Adding Domain-Specific Features to a Text-Editor to Support Diverse, Real-World Approaches to Time Management Planning

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ABSTRACT

Many tools are designed to support users in maintaining or developing strong time management practices. Abandonment of these specialized tools is common, in favor of returning to a more general-purpose unstructured tool. How can designs leverage the familiarity of general-purpose tools and the advantages of specialized ones? We explore if applying a time-management-specific understanding of conventions and interactions within unstructured plain-text can be a successful approach to designing support for these tasks. We report the results of two field deployments (combined n=29) of "*Plan*" - a mobile application with a notes-application-based interface designed to support the practice of Time Management Planning. We show that modest, domain-specific modifications of general-purpose designs can facilitate users' pre-existing workflows and nudge them towards better practices while leaving interfaces familiar and flexible. However, those with minimal planning experience desired additional structure.

CCS CONCEPTS

• **Human-centered computing → Interactive systems and tools**; **Empirical studies in HCI**.

KEYWORDS

time management planning, field deployment, interviews

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1 INTRODUCTION

Personal informatics (PI) is a research area that aims to support self-knowledge, reflection, and sometimes action through collecting and presenting personal data. These tools are necessarily situated in the lives and circumstances of users, and as such, one size does not fit all [24, 36]. Time management and productivity tools are a particularly challenging domain for creating PI tools: people develop their own systems that are different from each other in subtle and not-so-subtle ways. Supporting the least common denominator can easily result in a tool that only works for some. Even worse, many opportunities exist to see and impose a structure that does not reflect real user needs or behaviors. Thus, despite decades of HCI research exploring opportunities to improve time management and productivity software, when it comes to Time Management Planning (TMP) — figuring out what tasks are going to get done in a day, when they will happen, and how long they are going to take — people overwhelmingly rely on general-purpose tools: notes applications, notebooks, scrap paper, word processing documents, email drafts, or sticky notes [27, 29].

This paper reports an in-depth investigation of the time management practices of undergraduate student who use unstructured note-taking tools. To facilitate the investigation, we designed and implemented a mobile application called *Plan* (Section 3). *Plan* works as a text editor and can be used without relying on domain-specific features. It also includes a range of features motivated by the literature [29] that make it easier to carry out the planning process according to TMP principles. To understand how people engage with this tool (RQ 1), how the presence of these features affects their planning (RQ 2), and whether they would use it over a longer term (RQ 3), we deployed *Plan* twice. A total of 29 undergraduate students participated in a one-week (Phase 1) or a five- to six-week (Phase 2) study using *Plan* in their daily lives.

Results (Section 5) showed that the interface and text-based input had more latent effects on participants' processes than we expected, both positive and negative. Most, particularly those with prior planning experience, found ways to adapt it to their needs. Features like reminders, copying data in from external sources, and snoozing created novel experiences for some participants. The features encouraged starting or expanding the use of effective TMP practices. Over the five-week deployment in Phase 2, we also observed that participants followed patterns of planning that were not necessarily regular from day to day; planning was a daily choice based on cost/benefit analysis for most participants. We extend the existing literature through the following contributions:

- providing deeper insights into time management practices with an unstructured note-taking tool,
- discussing empirical evidence on how domain-specific features affect students' planning practices, and
- providing a prototype tool that other researchers can build upon or use to explore further research in this domain.[1]

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[1] Code available at: https://github.com/Personal-Data-and-Empowerment-Lab/plan_app

2 RELATED WORK

Time management skills are increasingly valuable to both individuals and society at large. Effective time management has been shown to provide benefits to stress-related outcomes for individuals such as perceived control of time [2, 20, 30, 33], job satisfaction [30], and health [9]. Additionally, using time management strategies is positively correlated with academic performance [10, 31] and job performance [5].

Of these behaviors, short-term planning or Time Management Planning (TMP) is especially critical [12]. Parke et al. define TMP as, "*determining tasks to be performed on a particular day, prioritizing and scheduling the order of such tasks, and sketching out the approximate amount of time to be spent on each task*" [34]. TMP practices have been shown to have the most significant relationship to desired outcomes [12, 22]. TMP also has characteristics that make it particularly important for supporting individuals in managing their time when coping with a lack of structure. Despite Suchman's insight that people do not always follow plans in the moment because actions are situated in time and place [37], planning can still help by reducing the cognitive load associated with worrying about unfinished tasks [32], assisting individuals in avoiding procrastination and prospective memory (remembering tasks at appropriate times to work on them) [42], helping with coordination and anticipating conflicts [27], lowering the activation energy required to get started on difficult tasks [25], and improving time estimation and helping identify priorities [3]. As such, TMP is particularly interesting for knowledge worker populations and those adjacent to them, such as higher education students. Recent HCI work has targeted these populations, examining planning [3, 29], as well as what productivity means in these complex environments [16, 23].

