being done as part of PhD research at UCL. Thank you for reading this.

28. **What is the project's purpose?**
    Self-tracking apps and devices like the Fitbit could help people to reflect about their health and make some new insights. They could also encourage people to talk about health. Similar apps exist for tracking productivity, stress, sleep and other things that could affect school life and wellbeing. This project asks young people to try a free self-tracking app on their smartphone and then to talk about their data in a discussion with other student participants, led by the researcher. We think this could help you explore important topics and learn new things.

29. **Why have I been chosen?**
    Your school has agreed for the study to happen and you were chosen because you put your hand up when your teacher asked if anyone was interested in taking part. You can only take part in this study if you have a phone and can download apps onto it. I'm sorry if you are unable to take part for this reason.

30. **Do I have to take part?**
    It is up to you to decide whether or not you want to take part. If you do decide to take part you will be given this information sheet to keep (and be asked to sign a consent form from you and your parent to return to your teacher). You can drop out of the study at any time without giving a reason and without any penalty, punishment or other consequences. You can drop out by not coming to a session or by putting your hand up in a session and asking to go back to tutor period / break time. If you decide to drop out of the study, you will be asked what you wish to happen to the audio recordings of sessions or any screenshots you've already given us. For example, we could delete the screenshots or leave your contribution out when writing down what was said in the session.

31. **What will happen to me if I take part?**
    You will download a self-tracking app on your phone. This is a like a visual diary where you collect data about yourself or note things that happen e.g. your mood, how you slept, and who you were with. You are collecting this so you can look back on it later and reflect on your week.

    You will use the app in your own time for a week. It's up to you how much you use it but try to aim for once a day. At the end of the week you will come to a discussion with others in your year. You will discuss your data and talk about your week. The discussion will connect to a topic to do with your tracking like sleep or stress.

    You will then use the app for another week. Finally, you will come to a one-to-one interview with the researcher (Mr Potapov). The interview will be about how you found the app and what you learned. You will be asked to talk about your data. You can either show the data on your phone

while talking about it, share a screenshot by email before the interview, or just talk about <u>without showing or sharing it</u>. It's up to you what you show.

You will be invited to five discussion sessions in a classroom at your school. These won't happen during lesson time. Each session will last about half an hour.

The discussion and the interview will last about thirty minutes. They will happen at your school during break time or tutor period.

32. Will I be recorded and how will the recorded media be used?
Every session will be audio recorded. These recordings will be written down, analysed and used in conference presentations and research papers. If you shared any screenshots of your app with us, we will use it in the same way. If you share a screenshot, we will crop it so you can't be identified from it e.g. to only show a graph of the data with blurred text. You won't share anything else from your phone and don't have to share any screenshots. No other use will be made of them without your written permission, and no one outside the project will be allowed access to the original recordings.

33. What are the possible disadvantages and risks of taking part?
We will sit and discuss personal topics like stress and sleep and people might bring up things like bullying and anxiety. This could be quite upsetting. However, you'll never be forced to speak and the researcher will make sure that the topics are discussed respectfully. We will change topic if the discussion becomes too sensitive. If a topic is upsetting, you can take some time outside, sit out the whole session, or leave the study and not come to future sessions.

It's also possible that your data will somehow make you look bad (e.g. lazy). It is completely your choice what you choose to track and what you share with the group, and one thing we will learn is that the same bit of data can be interpreted in many different ways.

34. What are the possible benefits of taking part?
- You could find new apps that you'll find useful in future (for health, wellbeing, productivity etc) and get good support learning how to use these apps well
- You could learn more about technology in general and change the way you look at it
- You'll have an opportunity to discuss important topics and learn from others

35. What if something goes wrong?
If you have a complaint about some part of the study how you were treated or the conduct of the researcher, please contact the researcher's supervisor, Paul Marshall (paul.marshall@ucl.ac.uk) If something serious occurred during or following participation in the study or if you do not feel your complain was adequately dealt with, you can contact the Chair of the UCL Research Ethics Committee – ethics@ucl.ac.uk

36. Will my taking part in this project be kept confidential?
All the information that we collect during the course of the research will be kept strictly confidential. You will not be able to be identified in any ensuing reports or publications. Audio recordings will be stored securely and deleted at the completion of the research. Transcripts will be edited to use pseudonyms and with identifying information not recorded. If you share a screenshot from your phone, any identifying information will be edited out.

37. Limits to confidentiality
- Please note that if you disclose something that poses a risk of harm yourself or others, the school's safeguarding policies will be followed and the school's safeguarding team notified
- Please note that confidentiality may not be guaranteed because of the group discussion format. Participants will be told that sessions are not secret but encouraged against discussing the contents of sessions with others in the school.

38. What will happen to the results of the research project?

The data collected from this research will be presented within a PhD thesis and may be published in articles or presented at conferences. Participants will not be identified in any report or publication. Recordings of sessions and screenshots will be stored on a secure laptop and UCL's "data haven" safe storage facility. Recordings will be deleted at the completion of the PhD (By 2022).

We will conclude what we have found in the last session but you or your parent can email the researcher if you want a copy of the completed thesis or any publications: kyrill.potapov.16@ucl.ac.uk or indicate it on the consent form

The transcripts and screenshots may also be used for subsequent research.

39. **Data Protection Privacy Notice**

The controller for this project will be University College London (UCL). The UCL Data Protection Officer provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk

This 'local' privacy notice sets out the information that applies to this particular study. Further information on how UCL uses participant information can be found in our 'general' privacy notice:

https://www.ucl.ac.uk/legal-services/privacy/ucl-general-research-participant-privacy-notice
The information that is required to be provided to participants under data protection legislation (GDPR and DPA 2018) is provided across both the 'local' and 'general' privacy notices.

The categories of personal data used will be as follows:

Name (Pseudonymized)

The lawful basis that would be used to process your *personal data* will be performance of a task in the public interest.

The lawful basis used to process *special category personal data* will be for scientific and historical research or statistical purposes.

Your personal data will be processed so long as it is required for the research project. If we are able to anonymise or pseudonymise the personal data you provide we will undertake this, and will endeavour to minimise the processing of personal data wherever possible.

If you are concerned about how your personal data is being processed, or if you would like to contact us about your rights, please contact UCL in the first instance at data-protection@ucl.ac.uk.

14. **Contact for further information**
Kyrill Potapov
[ ]

You will be given a copy of this information sheet and a consent form.

Thank you for reading this information sheet and for considering to take part in this research study.

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<u>**Participant Information Sheet For Parent of Participants**</u>
UCL Research Ethics Committee Approval ID Number: 10269/002

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

DISCUSSING SELF-TRACKED DATA WITH PEERS
Department: UCL Interaction Centre
Name and Contact Details of the Researcher(s): Kyrill Potapov   kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall   paul.marshall@ucl.ac.uk

40. **Invitation Paragraph**
    Your child is being invited to take part in a research project. Before you decide if they can take part, it is important for you to understand why the research is being done and what taking part will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish your child to take part. This study is being done as part of PhD research at UCL. Thank you for reading this.

41. **What is the project's purpose?**
    Self-tracking technologies like the Fitbit could help people to reflect about their health and make some new insights. They could also encourage people to talk about health. Similar apps exist for tracking productivity, stress, sleep and other things that could affect school life and wellbeing. This project asks young people to try a free self-tracking app on their smartphone and then to talk about their data in a discussion with other student participants, led by the researcher. We think this could make it easier for students to learn in meaningful ways about stress, sleep and other topics relating to their own wellbeing.