2.1 Tools for time management

Prior work, including Lund & Wiese's work with graduate students [29] and Leshed & Senger's work with a wider demographic range of Americans [27], suggests people generally use unstructured tools when engaging in TMP. These tools include notes applications, notebooks, scrap paper, word processing documents, email drafts, etc. used to create and manage plans. People often use similar tools for task management, a related behavior. Haraty et al., Bellotti et al., and Blandford et al. each studied how individuals engaged in time and task management and found that individuals often use these same unstructured or unspecialized tools to track tasks [6, 8, 14, 19]. Prior literature also gives insight into why people rely on these unstructured tools. Their need for support or goals evolve in and out of the support a specialized tool provides too frequently [3, 18, 24, 29, 36], they want more control over the structure of their personal data [1, 4, 6, 19, 24, 29, 39], they need a tool that can integrate with a complex network of tools they already use [8, 38], or they need faster or easier data entry than a specialized tool provides [7, 11, 29, 38, 40, 41].

How do we design tools to accommodate these needs and provide useful support for these tasks? Haraty et al. took a structured approach when developing *ScriPer* - a task manager that allows the user to "script" additional features or interactions to better meet their needs [18]. Bellotti et al. proposed the concept of *task vistas* or different views of tasks suited for planning and suggested that a task list manager should facilitate the crafting and presenting of various vistas to help users reason about their tasks more effectively [6]. A different approach is to start from the baseline of an unstructured application - a basic text editor - and enhance the experience while still leaving text entry as the primary interaction. Van Kleek et al. took this approach with their tools *JourKnow* and *List-it*, both designed to help people capture and retrieve information scraps [7] of various kinds more effectively than unstructured tools. The primary interface for both these tools is a text box where notes and other content can be entered immediately, without interruptions [40, 41]. After the content is entered, the system performs additional processing to assist in retrieving it by linking related notes together by context or content - sometimes assisted by the user via keywords or shorthand. A major benefit of this approach is providing a central place to capture data relevant to the task at hand and then delaying (or ignoring) organizing it when unnecessary. Another illustrative example is the mobile application *Scraps* from Swearngin et al. that allows users to capture quick notes, photos, links, etc., related to ongoing writing projects that are then accessible from a sidebar in Microsoft Word when composing a document [38].

The above work on unstructured applications focuses on capturing information scraps and other miscellaneous information. However, the nature of TMP is quite different, and it is unclear how users might react to an unstructured tool built specifically for TMP. This leads to our first research question:

***RQ 1**: What are participants' experiences using a primarily unstructured, text-based interface to support their plan formats and use cases?*

2.2 Domain-specific text editing features

One opportunity to make an unstructured, text-entry-based application more useful than a simple, general-purpose one is by applying domain-specific knowledge of the target task to enhance the experience. When working with text as a primary medium, one approach is providing features that help manipulate the text in ways users commonly need to. Lund & Wiese take this approach with their proposed design of a planning application by including a toolbar with features observed from graduate students when planning such as inserting formatted times, moving plan items to the next day, or adding a reminder to a plan item at its scheduled time [29]. This approach is similar to that of a word processor, where highlighting text and then clicking or tapping features like prepending bullets or indenting result in a common, tedious operation being performed automatically by the system. Jones et al. went even further with their *Personal Project Planner* and augmented common interactions like copy-pasting to more effectively link information [21]. Their tool was designed to support project planning and would allow for text copied from one part of the plan to another to create a clickable link back to the original location of the text, even supporting text from web pages, emails, or supported local documents. The system still facilitated advanced navigation and information structuring without interrupting the primary interaction of text entry.

Another way to provide domain-specific support in this context is to use the semantics or domain-specific structures of the task to

extract information from patterns in the user-provided text. Van Kleek et al.'s *JourKnow* uses this approach to assist users in capturing information scraps by recognizing named entities, supporting in-line tagging with "@" symbols to link notes, and leveraging pidgin grammars and Notation3 to facilitate extracting structured information from largely unstructured text [41]. Chang et al. built a somewhat similar system for the mobile context called *Listpad* that instead takes the approach of letting users insert a particular character (a blue diamond) to indicate breaks between "fields" of an item in the list [11]. Users can define their own data structures or ignore them entirely and only use free text.