42. **Why has my child been chosen?**
    Your child's school has agreed for this research to be conducted. You child's teacher told them about the research and they expressed interest by taking home this information sheet and consent form. We will recruit between six and twelve student participants for your child's study group. Please note that unfortunately this study is only open to students who own a smartphone and can download an app onto it.

43. **Does my child have to take part?**
    It is up to you to decide whether or not you want your child to take part. If you do decide for your child to take part you will be given this information sheet to keep (and be asked to sign a consent form to return). Your child can withdraw at any time without giving a reason and without any penalty or loss of benefit. During a session, they can withdraw by returning to their timetabled activity, whether it is break time or tutor period. The data will take the form of audio recordings of sessions and any app screenshot your child might choose to share. They can uninstall the self-tracking app or stop using it at any time. If your child decides to withdraw they will be asked what they wish to happen to the data they have provided up that point.

44. **What will happen to my child if they take part?**
    Participants will download a free app on their phone. This app will be like a visual diary with which they will log things about their day such as their mood and sleep quality. They will use this app to help them reflect on their week. For example, they can look back on their data to see what they were doing on days when they have a bad mood.

    After using the app for a week, they will be invited to a discussion session with a group of peers facilitated by the lead researcher (Mt Potapov). They will discuss a topic like sleep or stress and reflect on the data / entries they collected in the previous week using the app. This will help them to connect the topic to their own experience. The aim of this session is for them to learn about the topic (sleep, stress) and to share their own ideas and concerns about it.

After the discussion session, they will use the app for one more week to test what they learned. Finally, they will be invited to a one-to-one interview to discuss what they learned from the discussion and by using the app. They will be asked to talk about the data they collected. They can show their data on their phone screen or share a screenshot of it by email before the session. They can also talk about it without sharing or showing it.

Sessions will last approximately thirty minutes and happen in a classroom at their school, outside timetabled lessons.

45. **Will I be recorded and how will the recorded media be used?**
Transcripts of the audio recordings of your child's activities made during this research will be used only for analysis and for illustration in conference presentations and research papers. The same applies to any phone screenshots shared by your child. Your child will not be asked to share any other data from their phone. If they choose to share a screenshot, this will be cropped or blurred to remove identifying information. No other use will be made of them without your written permission, and no one outside the project will be allowed access to the original recordings.

46. **What are the possible disadvantages and risks of taking part?**
The group may introduce topics to the discussion that your child finds distressing, for example, bullying or anxieties about the future. The researcher will moderate discussions to ensure topics are dealt with sensitively. Speaking in sessions is completely voluntary and your child will be free to leave the session at any time. Your child may feel that their data portrays them in a negative light either in their personal tracking or in what they share with the group, for example, their phone activity may make them look lazy. The risk here will be minimized by making it clear that self-tracking is something the participants themselves direct and can interpret in different ways.

47. **What are the possible benefits of taking part?**
Although there is no direct benefit from taking part, we hope the session can support learning in some areas and involve:
- Exposure to tools and support in using tools that may help participants to set and track goals and to reflect on aspects of their health and wellbeing
- Exposure to new apps that may reframe how participants see their technology and its potential uses
- Opportunity to learn about and share perspectives on topics within personal, social and health education.

48. **What if something goes wrong?**
If you have a complaint about some part of the study, the treatment of your child or the conduct of the researcher, please contact the researcher's supervisor, Paul Marshall (paul.marshall@ucl.ac.uk) If something serious occurred during or following participation in the study or if you do not feel your complain was adequately dealt with, you can contact the Chair of the UCL Research Ethics Committee – ethics@ucl.ac.uk

49. **Will my taking part in this project be kept confidential?**
All the information that we collect about your child during the course of the research will be kept strictly confidential. You will not be able to be identified in any ensuing reports or publications. Audio recordings will be stored securely and deleted at the completion of the research. Transcripts will be edited to use pseudonyms and with identifying information not recorded. If your child shares a screenshot from their phone, any identifying information will be edited out.

50. **Limits to confidentiality**
- Please note that if your child discloses something that poses a risk of harm to themselves or others, the school's safeguarding policies will be followed and the school's safeguarding team notified

- Please note that confidentiality may not be guaranteed because of the group discussion format. Participants will be told that sessions are not secret but encouraged against discussing the contents of sessions with others in the school.

51. **What will happen to the results of the research project?**
The data collected from this research will be presented within a PhD thesis and may be published in articles or presented at conferences. Participants will not be identified in any report or publication. Recordings of sessions and screenshots will be stored on a secure laptop and UCL's "data haven" safe storage facility. Recordings will be deleted at the completion of the PhD (By 2022).

Preliminary conclusions of the study will be shared verbally with participants. If you would like to obtain a copy of the completed thesis or any publications, please send your email to the researcher at kyrill.potapov.16@ucl.ac.uk or indicate it on the consent form

The transcripts and screenshots may also be used for subsequent research.

52. **Data Protection Privacy Notice**

The controller for this project will be University College London (UCL). The UCL Data Protection Officer provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk

This 'local' privacy notice sets out the information that applies to this particular study. Further information on how UCL uses participant information can be found in our 'general' privacy notice:

https://www.ucl.ac.uk/legal-services/privacy/ucl-general-research-participant-privacy-notice
The information that is required to be provided to participants under data protection legislation (GDPR and DPA 2018) is provided across both the 'local' and 'general' privacy notices.

The categories of personal data used will be as follows:

Name (Pseudonymized)

The lawful basis that would be used to process your *personal data* will be performance of a task in the public interest.

The lawful basis used to process *special category personal data* will be for scientific and historical research or statistical purposes.

Your personal data will be processed so long as it is required for the research project. If we are able to anonymise or pseudonymise the personal data you provide we will undertake this, and will endeavour to minimise the processing of personal data wherever possible.

If you are concerned about how your personal data is being processed, or if you would like to contact us about your rights, please contact UCL in the first instance at data-protection@ucl.ac.uk.

14. **Contact for further information**
Kyrill Potapov
[ ]

You will be given a copy of this information sheet and a consent form.

Thank you for reading this information sheet and for considering to take part in this research study.

<u>**Participant Information Sheet For Student Participant**</u>
UCL Research Ethics Committee Approval ID Number: 10269/002

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

USING SELF TRACKING APPS AS PART OF MENTORING
Department: UCL Interaction Centre
Name and Contact Details of the Researcher: Kyrill Potapov   kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall   paul.marshall@ucl.ac.uk

53. **Invitation Paragraph**
   You are being invited to take part in a research project. Before you decide to take part, it is important for you to understand why the research is being done and what taking part will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. This study is being done as part of PhD research at UCL. Thank you for reading this.

54. **What is the project's purpose?**
   Self-tracking apps and devices like the Fitbit could help people to reflect about their health and make some new insights. They could also encourage people to talk about health and other issues that affect your school work. We think apps like this could be useful as part of the discussion and goal setting you already do in school during mentoring.

55. **Why have I been chosen?**
   Your school has agreed for the study to happen and you volunteered when Mr Potapov (the lead researcher) told you about the study in tutor period. You can only take part in this study if you have a phone and can download apps onto it. We're sorry if you are unable to take part for this reason.

56. **Do I have to take part?**
   It is up to you to decide whether or not you want to take part. If you do decide to take part you will be given this information sheet to keep (and be asked to sign a consent form from you and your parent to return to your teacher). You can drop out of the study at any time without giving a reason and without any penalty, punishment or other consequences. If you drop out of the study, it won't affect your mentoring.
   a)   You can uninstall the self-tracking app at any time or stop using it
   b)   You can carry on using the app but choose not to be interviewed about it and for your mentoring to not be recorded
   If you decide to drop out of the study, you will be asked what you wish to happen to the audio recordings of the interview or any screenshots you've given us.

57. **What will happen to me if I take part?**
   Your mentor will recommend some apps you can use to track your goals or an area of interest during mentoring. This will be a self-tracking app you use for collecting data about an aspect of your own life like your sleep or time you spend on homework. You'll use the app across the weeks that you're in mentoring, but you can delete it at any time or try a new one. During your sessions with your mentor you might find it helpful to talk about your data and anything you've learned from it. You can use the data to help you track and reflect on your targets.

58. **Will I be recorded and how will the recorded media be used?**
   Your mentoring sessions will be recorded. Only the sound will be recorded. These recordings will be written down, analysed and used in conference presentations and research papers. This will also be the case if you have shared any screenshots of your data with us. No other use will be made of them

without your written permission, and no one outside the project will be allowed access to the original recordings.

59. What are the possible disadvantages and risks of taking part?
Your sessions with your mentor might talk about personal or emotional topics and you might feel like having them recorded is invading your privacy. You'll be free to only answer the questions you want to answer. You can also ask for a session or a part of the session not to be recorded. You can ask the mentor to stop the recording at any time. The focus will be on your targets and how you learned from data rather than your personal life.

60. What are the possible benefits of taking part?
- You could find new apps that you'll find useful in future (for health, wellbeing, productivity etc) and get good support learning how to use these apps well
- You could learn more about technology in general and change the way you look at it

61. What if something goes wrong?
If you have a complaint about some part of the study how you were treated or the conduct of the researcher, please contact the researcher's supervisor, Paul Marshall (paul.marshall@ucl.ac.uk) If something serious occurred during or following participation in the study or if you do not feel your complain was adequately dealt with, you can contact the Chair of the UCL Research Ethics Committee – ethics@ucl.ac.uk

62. Will my taking part in this project be kept confidential?
All the information that we collect during the course of the research will be kept strictly confidential. You will not be able to be identified in any ensuing reports or publications. Audio recordings will be stored securely and deleted at the completion of the research. Transcripts will be edited to use pseudonyms and with identifying information not recorded. If you share a screenshot from your phone, any identifying information will be edited out.

63. Limits to confidentiality
- Please note that assurances on confidentiality will be strictly adhered to unless evidence of wrongdoing or potential harm is uncovered. In such cases the University may be obliged to contact relevant statutory bodies/agencies.
- Please note that if you disclose something that poses a risk of harm yourself or others, the school's safeguarding policies will be followed and the school's safeguarding team notified
- Confidentiality will be respected subject to legal constraints and professional guidelines.
- Confidentiality will be respected unless there are compelling and legitimate reasons for this to be breached. If this was the case we would inform you of any decisions that might limit your child's confidentiality.
- Confidentiality may be limited and conditional and the researcher has a duty of care to report to the relevant authorities possible harm/danger to the participant or others.

64. What will happen to the results of the research project?
The data collected from this research will be presented within a PhD thesis and may be published in articles or presented at conferences. Participants will not be identified in any report or publication. Recordings of sessions and screenshots will be stored on a secure laptop and UCL's "data haven" safe storage facility. Recordings will be deleted at the completion of the PhD (By 2022).

We will conclude what we have found in the last session but you or your parent can email the researcher if you want a copy of the completed thesis or any publications: kyrill.potapov.16@ucl.ac.uk or indicate it on the consent form

The transcripts and screenshots may also be used for subsequent research.

65. Data Protection Privacy Notice

Notice:
The data controller for this project will be University College London (UCL). The UCL Data Protection Office provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk. UCL's Data Protection Officer can also be contacted at data-protection@ucl.ac.uk.

Your personal data will be processed for the purposes outlined in this notice.

The legal basis that would be used to process your child's personal data will be your consent/performance of a task in the public interest.

The legal basis used to process special category personal data (your child's philosophical beliefs and health habits) will be for scientific and historical research or statistical purposes/explicit consent.

Your personal data will be processed so long as it is required for the research project. If we are able to anonymise or pseudonymise the personal data you provide we will undertake this, and will endeavour to minimise the processing of personal data wherever possible.

If you are concerned about how your personal data is being processed, please contact UCL in the first instance at data-protection@ucl.ac.uk. If you remain unsatisfied, you may wish to contact the Information Commissioner's Office (ICO). Contact details, and details of data subject rights, are available on the ICO website at: https://ico.org.uk/for-organisations/data-protection-reform/overview-of-the-gdpr/individuals-rights/

16. **Contact for further information**
    Kyrill Potapov
    [ ]

    You will be given a copy of this information sheet and a consent form.

Thank you for reading this information sheet and for considering to take part in this research study.

-- -------

<u>**Participant Information Sheet For Parent of Participants**</u>
UCL Research Ethics Committee Approval ID Number: 10269/002
YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

USING SELF-TRACKING APPS AS PART OF MENTORING
Department: UCL Interaction Centre
Name and Contact Details of the Researcher(s): Kyrill Potapov   kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall   paul.marshall@ucl.ac.uk

66. Invitation Paragraph
Your child is being invited to take part in a research project. Before you decide if they can take part, it is important for you to understand why the research is being done and what taking part will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish your child to take part. This study is being done as part of PhD research at UCL. Thank you for reading this.

67. What is the project's purpose?
Self-tracking technologies like the Fitbit could help people to reflect about their health or other aspects of their life. They could also encourage people to talk about health, schoolwork and other issue. Similar apps exist for tracking productivity, stress, sleep and other things that could affect school life and wellbeing. This project asks young people to try a free self-tracking app on their smartphone and then to talk about their data with their mentor during their usual school mentoring sessions. We think this process can help students to set and track goals and talk about them.

68. Why has my child been chosen?
Your child's school has agreed for this research to be conducted. The lead researcher told your child about the research in a tutor period mentoring session and they expressed interest by taking home this information sheet and consent form. We will recruit between six and twelve student participants for your child's study group. Please note that unfortunately this study is only open to students who own a smartphone and can download an app onto it.

69. Does my child have to take part?
It is up to you to decide whether or not you want your child to take part. If you do decide for your child to take part you will be given this information sheet to keep (and be asked to sign a consent form to return). Your child can withdraw at any time without giving a reason and without any penalty or loss of benefit. The data will take the form of audio recordings of sessions and any app screenshot your child might choose to share.

If your child drops out of the study, they can continue with their regular mentoring sessions and uninstall the self-tracking app at any time or stop using it, or continue using it but opt out from their sessions being recorded. If your child decides to withdraw they will be asked what they wish to happen to the data they have provided up that point.