However, it is unclear if adding these domain-specific features changes people's behaviors; they may not use these features at all. Even if they use them, the features may just make it easier to do what they were already doing, or they may lead users to engage in new behaviors. This leads to the next research question:
RQ 2: *How do domain-specific features affect the planning process?*

2.3 Long-term Personal Informatics tool use

Long-term use of PI tools is nuanced. Although tools are generally designed with long-term, consistent use in mind, this does not usually reflect reality. Lazar et al. studied people's longer-term (two months) use of smart devices and found that abandonment was high - nearly 80% [26]. They found that these tools were abandoned if they did not fit how people viewed themselves, they did not feel the data they collected was useful, or integrating the devices into their daily routines was too burdensome. Clawson et al. similarly surveyed Craigslist postings of fitness trackers for sale and found factors such as "expectation mismatch", "activity change", "experimentation", "peer influence", and "change in health status" or "goal met" [13]. In Gulotta et al.'s work examining the wide range of design problems PI systems face with engagement, they cite misalignment of user and system goals and the difficulty of maintaining the system as primary challenges that limit engagement [17].

These findings suggest that complex factors of individuals' needs and goals and their evolving nature make long-term, consistent usage unlikely for many users and devices. To this end, Epstein et al.'s Lived Informatics model of PI integrates "lapsing" as a core part of their cyclic model and note that lapsing is sometimes merely a temporary break with the intention to return [15]. Together, this work suggests designs should anticipate lapsing and that there is an opportunity for research to better understand what patterns of use (or disuse) people develop and why to provide PI tools that better support their users. This leads to our final research question:
RQ 3: *How do participants engage with the tool over an extended period?*

3 PROTOTYPE APPLICATION: *PLAN*

We developed a prototype mobile application called *Plan* to facilitate our investigation. Our prior work on tools for supporting TMP suggests not to enforce a particular structure or planning process on users, to make users' current planning methods easier, and to encourage good planning behaviors by making them easy or implied [29]. *Plan* was designed following these guidelines and developed using the Flutter framework[2] (v1.22.6), which uses the Dart programming language. We deployed the application for both iOS and Android from the same codebase via Apple's TestFlight program and as a beta app on the Google Play Store.

[2]https://flutter.dev/

3.1 Prototype features

Plan is primarily a text editor with a single large text box, similar to a notes application, with the date, navigation, overflow menu, and toolbar (see Figure 1). Decisions for what features to implement and the general design approach for the app drew directly from prior literature [29]. The toolbar contains additional features to assist planning, such as adding checkboxes, formatted times, reminders, snoozing, and a shortcut to opening the sources drawer (see Table 1 for a description of these features).

The sources drawer is a novel feature of this application that allows importing tasks and events from third-party sources the user has signed into within the application (e.g., local calendars, Canvas-course management software, Google tasks). It allows the data received from external applications to be copied into the editor as plain text and manipulated seamlessly with other contents in the plan. All items copied from an external source have the text of that item copied in: for events the name of the event, the to-do item from a task list. Events also automatically pasted in start and end times on the line and tasks automatically included checkboxes. None of the connections to external sources were bi-directional — checking off an item in *Plan* that was added from the sources drawer would not also check it off in the source repository. This was a difficult design decision, but ultimately we did not want *Plan* to negatively impact participants' data, and we were concerned that implementing a bi-directional connection might discourage use. However, this is also a limitation and warrants future study moving forward.

3.2 Study integration

Plan logs users' actions automatically using the Flutter package *F_logs*. These logs were exported either manually by participants in Phase 1 or automatically to Firebase cloud storage in Phase 3 for the research team to analyze. A snapshot of the plan being edited was logged every five edits, but any text that was not a checkbox, reminder emoji, or formatted time was converted to asterisks to ensure participants' data privacy. The application also supported manually exporting the past seven or more plans as plain text to Firebase, which participants were asked to do as part of the preparation for interviews so the content of the plans could be reviewed together (see Section 4). Participants could keep the prototype installed and continue receiving updates after the studies.

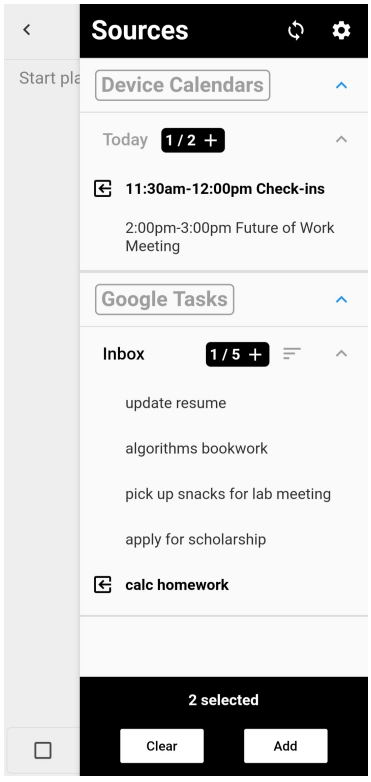
3.3 Changes between Phase 1 and Phase 2

This paper discusses the results of two field deployments with the *Plan* app, administered in two different semesters of the same academic year. Between the two studies, minor updates were made to the prototype:

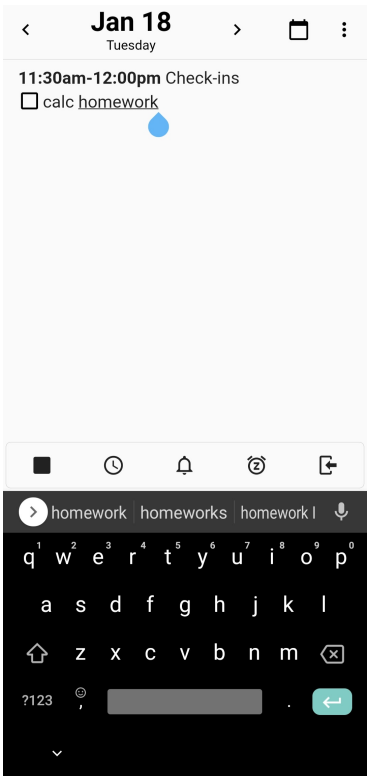
- Minor bug fixes to address issues with integrations, reminders, and text parsing/formatting issues

Table 1: A summary of the domain-specific features implemented in *Plan*

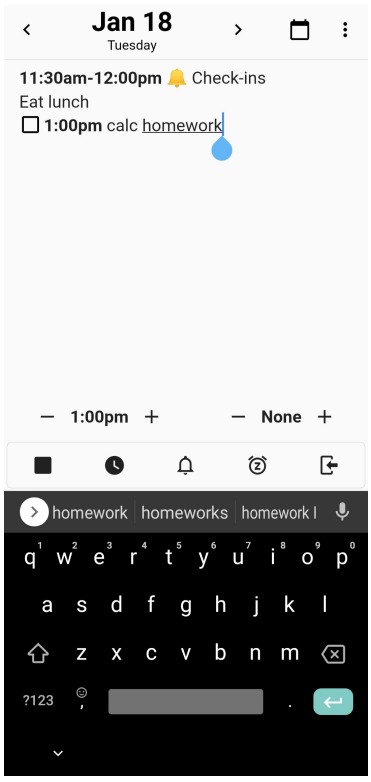
Feature	Description
Checkboxes	*Plan* recognizes and replaces "[ ]" with an image of a checkbox that can be tapped to check or uncheck. Tapping the checkbox button removes the first checkbox from the selected line, or if no checkbox is on that line it adds a checkbox to the beginning of the line.
Formatted Times and Time Picker	Pressing "+" or "-" on the time picker will add a start or end time to the start of the current line if one is not already there, otherwise it will increment or decrement by 15 minutes. Users can also type them out in various recognized formats (e.g., "1pm", "10:00am", "2-3pm").
Reminders	The reminder button adds a bell emoji after a recognized time in the current line, adding a time if it is not already there. Push notifications are created for all lines with bell emojis. Tapping the reminder button on a line with a reminder will remove it. Users can manually delete/add by deleting/adding the bell emoji.
Snoozing	Pressing the snooze button copies the text of the current line to the next day's plan.
Sources	The sources drawer contains imported tasks and events from third-party sources the user has signed into within the application. Supported integrations are the iOS/Android native calendars, Canvas (Learning Management Software), and Google Tasks. The calendar source displayed any events on the user's calendars for the current date in the editor. The Canvas and Google Tasks integrations displayed all the tasks available in their respective repositories, separated by list or course. Tasks marked complete in the data provided by the APIs are not displayed. Source items (events or tasks) can be selected individually or in a batch by list. Tapping "add" at the bottom of the sources drawer closes the drawer and pastes the selected items as plain text on separate lines at the bottom of the plan in the editor.



(a) Users can review and select tasks or events from external sources.



(b) Imported content is pasted in and can be edited as text.



(c) Times, checkboxes, etc., can be added manually or with toolbar buttons.