70. What will happen to my child if they take part?
Your child is taking part in a school mentoring programme in which they choose some academic or pastoral targets to follow with a mentor. They meet once a week to discuss how the targets are going. They will be asked to think about how they could a self-tracking app to track one of their targets. For example, they could track how long they have slept or how long they have spent on their homework. They will choose an app with their mentor that is relevant to their target. They will be asked to try this app out at home on their own phone or other device. They are free to delete the app or install a new one at any time. In subsequent mentoring sessions, their mentor will ask them if they want to discuss the data they collected on their app. They do not have to talk about or share their data with their mentor if they do not want to and it is up to them what they share if they choose to. This will happen on a weekly basis across six mentoring sessions (or less, if they do not have six sessions this term).

71. Will they be recorded and how will the recorded media be used?
The audio recordings of your child's activities made during this research will be used only for analysis and for illustration in conference presentations and research papers. The same applies to any phone screenshots shared by your child. No other use will be made of them without your written permission, and no one outside the project will be allowed access to the original recordings.

72. What are the possible disadvantages and risks of taking part?
Your child may feel that recording the discussions in their mentoring sessions is an invasion of their privacy. They will be free not to answer questions or to ask for the session not to be recorded. The focus of the discussion will be on data and goal setting rather than your child's person life. The mentoring discussion may lead to a sensitive topic. The researcher will check in with your child after the session to check if they would like additional support such as talking through a topic more fully or with a member of the school pastoral team.

73. What are the possible benefits of taking part?
Although there is no direct benefit from taking part, we hope the session can support learning in some areas and involve:
- Potentially more effective mentoring / goal setting
- Supported exposure to a tool or set of tools they can use to support their own aims outside of mentoring sessions

74. What if something goes wrong?
If you have a complaint about some part of the study, the treatment of your child or the conduct of the researcher, please contact the researcher's supervisor, Paul Marshall (paul.marshall@ucl.ac.uk) If something serious occurred during or following participation in the study or if you do not feel your complain was adequately dealt with, you can contact the Chair of the UCL Research Ethics Committee – ethics@ucl.ac.uk

75. Will my taking part in this project be kept confidential?
All the information that we collect about your child during the course of the research will be kept strictly confidential. You will not be able to be identified in any ensuing reports or publications. Audio recordings will be stored securely and deleted at the completion of the research. Transcripts will be edited to use pseudonyms and with identifying information not recorded. If your child shares a screenshot from their phone, any identifying information will be edited out.

76. Limits to confidentiality
- Please note that assurances on confidentiality will be strictly adhered to unless evidence of wrongdoing or potential harm is uncovered. In such cases the University may be obliged to contact relevant statutory bodies/agencies.
- Please note that if your child discloses something that poses a risk of harm to themselves or others, the school's safeguarding policies will be followed and the school's safeguarding team notified
- Confidentiality will be respected subject to legal constraints and professional guidelines.
- Confidentiality will be respected unless there are compelling and legitimate reasons for this to be breached. If this was the case we would inform you of any decisions that might limit your child's confidentiality.
- Confidentiality may be limited and conditional and the researcher has a duty of care to report to the relevant authorities possible harm/danger to the participant or others.

77. What will happen to the results of the research project?
The data collected from this research will be presented within a PhD thesis and may be published in articles or presented at conferences. Participants will not be identified in any report or publication. Recordings of sessions and screenshots will be stored on a secure laptop and UCL's "data haven" safe storage facility. Recordings will be deleted at the completion of the PhD (By 2022).

Preliminary conclusions of the study will be shared verbally with participants. If you would like to obtain a copy of the completed thesis or any publications, please send your email to the researcher at kyrill.potapov.16@ucl.ac.uk or indicate it on the consent form

The transcripts and screenshots may also be used for subsequent research.

78. **Data Protection Privacy Notice**

Notice:
The data controller for this project will be University College London (UCL). The UCL Data Protection Office provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk. UCL's Data Protection Officer can also be contacted at data-protection@ucl.ac.uk.

Your personal data will be processed for the purposes outlined in this notice.

The legal basis that would be used to process your child's personal data will be your consent/performance of a task in the public interest.

The legal basis used to process special category personal data (your child's philosophical beliefs and health habits) will be for scientific and historical research or statistical purposes/explicit consent.

Your personal data will be processed so long as it is required for the research project. If we are able to anonymise or pseudonymise the personal data you provide we will undertake this, and will endeavour to minimise the processing of personal data wherever possible.

If you are concerned about how your personal data is being processed, please contact UCL in the first instance at data-protection@ucl.ac.uk. If you remain unsatisfied, you may wish to contact the Information Commissioner's Office (ICO). Contact details, and details of data subject rights, are available on the ICO website at: https://ico.org.uk/for-organisations/data-protection-reform/overview-of-the-gdpr/individuals-rights/

16. **Contact for further information**
Kyrill Potapov
[ ]

You will be given a copy of this information sheet and a consent form.

Thank you for reading this information sheet and for considering to take part in this research study.

B. *Consent forms*

Consent form: Self-tracking toolkit workshop

This study has been approved by the UCL Research Ethics Committee [Project ID number]: 10269/002

UCL Interaction Centre
University College London,

University College London

Research team:
Kyrill Potapov and Paul Marshall

Telephone:

Email: kyrill.potapov.16@ucl.ac.uk; paul.marshall@ucl.ac.uk

Please tick appropriate boxes:

☐ **Yes**, I give permission that my child can participate in this study.

☐ **No**, I do not want my child to participate in this study.

If Yes, please complete the following:

☐ I have read the information sheet;

☐ I had the opportunity to ask questions and discuss the study;

☐ I have received satisfactory answers to all my questions or have been advised of an individual to contact for answers to pertinent questions about the research and my rights as a participant;

☐ I understand that I may withdraw myself and my child from the study at any time without giving a reason;

☐ I consent to the use of my personal information for the purposes of this study only and that it will not be used for any other purpose;.

☐ I consent to having audio recordings made during the interview;

☐ I understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998;

☐ I have the names and telephone numbers of the research team in case I have any queries in the future.

Date _____/_____/_____ *(DAY/MONTH/YEAR)* _____

Parent's Name: _____   Signature: _____

Address: _____

Telephone number: _____

Email: _____

CONSENT FORM FOR PARTICIPANTS IN RESEARCH STUDIES

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: REFLECTING ON DESIGN OF A SELF-TRACKING APP
Department: UCL Interaction Centre
Name and Contact Details of the Researcher(s): Kyrill Potapov   kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall   paul.marshall@ucl.ac.uk
Name and Contact Details of the UCL Data Protection Officer: Alex Potts data-protection@ucl.ac.uk
This study has been approved by the UCL Research Ethics Committee: Project ID number: 10269/002

Thank you for considering taking part in this research. The person organising the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

I confirm that I understand that by ticking/initialling each box below I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes means that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element that I may be deemed ineligible for the study.

		Tick Box
1.	*I confirm that I have read and understood the Information Sheet for the above study. I have had an opportunity to consider the information and what will be expected of me. I have also had the opportunity to ask questions which have been answered to my satisfaction and I would like to take part in (please tick one or more of the following) - A one to one interview - Sharing images and other materials I designed for my app	
2.	*I understand that I will be able to withdraw my data up to 4 weeks after the last session or interview.	
3.	*I consent to participate in the study. I understand that my personal information (recordings of my voice and screenshots I've chosen to share) will be used for the purposes explained to me. I understand that according to data protection legislation, 'public task' will be the lawful basis for processing.	
4.	**Use of the information for this project only** *I understand that all personal information will remain confidential and that all efforts will be made to ensure I cannot be identified (unless you state otherwise, because you have disclosed information that could put yourself or others at risk or except as required by law). I understand that my first name **will be** used as part of the findings and could appear in publications or presentations	
5.	*I understand that my information may be subject to review by responsible individuals from the University for monitoring and audit purposes.	
6.	*I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason, without the care I receive or my legal rights being affected. I understand that if I decide to withdraw, any personal data I have provided up to that point will be deleted unless I agree otherwise.	
7.	I understand the potential risks of participating and the support that will be available to me should I become distressed during the course of the research.	
8.	I understand the direct/indirect benefits of participating.	
9.	I understand that the data will not be made available to any commercial organisations but is solely the responsibility of the researcher(s) undertaking this study.	

10.	I understand that I will not benefit financially from this study or from any possible outcome it may result in in the future.	
11.	I agree that my research data will not be used by others in future work.	
12.	I understand that the information I have submitted will be published as a report and I wish to receive a copy of it. Yes/No	
13.	I consent to my study sessions being audio recorded and understand that the recordings will be stored anonymously, using password-protected software and will be used for training, quality control, audit and specific research purposes. **Note:** If you do not want your participation recorded you can still take part in the study.	
14.	I hereby confirm that I understand the inclusion criteria as detailed in the Information Sheet and explained to me by the researcher.	
15.	I am aware of who I should contact if I wish to lodge a complaint.	
16.	I voluntarily agree to take part in this study.	
17.	Use of information for this project and beyond I would be happy for the data (transcripts and screenshots) I provide to be archived in UCL's online "data haven" storage facility after the study. I would be happy for the data (audio recordings) I provide to be archived on an encrypted laptop until the completion of the researcher's PhD thesis (before 2022). I understand that other authenticated researchers will have access to my data.	

_____   _____   _____

Name of participant   Date   Signature

_____   _____   _____

Researcher   Date   Signature

CONSENT FORM FOR PARENTS OF PARTICIPANTS IN RESEARCH STUDIES

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: REFLECTING ON DESIGN OF A SELF-TRACKING APP
Department: UCL Interaction Centre
Name and Contact Details of the Researcher(s): Kyrill Potapov   kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall   paul.marshall@ucl.ac.uk
Name and Contact Details of the UCL Data Protection Officer: Alex Potts data-protection@ucl.ac.uk
This study has been approved by the UCL Research Ethics Committee: Project ID number: 10269/002

Thank you for considering taking part in this research. The person organising the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

I confirm that I understand that by ticking/initialling each box below I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes means that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element that I may be deemed ineligible for the study.

		Tick Box
1.	*I confirm that I have read and understood the Information Sheet for the above study. I have had an opportunity to consider the information and what will be expected my child. I have also had the opportunity to ask questions which have been answered to my satisfaction and I would like my child to take part in (please tick one or more of the following) - A one to one interview - Sharing images or other material designed by your child	
2.	*I understand that I will be able to withdraw my child's data up to 4 weeks after the last session or interview.	
3.	*I consent for my child to participate in the study. I understand that my child's personal information (recordings of my child's voice and screenshots they've chosen to share) will be used for the purposes explained to me. I understand that according to data protection legislation, 'public task' will be the lawful basis for processing.	
4.	**Use of the information for this project only** *I understand that all personal information will remain confidential and that all efforts will be made to ensure my child cannot be identified (unless you state otherwise, because they have disclosed information that could put themselves or others at risk or except as required by law). **However,** I give permission for my child's real first name to appear in future publications (such as the PhD thesis) and any presentations given on this work.	
5.	*I understand that my information may be subject to review by responsible individuals from the University for monitoring and audit purposes.	
6.	*I understand that my child's participation is voluntary and that they are free to withdraw at any time without giving a reason, without the care they receive or legal rights being affected. I understand that if I decide to withdraw, any personal data my child may have provided up to that point will be deleted unless I agree otherwise.	
7.	I understand the potential risks of participating and the support that will be available to my child should they become distressed during the course of the research.	
8.	I understand the direct/indirect benefits of participating.	
9.	I understand that the data will not be made available to any commercial organisations but is solely the responsibility of the researcher(s) undertaking this study.	

10.	I understand that I or my child will not benefit financially from this study or from any possible outcome it may result in in the future.	
11.	I understand that transcripts of my child's data will not be shared with researchers for future work.	
12.	I understand that the information my child has submitted will be published as a report and I wish to receive a copy of it. Yes/No	
13.	I consent to my child's study sessions being audio recorded and understand that the recordings will be stored anonymously, using password-protected software and will be used for training, quality control, audit and specific research purposes. **Note:** If you do not want your participation recorded you can still take part in the study.	
14.	I hereby confirm that I understand the inclusion criteria as detailed in the Information Sheet and explained to me by the researcher.	
15.	I am aware of who I should contact if I wish to lodge a complaint.	
16.	I voluntarily agree for my child to take part in this study.	
17.	Use of information for this project and beyond I would be happy for the data (transcripts and screenshots) my child provides to be archived in UCL's online "data haven" storage facility after the study. I would be happy for the data (audio recordings) my child provides to be archived on an encrypted laptop until the completion of the researcher's PhD thesis (before 2022). I understand that other authenticated researchers will have access to my child's data.	

_____   _____   _____

Name of participant   Date   Signature

_____

Preferred Contact Details

_____   _____   _____

Researcher   Date   Signature

CONSENT FORM FOR PARTICIPANTS IN RESEARCH STUDIES

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: DISCUSSING SELF-TRACKED DATA WITH PEERS
Department: UCL Interaction Centre
Name and Contact Details of the Researcher(s): Kyrill Potapov   kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall   paul.marshall@ucl.ac.uk
Name and Contact Details of the UCL Data Protection Officer: data-protection@ucl.ac.uk
This study has been approved by the UCL Research Ethics Committee: Project ID number: 10269/002

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		Tick Box
1.	*I confirm that I have read and understood the Information Sheet for the above study. I have had an opportunity to consider the information and what will be expected of me. I have also had the opportunity to ask questions which have been answered to my satisfaction and I would like to take part in (please tick one or more of the following) - A group discussion - An individual interview	
2.	*I understand that I will be able to withdraw my data up to 4 weeks after the last session or interview.	
3.	*I consent to participate in the study. I understand that my personal information (recordings of my voice and screenshots I've chosen to share) will be used for the purposes explained to me. I understand that according to data protection legislation, 'public task' will be the lawful basis for processing.	
4.	**Use of the information for this project only** *I understand that all personal information will remain confidential and that all efforts will be made to ensure I cannot be identified (unless you state otherwise, because you have disclosed information that could put yourself or others at risk or except as required by law). I understand that my data gathered in this study will be stored pseudonymously and securely. It will not be possible to identify me in any publications.	
5.	*I understand that my information may be subject to review by responsible individuals from the University for monitoring and audit purposes.	
6.	*I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason, without the care I receive or my legal rights being affected. I understand that if I decide to withdraw, any personal data I have provided up to that point will be deleted unless I agree otherwise.	
7.	I understand the potential risks of participating and the support that will be available to me should I become distressed during the course of the research.	
8.	I understand the direct/indirect benefits of participating.	
9.	I understand that the data will not be made available to any commercial organisations but is solely the responsibility of the researcher(s) undertaking this study.	