Figure 1: Screenshots from *Plan* demonstrating some of its unique features.

- The process of exporting usage logs to the research team was shifted from happening manually via a button the participants pressed to happening automatically whenever the app was opened or closed
- The onboarding process was adjusted to obtain consent and collect demographic/contact information as required since

participants installed the app organically and were not required to participate in interviews
- A push notification reminder to plan was added that triggers after three days of no usage

4 METHODS

To investigate our research questions, we conducted two small-scale studies with first or second-year undergraduate students at a large research university. These studies will be referred to as *Phase 1* and *Phase 2*. Phase 1 investigated how students planned without the prototype for 1-week and then how they planned using the prototype for another week (2 weeks total). Phase 2 examined longer-term and more organic use. All study procedures were approved by our institution's Institutional Review Board (IRB).

4.1 Phase 1: Oct-Nov 2020

4.1.1 Participants. Phase 1 recruited 12 first-year undergraduate participants (average age= 20; 5 female, 5 male, and 2 non-binary) from various departments at a large research university via mass email lists. They received information about the study and a link to a screening survey that included details about the study procedures, compensation, etc. (see supplemental materials). Students who were not in their first-year or had any prior relationship with research staff were excluded. Participants indicated they either "somewhat agree" (n= 5) or "strongly agree" (n= 7) that they were "interested in improving how I manage my time" (see supplementary materials). Students with disabilities were not explicitly recruited, but also not excluded. No participants brought a disability to our attention and we did not ask explicitly. Additional information about the participants is available in the supplemental materials.

Following completion of the screening survey, participants were informed they would be contacted by research staff within 2 weeks if they met the screening criteria based on their survey responses. Those who met the screening criteria were notified via email or text message to confirm participation and schedule the first interview.

4.1.2 Task. Participants were asked to plan their time for two weeks — one week using the *Plan* application, and one week using their prior methods — and to provide those plans to us.

4.1.3 Study design. The study used a within-subjects counterbalanced design, meaning that some subjects had an "AB" treatment while others had a "BA" treatment. Each participant was observed engaging in planning for 2 full weeks, with interviews before the first week, in between weeks, and following the second week. They were randomly assigned to use the prototype or their prior methods for the first week, then switched to the opposite for the second. Participants from Phase 1 are referred to as *A#* in this paper. Seven participants were assigned to use the prototype first (A1,4-5,7-10), and five to use it second (A2,3,6,11,12).

We conducted the first interview before beginning the diary activity and asked participants to describe their prior planning methods and tools (if any). Participants using the prototype for the first week were asked to install it and then shown a video demonstrating the app's features. We reminded them that their methods of using the app did not need to resemble those shown in the video.

The second and third interviews focused on participants' planning experiences during the previous week with whichever tools they were asked to use. They were asked to compare the two weeks and which tools they planned to use going forward as part of the third (final) interview (interview scripts are available in supplementary materials). Participants could keep the application installed on their devices if they wished. They received a $30.00 Amazon gift card as compensation for their time after the final interview. All participants completed the study in full.

4.1.4 Hypotheses. Our primary hypothesis was that participants would find value in the design of *Plan*, and thus that at least some participants would be interested in continuing to use it to plan out their time. We also hypothesized that there would be carryover in practices between participants' usage of *Plan* and their prior methods, or visa versa.

Our decision to use the counterbalanced design was based on the second hypothesis described above: that using *Plan* might have an impact on their TMP practices when they revert to their own tools and methods, and simultaneously that their prior behaviors might carry over into their tool use. We saw evidence that students' prior practices seemed to impact their use of the tool (described in Section 5.1). However, we did not see evidence of new behaviors in the "*Plan*-first, own-approach second" condition of the counterbalance. As a result, we dropped that research question and the counterbalanced design for Phase 2, described below.

4.2 Phase 2: Mar-May 2021

4.2.1 Participants. We recruited 17 first or second-year undergraduate students (average age= 20; 9 female and 8 male) in Phase 2 via emails from the academic advisors of various departments or professors of introductory undergraduate courses at a large research university. Those who indicated they were not first or second-year students, not students at the university, or had any prior relationship with any member of the research staff were excluded. Students with disabilities were not explicitly recruited, but also not excluded. No participants brought a disability to our attention and we did not ask explicitly. 11 of the 17 participants agreed to participate in interviews, while the other 6 opted to only use the application and have logs collected about their usage. Participants with usage spanning less than 24 hours were excluded from the analysis. In the remaining sections of this paper, *B#* represents participants of Phase 2. Note that Phase 2 included participants who participated in interviews and those who only provided usage logs. Usage-log-only participants of Phase 2 will be referred to as *BU#*.