10.	I understand that I will not benefit financially from this study or from any possible outcome it may result in in the future.	
11.	I agree that my pseudonymised research data may be used by others for future research. [No one will be able to identify you when this data is shared.]	
12.	I understand that the information I have submitted will be published as a report and I wish to receive a copy of it. Yes/No	
13.	I consent to my study sessions being audio recorded and understand that the recordings will be stored anonymously, using password-protected software and will be used for training, quality control, audit and specific research purposes. **Note:** If you do not want your participation recorded you can still take part in the study.	
14.	I hereby confirm that I understand the inclusion criteria as detailed in the Information Sheet and explained to me by the researcher.	
15.	I am aware of who I should contact if I wish to lodge a complaint.	
16.	I voluntarily agree to take part in this study.	
17.	Use of information for this project and beyond I would be happy for the data (transcripts and screenshots) I provide to be archived in UCL's online "data haven" storage facility after the study. I would be happy for the data (audio recordings) I provide to be archived on an encrypted laptop until the completion of the researcher's PhD thesis (before 2022). I understand that other authenticated researchers will have access to my pseudonymised data.	

_____   _____   _____

Name of participant   Date   Signature

_____   _____   _____

Researcher   Date   Signature

CONSENT FORM FOR PARENTS OF PARTICIPANTS IN RESEARCH STUDIES

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: DISCUSSING SELF-TRACKED DATA WITH PEERS
Department: UCL Interaction Centre
Name and Contact Details of the Researcher(s): Kyrill Potapov   kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall   paul.marshall@ucl.ac.uk
Name and Contact Details of the UCL Data Protection Officer: Alex Potts data-protection@ucl.ac.uk
This study has been approved by the UCL Research Ethics Committee: Project ID number: 10269/002

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		Tick Box
1.	*I confirm that I have read and understood the Information Sheet for the above study. I have had an opportunity to consider the information and what will be expected my child. I have also had the opportunity to ask questions which have been answered to my satisfaction and I would like my child to take part in (please tick one or more of the following) - A group discussion - An individual interview	
2.	*I understand that I will be able to withdraw my child's data up to 4 weeks after the last session or interview.	
3.	*I consent for my child to participate in the study. I understand that my child's personal information (recordings of my child's voice and screenshots they've chosen to share) will be used for the purposes explained to me. I understand that according to data protection legislation, 'public task' will be the lawful basis for processing.	
4.	**Use of the information for this project only** *I understand that all personal information will remain confidential and that all efforts will be made to ensure my child cannot be identified (unless you state otherwise, because they have disclosed information that could put themselves or others at risk or except as required by law). I understand that my child's data gathered in this study will be stored pseudonymously and securely. It will not be possible to identify my child in any publications.	
5.	*I understand that my information may be subject to review by responsible individuals from the University for monitoring and audit purposes.	
6.	*I understand that my child's participation is voluntary and that they are free to withdraw at any time without giving a reason, without the care they receive or legal rights being affected. I understand that if I decide to withdraw, any personal data my child may have provided up to that point will be deleted unless I agree otherwise.	
7.	I understand the potential risks of participating and the support that will be available to my child should they become distressed during the course of the research.	
8.	I understand the direct/indirect benefits of participating.	
9.	I understand that the data will not be made available to any commercial organisations but is solely the responsibility of the researcher(s) undertaking this study.	

10.	I understand that I or my child will not benefit financially from this study or from any possible outcome it may result in in the future.	
11.	I agree that my child's pseudonymised research data may be used by others for future research. [No one will be able to identify your child when this data is shared.]	
12.	I understand that the information my child has submitted will be published as a report and I wish to receive a copy of it. Yes/No	
13.	I consent to my child's study sessions being audio recorded and understand that the recordings will be stored anonymously, using password-protected software and will be used for training, quality control, audit and specific research purposes. **Note:** If you do not want your participation recorded you can still take part in the study.	
14.	I hereby confirm that I understand the inclusion criteria as detailed in the Information Sheet and explained to me by the researcher.	
15.	I am aware of who I should contact if I wish to lodge a complaint.	
16.	I voluntarily agree for my child to take part in this study.	
17.	Use of information for this project and beyond I would be happy for the data (transcripts and screenshots) my child provides to be archived in UCL's online "data haven" storage facility after the study. I would be happy for the data (audio recordings) my child provides to be archived on an encrypted laptop until the completion of the researcher's PhD thesis (before 2022). I understand that other authenticated researchers will have access to my pseudonymised data.	

_____   _____   _____

Name of participant   Date   Signature

_____

Preferred Contact Details

_____   _____   _____

Researcher   Date   Signature

CONSENT FORM FOR PARTICIPANTS IN RESEARCH STUDIES

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: Using self-tracking apps as part of mentoring
Department: UCL Interaction Centre
Name and Contact Details of the Researcher(s): Kyrill Potapov   kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall   paul.marshall@ucl.ac.uk
Name and Contact Details of the UCL Data Protection Officer: data-protection@ucl.ac.uk
This study has been approved by the UCL Research Ethics Committee: Project ID number:
10269/002

Thank you for considering taking part in this research. The person organising the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

I confirm that I understand that by ticking/initialling each box below I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes means that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element that I may be deemed ineligible for the study.

		Tick Box
1.	*I confirm that I have read and understood the Information Sheet for the above study. I have had an opportunity to consider the information and what will be expected of me. I have also had the opportunity to ask questions which have been answered to my satisfaction and I would like to take part in an individual interview.	
2.	-I consent to discussing data I collect using a self-tracking app as part of mentoring	
3.	*I understand that I will be able to withdraw my data up to 4 weeks after my last mentoring session.	
4.	*I consent to participate in the study. I understand that my personal information (recordings of my voice and screenshots I've chosen to share) will be used for the purposes explained to me. I understand that according to data protection legislation, 'public task' will be the lawful basis for processing.	
5.	**Use of the information for this project only** *I understand that all personal information will remain confidential and that all efforts will be made to ensure I cannot be identified (unless you state otherwise, because you have disclosed information that could put yourself or others at risk or except as required by law). I understand that my data gathered in this study will be stored pseudonymously and securely. It will not be possible to identify me in any publications.	
6.	*I understand that my information may be subject to review by responsible individuals from the University for monitoring and audit purposes.	
7.	*I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason, without the care I receive or my legal rights being affected. I understand that if I decide to withdraw, any personal data I have provided up to that point will be deleted unless I agree otherwise.	
8.	I understand the potential risks of participating and the support that will be available to me should I become distressed during the course of the research.	
9.	I understand the direct/indirect benefits of participating.	
10.	I understand that the data will not be made available to any commercial organisations but is solely the responsibility of the researcher(s) undertaking this study.	
11.	I understand that I will not benefit financially from this study or from any possible outcome it may result in in the future.	
12.	I agree that my pseudonymised research data may be used by others for future research. [No one will be able to identify you when this data is shared.]	

13.	I understand that the information I have submitted will be published as a report and I wish to receive a copy of it. Yes/No	
14.	I consent to my study sessions being audio recorded and understand that the recordings will be stored anonymously, using password-protected software and will be used for training, quality control, audit and specific research purposes. **Note:** If you do not want your participation recorded you can still take part in the study.	
15.	I hereby confirm that I understand the inclusion criteria as detailed in the Information Sheet and explained to me by the researcher.	
16.	I hereby confirm that: (a) I understand the exclusion criteria as detailed in the Information Sheet and explained to me by the researcher; and (b) I do not fall under the exclusion criteria.	
17.	I have informed the researcher of any other research in which I am currently involved or have been involved in during the past 12 months.	
18.	I am aware of who I should contact if I wish to lodge a complaint.	
19.	I voluntarily agree to take part in this study.	
20.	Use of information for this project and beyond I would be happy for the data (transcripts and screenshots) I provide to be archived in UCL's online "data haven" storage facility after the study. I would be happy for the data (audio recordings) I provide to be archived on an encrypted laptop until the completion of the researcher's PhD thesis (before 2022). I understand that other authenticated researchers will have access to my pseudonymised data.	

Please return this form by asking your parent to email it, with their own one, to:
kyrill.potapov.16@ucl.ac.uk

_____   _____   _____
Name of participant   Date   Signature

Kyrill Potapov
Researcher   Date   Signature

CONSENT FORM FOR PARENTS OF PARTICIPANTS IN RESEARCH STUDIES

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: USING SELF-TRACKING APPS AS PART OF MENTORING
Department: UCL Interaction Centre
Name and Contact Details of the Researcher(s): Kyrill Potapov kyrill.potapov.16@ucl.ac.uk
Name and Contact Details of the Principal Researcher: Paul Marshall paul.marshall@ucl.ac.uk
Name and Contact Details of the UCL Data Protection Officer: data-protection@ucl.ac.uk
This study has been approved by the UCL Research Ethics Committee: Project ID number: 10269/002

Thank you for considering taking part in this research. The person organising the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

I confirm that I understand that by ticking/initialling each box below I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes means that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element that I may be deemed ineligible for the study.

		Tick Box
1.	*I confirm that I have read and understood the Information Sheet for the above study. I have had an opportunity to consider the information and what will be expected my child. I have also had the opportunity to ask questions which have been answered to my satisfaction and I would like my child to take part in an interview.	
2.	I consent to my child discussing data they collect about themselves using a self-tracking app on their phone with their mentor during school peer mentoring sessions	
3.	*I understand that I will be able to withdraw my child's data up to 4 weeks after the last mentoring session.	
4.	*I consent for my child to participate in the study. I understand that my child's personal information (recordings of my child's voice and screenshots they've chosen to share) will be used for the purposes explained to me. I understand that according to data protection legislation, 'public task' will be the lawful basis for processing.	
5.	**Use of the information for this project only** *I understand that all personal information will remain confidential and that all efforts will be made to ensure my child cannot be identified (unless you state otherwise, because they have disclosed information that could put themselves or others at risk or except as required by law). I understand that my child's data gathered in this study will be stored pseudonymously and securely. It will not be possible to identify my child in any publications.	
6.	*I understand that my information may be subject to review by responsible individuals from the University for monitoring and audit purposes.	
7.	*I understand that my child's participation is voluntary and that they are free to withdraw at any time without giving a reason, without the care they receive or legal rights being affected. I understand that if I decide to withdraw, any personal data my child may have provided up to that point will be deleted unless I agree otherwise.	
8.	I understand the potential risks of participating and the support that will be available to my child should they become distressed during the course of the research.	
9.	I understand the direct/indirect benefits of participating.	
10.	I understand that the data will not be made available to any commercial organisations but is solely the responsibility of the researcher(s) undertaking this study.	
11.	I understand that I or my child will not benefit financially from this study or from any possible outcome it may result in in the future.	
12.	I agree that my child's pseudonymised research data may be used by others for future research. [No one will be able to identify your child when this data is shared.]	

13.	I understand that the information my child has submitted will be published as a report and I wish to receive a copy of it. Yes/No	
14.	I consent to my child's interview being audio recorded and understand that the recordings will be stored anonymously, using password-protected software and will be used for training, quality control, audit and specific research purposes. **Note:** If you do not want your participation recorded you can still take part in the study.	
15.	I hereby confirm that I understand the inclusion criteria as detailed in the Information Sheet and explained to me by the researcher.	
16.	I hereby confirm that: (c) I understand the exclusion criteria as detailed in the Information Sheet and explained to me by the researcher; and (d) My child does not fall under the exclusion criteria.	
17.	I have informed the researcher of any other research in which my child is currently involved or has been involved in during the past 12 months.	
18.	I am aware of who I should contact if I wish to lodge a complaint.	
19.	I voluntarily agree for my child to take part in this study.	
20.	Use of information for this project and beyond I would be happy for the data (transcripts and screenshots) my child provides to be archived in UCL's online "data haven" storage facility after the study. I would be happy for the data (audio recordings) my child provides to be archived on an encrypted laptop until the completion of the researcher's PhD thesis (before 2022). I understand that other authenticated researchers will have access to my pseudonymised data.	

IF YOU CONSENT TO THE STUDY, PLEASE EMAIL THIS COMPLETED CONSENT FORM AND YOUR CHILD'S CONSENT FORM TO THE FIRST RESEARCHER: kyrill.potapov.16@ucl.ac.uk

Many thanks

_____   _____   _____
Name of participant   Date   Signature

_____
Preferred email **(this will be used to confirm interview dates and send a joining link)**

Kyrill Potapov
Researcher   Date   Signature

c.   *Approach Statements*

STUDY 1

I'm looking for some volunteers for a study I'm doing as a researcher with University College London. It's about how young people can use apps and technology (like Fitbit and Daylio) to learn about themselves. You'll be helping us design ways to use the technology to improve things to do with learning. It'll be for about six tutor periods. You will need to download some apps and use them on your phone for about four weeks. If anyone's interested I have letters for you and your parents which you need to read and if you want to take part in the study just return both signed letters to me. I'll leave some letters with you tutor.

STUDY 3

I'm looking for some volunteers for a study I'm doing as a researcher with University College London. It's about how young people can use technology to learn about themselves and discuss what's important to them. You'll be trying out an app on your phone and then discussing it with a group of other students during tutor periods. The app will help you to choose and measure goals related to your health and wellbeing. If anyone's interested I have letters for you and your parents which you need to read to find out more. If you want to take part you need to return both signed forms. You don't need to take part if you don't want to. You will be able to return the forms to your tutor.

STUDY 4

I'm looking for some volunteers for a study I'm doing as a researcher with University College London. It's about how young people can use technology to learn about themselves and discuss what's important to them. If you take part you will be paired with a mentee who also agreed to take part. They will download a self-tracking app like Fibit and Daylio to track information about their life. You will help them to connect it to the goals you are focusing on in mentoring. For example, they could track their mood when they are doing different kinds of homework. Please talk to me if you are interested and I will give letters for you and your parents.