4.2.2 Task. Participants received information about the study and a link to install the application from the Google Play Store or Apple TestFlight. Phase 2 used the same prototype as Phase 1 with minor changes described in Section 3.3. The application's onboarding process included information about the study procedures, collected basic demographic data, and asked for consent. They were also encouraged to use the prototype however it was useful to them.

4.2.3 Study design. Phase 2 was designed as an in-the-wild field deployment intending to explore longer term usage. Participants were asked if they would participate in two interviews about their experiences using the application. If they agreed, they were asked

for contact information and were informed that research staff would contact them to schedule interviews. The 11 participants who agreed to participate in interviews were interviewed at approximately 2 weeks and 4 weeks into the study. Participants were not required to maintain usage to participate in interviews. For example, we interviewed and report results below from two participants (B6,11) who used the application during the first week but did not continue use afterward.

Phase 2 concluded on the last day of the Spring semester (May 3, 2021). Participants did not join all at once, so interviews took place at different times, and some used the app longer than others. The shortest period between app installation and study conclusion was 33 days (median: 41, mean: 40). All 11 interview participants completed both interviews and were compensated with a $30.00 Amazon gift card following the second interview. Interviews included questions about how they used the app to plan, their planning experience in general, when planning or the prototype is helpful or unhelpful to them, and any impacts on their time management they observed (see supplementary materials).

4.2.4 Hypotheses. We had hypothesized that our participants would follow a typical cycle of trying out most of *Plan*'s features early in the study, before settling into a more consistent usage pattern. A primary objective of Phase 2 was to understand which features participants continued to use over a longer term. We also had a hypothesis that there would be differences in this longer-term usage between participants, though we did not know what those differences would be.

4.3 Data collection and analysis

Interviews for both phases were conducted remotely and recorded via Zoom video calls with participants' consent. We conducted a reflexive thematic analysis of the interview data. First, the interviews were transcribed verbatim using Otter.ai[3]. Three researchers separately open-coded transcripts of Phase 1 and Phase 2 using Atlas.ti Web[4]. The researchers met before coding for each phase and coded one transcript together. Transcripts were then distributed between the researchers with an overlap of one to two transcripts per phase. Researchers met weekly to discuss and resolve the codebook and coding discrepancies.

Two researchers organized the codes for Phase 1 and Phase 2 into code groups. Since the code groups from the two phases overlapped significantly, the remaining stages of thematic analysis were done with the combined code set. From the open-coding process, we found 1707 codes and developed a sense that there were two types of codes. First, participants shared their experiences, outlook, feelings, and regular practices with time management using their prior tools (especially during Phase 1). Second, participants shared their experience with and opinion of *Plan*. The topics in the former set are well-covered in the literature [3, 6, 8, 19, 27, 29]. Hence, we identified those 946 codes and removed them from our analysis to make the remainder of our thematic analysis process more tractable. Two researchers then iteratively organized the code groups, settling on 20 sub-themes, and then subsequently organized those into 5 themes using Miro[5]. The researchers conducted checks between iterations to ensure that derived themes were consistent with the underlying codes.

Interestingly, A12 answered questions in interviews as if they used the prototype throughout the week, but usage logs revealed that their plans were all created on the day of the interview and copy-pasted onto previous days, suggesting falsification. Therefore, we excluded A12's interview data from our analysis.

Three researchers processed and analyzed usage logs from the *Plan* app using Google Sheets and Python notebooks to wrangle and visualize data. Discrete action records were grouped according to which features they corresponded with. A mapping of which days users used the application was created by linking timestamps from usage logs and user IDs with participant IDs.

4.4 Limitations

Participants were all from the same university in the United States and self-selected to participate. They are likely to have a higher-than-average interest in time management and related tools. Further, different cultures worldwide have been shown to demonstrate different attitudes and behaviors concerning planning and time management [35]. Additionally, Phase 2 concluded at the end of an academic semester, so interpretation of how usage changed after the study should be made with care — participants' behaviors could be influenced by their feelings about the prototype, a change in time management demands, or a combination of both.

5 RESULTS

This section presents the results of the two field studies with a prototype tool described previously to answer the earlier question of if this approach to design can be successful. Specifically, we observed that participants adapted the tool to match their existing practices for TMP. The domain-specific features included in the tool also provided novel interactions for the participants. This study also revealed that participants' personal choices and approaches to time management practices influence long-term usage of TMP tools. In the sections below, quotes included have been lightly edited for clarity (primarily removing 'like's and false starts).