I'm looking for some volunteers for a study I'm doing as a researcher with University College London. It's about how young people can use technology to learn about themselves and discuss what's important to them. Taking part in the study will involve downloading an app and using it in your mentoring. We'll ask you to use to app and then talk about some of the goals and issues you are focusing on during your mentoring sessions. The app can help you collect information related to the goals. We are focusing on self-tracking apps like Fitbit and Daylio. If interested in taking part in the study I have letters for you and your parents which you need to read to find out more. If you want to take part you need to return both signed forms. You don't need to take part if you don't want to. You will be able to return the forms to your mentor or form tutor.

STUDY 1

1.1 (After Ps view presentation giving examples of self-tracking carried out by a variety of users in different contexts)
*Did you find anything about those [examples] interesting?
*Was there one you found particularly interesting?
     -Why?
     -Was there anything else interesting about it?
     -Did anyone else find that one interesting? Did you find anything else interesting about it?
*Any other ones anyone found interesting?
     -Tell me about it.
     -Anyone else have anything to say about that one?
1.2 (Ps will split into pairs and each pair will look at a laptop with the self-tracking profiles of a fictional student)
The main questions will be written on the board. Group Ps should discuss their answer with one-another in relation to the figures they are exploring on the laptop. The follow-up questions will be asked verbally during whole-group feedback.
*What was this student tracking?
     -What kinds of things do you think he was doing?
*What kinds of things could this student learn from his data?
     -What's the data meant to show us on this one?
     -If this was your data, what would you think?
     -Does it show you anything else?
     -Does it suggest anything else about him?
     -Do you think any of this is useful? Could it be useful for him to know this?
     -How might that be useful?
     -So what could he learn from the data?
     -And do you think it's telling us anything else about him or what he was doing?
     -Is there anything else you think he might have been doing that we haven't picked up on yet?

2.1 (While Ps review list of "Activities" and "What can we learn?" from the last session)
*This study is focused on learning and how you can improve your learning. So what I'd like you to do in pairs is think about whether any of these things on the board can relate to learning?
     -Anything else we can link to learning?
     -Do you think anything else here could impact how we learn?
     -We're looking for anything than can affect your learning either at school or at home, whether it's a positive or a negative effect.
     -So we're leaving out [example from the board]? You don't think this one relates to learning? I'm just checking. And [another example from the board]?
*Now I'll just give you a minute for this. Do you think there's anything else that affects learning that isn't on our list? It could be anything.
     -So what are some of the things that help you to learn?
     - Just anything that can either help you to learn or it gets in the way.
     -Try and think about yourself. Is there anything you would do if you wanted to improve your learning? Maybe you need to prepare for an exam. What would you do?
     -Is there a specific time you can think of maybe. Are there times you learn better?
          -So what might be some of the things there that help you learn there?
     -Let's switch it round. What are some of the things that make it hard for us to learn?
     -So let's say you're trying to revise. Is there anything you do or you don't do that might have a negative impact?
     -You can think about other people you know as well. Like maybe a friend or your sister. Is there anything we haven't mentioned that has a negative or a positive impact on learning?
2.2. (To prime Ps before Ps choose something to track)
*Are there any of these you'd be interested in tracking yourself?
*Would you be curious to know any of these things about yourself?
*Is there one of these that has a big impact on your learning, specifically for you?

3.1 (Ps split into focus groups of three or four, feeding back on their own self-tracking)
The main questions will be written on the board. Group Ps discuss their answer with one-another. The follow-up questions will be asked verbally during whole-group feedback. Questions will generally be directed at the sub-group giving feedback but could be shifted to a specific participant or the whole group.
*What did you track?
     -So what were you trying to measure?

-Did you just focus on that one thing?
*How did it go? Were there any problems?
-How often did you track it? Did you stop doing the tracking at any point?
-Why do you think that was? Was there a reason?
-Did you manage to use the app OK and everything? Any technical issues?
-Were you able to understand what the app was showing you? Could you make sense of the data OK?
-Did you manage to track what you wanted?
-Do you think you picked the right thing to track?
-Is there anything else you would prefer to track now?
-Were you able to get the kind of data you wanted? Did the data show you what you wanted to know about?
-Do you think there's something else you could have tracked that might have shown it better?
-Is there some other kind of data or information it would have been useful for you to have?
*Did you learn anything?
-Did you get some good data? What was good about?
-Did you see anything impact your learning?
-Was it what you thought? Is it how you predicted?
-Did anything surprise you?
-Was there anything that turned out not quite as you predicted? For example, you found out that you sleep less than you thought you did.
-Was it useful to see your data?
-How was it useful?
-Is there anything that could have made it more useful?
-Was there anything else you found interesting? Anything you noticed?
3.2 (This will be done as a whole group rather than in sub-groups, after Ps have filled in [Session3Res])
*Can you tell me about some of the ways you can imagine students using self-tracking?
-Where would this be? In school?
-Why would they want to track it?
-What would they learn from that?
-How could they track that? What kinds of tools or apps could they use?
-What kind of students do you think would track that? Anyone you think it would be useful for?
-And do you think a student really would do that? What might encourage them to do this?
*Thinking about what we said when we were just feeding back about our own experience, is there anything else?
*Is there anything we can't track that you think students would want to track? Something that we could track in theory for example how hungry you are or how many words you've read.
*Does anyone think that students like you wouldn't use this kind of technology at all?
-Why not?
-Is there anything that might encourage them?
-Is there anything we can do – anything teachers or parents could do or anything you would tell them that might make them want to do it more?
4.1 (Ps feedback as a whole group)
*Is there anything important or interesting about the activity that the app didn't show us?
-Is there anything else we might want to know about this?
-If we're saying this activity impacts learning, is there any other data we would want?
-Is there any other kind of data that could confirm some of the predictions we might have about this?

Interview guide:
- What did you choose to track?
- What apps did you use?
- Did you find anything interesting?
- Did you learn anything while you were tracking?
- How did you find self-tracking overall?
- Can you think back to a particular day or time while you were tracking. Did the data show you anything about it?
- How did you find using the app?
- Do you think these kinds of apps are well designed for teenagers?

STUDY 2

1. Why did you decide to design *LifeMosaic?*
2. What is the purpose of *LifeMosaic?*

3. Why did you choose a smartphone app to address this purpose?
4. How is *LifeMosaic* different to existing apps?
5. How do you see people using *LifeMosaic?*
6. Could you talk me through the features of *LifeMosaic* and why you designed them that way?

STUDY 3

Remind me how you were using *LifeMosaic.* What were you focusing on?

1. Did you learn anything or find anything interesting while doing self-tracking?
   a. Did you learn this at the workshop or while using the app on your own?
   b. Did you learn anything about your sleep?
2. Overall, what do you think about using this kind of workshop to learn about sleep?
   a. How can we make the workshop better?
   b. Would it have been better to learn about it in a normal lesson?
   c. What was the difference?
3. How did you find using *LifeMosaic?*
   a. How did you use it?
   b. How often?
   c. What did you like about it?
   d. What did you not like?
   e. What would you add?
4. Do you have any questions about the study?

STUDY 4

- Did you use the self-tracking app? Do you have any data you'd like to discuss?
- Is there anything you find interesting about that?
- Is there anything else it could show you?
- How else could we interpret that?
- Do you think the data is right?
- That's an interesting claim, can we see that in your data? Can we test it next week?
- Tell me about one of the days in your data. What happened? How did it go? Can you remember anything else about it? Could you have done something different? What might happen if you did? What else could you do next time?
- Would you say you are on target? How do you know?
- What can we explore next week?