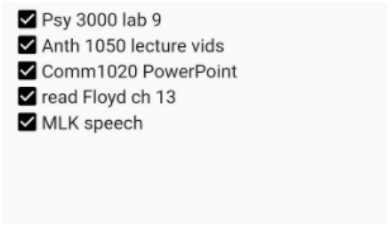
5.1 RQ 1: Participants' experiences using a primarily unstructured, text-based interface to support their plan formats and use cases

While investigating people's TMP processes and practices with an unstructured, text-based interface, we observed both positive and negative impacts of the interface and the text-based input methods. Most, particularly those with prior planning experience, found ways to adapt the tool to their approaches to TMP.

5.1.1 Different structures of plans. Participants that we could observe plan exports from (interview participants, combined n=23) organized their plans according to a variety of structures within the application. These structures were influenced by their prior planning methods if any, and the constraints and affordances of the application. Eight participants (A1,2,4,5,8,B3,4,7) primarily had

[3] Otter.ai
[4] Atlas.ti Web
[5] Miro

a single list of tasks as their primary plan structure - essentially a daily to-do list; Figure 2a shows one example of such a structure. These lists were organized by category or academic classes, by priority, or with no particular order or grouping. Participants also varied in the scope of their task lists. Some included non-academic tasks or personal notes, but others did not.



(a) A sample plan from A8 that illustrates a task list format. The plan contains only tasks with a course prepended to certain lines as an informal way of categorizing them.

(b) A sample plan from A3 that illustrates a combined schedule and task list format. There are two separate sections - a detailed schedule with events with start and end times and tasks mixed in and a separate list of tasks at the bottom.

Figure 2: Plans illustrating two common approaches to planning observed during prototype deployment

Ten participants had a schedule-like or chronological format with a mix of tasks and events (A3,6,7,11,B1,2,5,8-10); Figure 2b shows one example of such a structure. Often, not all items would have assigned times. A concrete, scheduled event, like a class, would have a start and end time, and tasks would be listed between other events with an associated time. The tasks in between were then implicitly scheduled, as there was still a block of time they were "assigned" to, but the tasks themselves did not have a specific time indicated. Most of these participants (8 of 10) maintained a schedule in one "section" with a task list created separately where some elements of the task list, but not all, would be duplicated and integrated into the schedule.

The remaining four participants (A9,10,B6,11) did not use the application enough to have any particular type of structure. On the one or two days they did create plans, they were generally task lists, although A9 made a detailed, combined schedule on the day they used the prototype.

5.1.2 Flexibility and adaptations using text. Participants perceived the flexibility of the interface as a positive experience; it offered them complete control over the placement of tasks, calendar events, or other plan content (A4,6,B8-10). B1 expressed that having all the disparate types of plan content in one place made planning more manageable, "*I actually really like the app …because it's kind of just one spot where I can do everything*". Five participants (A3,4,10,B1,3) made similar comments. B3 also noted that the interface better afforded switching between the different plan formats they used. Some participants opted for more structured interactions using emojis, question marks, exclamation points, or all capitals fonts.

5.1.3 Cases for more structure. Beyond additional control, while some participants (B1,9) felt the data entry via typing only was more straightforward than using more structured input, others found it to be cumbersome and sometimes a deterrent to use (A2,6,8,B6,9,10). A6 and B10 commented that they had started writing more abstract descriptions of tasks to reduce the amount of typing required, with B10 explaining, "*in my notebook, I'll usually put each individual assignment to mark off. Whereas in the Plan app, I usually am just putting the class or the course.*" A8 even said they had started typing their plans on their desktop and then transferring them to the app later. Participants also had mixed opinions about other issues with the text-based interface compared to something more structured, in particular, a digital calendar. For example, A6 and B2 noted it was more difficult to visualize their time with a text-based format, whereas others (B1,10) felt it presented a more helpful visualization of their time.

These effects sometimes had a visible impact on how participants planned. A7 explained the interface prompted them to take a different approach to plan – "*I wanted to fill in a lot more per day …Since I had way more space to actually work with it felt like I needed to push as much in as possible. And be as detailed as possible.*" Others commented it prompted them to break down tasks into smaller sub-tasks more than usual (B4) or be more specific about their plans (A3,B1) in contrast to those who felt pushed to be more abstract (A6,B10). A6 commented that they shifted from noting all their scheduled events and then filling in available time with tasks (their previous method using Google Calendar) to planning both events and tasks in chronological order in the prototype because it was annoying to go back and add new lines in between the events after listing them.

While many participants appreciated the flexibility afforded by a text-based interface, some wanted more structure (A3,9-11,B4), particularly those without established planning practices. They commented that having built-in time slots, like a calendar, (A10,11) or

providing templates of how an effective plan might be structured would help scaffold the planning process (A3,10). Others wondered if *Plan* could suggest tasks to plan based on items in the sources drawer from other applications or let the user define their default items like breaks. Additionally, A9 wished they had more support in developing a habit of planning and suggested the app could regularly remind them to plan. A8 similarly noted they could be reminded if there were unchecked-off tasks in their plans to revisit.

5.2 RQ 2: Impact of domain-specific features on TMP practices

In response to RQ2, we observed that the domain-specific features (e.g., reminders, source integration, snoozing) provided some novel interactions for the participants. However, the app's framing of the plan being for a specific day and only providing a daily view hindered some participants. The features also encouraged some participants to start or expand the use of effective TMP practices.

We included domain-specific elements in the *Plan* app like checkboxes, formatted times, snoozing of plan items to the next day, adding reminders to specific items, integration of third-party sources to insert tasks or events from within the app directly, and a daily framing of the text entry. Snoozing and in-line reminders, in particular, introduced new interactions that participants found novel or used in unanticipated ways. Figure 3 provides an aggregated overview of how much each of these features were used per day across the duration of the study.

5.2.1 Snoozing a task. The snooze feature allowed users to move a line in the plan to the next day's plan with a single tap. While this was relatively trivial to implement and happens automatically in most task list managers where uncompleted tasks don't disappear or show up red when they are overdue, this interaction had more impact on users than we anticipated. Making the behavior an explicit action (giving it a dedicated button) meant that participants found themselves more aware of when they were doing it (A7,8,B4,8) and also which kinds of tasks they were delaying or taking longer than expected to finish (A7,8,B4). A7 felt the snooze feature provided some validation for their existing planning behaviors because it, "*almost put a name to what I do in my head as well …the snooze button just makes me not feel guilty.*" Further, A3 commented that the ease of use of the feature changed their planning process by expanding the scope of the types of items they plan to include more flexible, personal tasks like dishes that often needed to be delayed. Snoozing also helped participants cope with feeling overwhelmed more effectively because it was functionally easy to move lower priority tasks off of the current day's plan (B1,8,10). Although procrastination is not considered a "good" time management practice, our participants' snoozing demonstrated that making the action more explicit could prompt reflection on why it was occurring and make revising a plan feel more acceptable.

Additionally, we saw some users appropriate features in unexpected ways. One user (A1) heavily used the snoozing feature to maintain a general task list. Rather than only list tasks relevant for the current day, they would list everything they needed to do for the foreseeable future and then snooze any incomplete items to the next day until they were eventually completed. In essence, they recreated the typical interaction pattern with task lists where the list remains static until items are complete. Another participant (A9) used reminders to create a secondary task list. They added reminders to any tasks that needed to happen during a particular time (in their case, after classes, but before it got too late) and set them for the beginning of this time. Then, instead of referring to the plan directly, they referred to their phone's lock screen where the reminder notifications had appeared and "checked off" items as they completed them by dismissing the notifications.

5.2.2 Integration of sources. Reviewing upcoming tasks and events and transferring them to a plan is a critical part of many people's planning efforts [29]. Therefore, integration with third-party applications (e.g., Google Tasks, phone calendar, and Canvas) was a significant focus in the design of *Plan*. Unfortunately, issues with the Canvas API at our university prevented the feature from working effectively during all of Phase 1 and most of Phase 2. This was disappointing as many participants (15 of the 23 interviewed) described this feature as one that would be useful to them, and those who were able to use it at the end of Phase 2 felt it did make planning easier (B2,3,5,8). Among other integrations, importing tasks from the phone's native calendar was most common and participants noted it helped make planning easier (A3,6-9,B2,5,8,9), more organized (A7,9) or reduced their need for checking the original sources when planning (A1,6,B5). The primary feedback about the source integration was asking for additional sources or more Canvas data to be imported.

5.2.3 Specifying a time for tasks. Interestingly, a number of participants reported adding specific times to tasks more frequently with the prototype than they had prior to using the prototype due to the ease with which they could be added either with the time picker or manually and then auto-formatted (A3,7,9,B1,5,8). B1 found that it helped them go to the gym more often: "*I never used to put a time for everything …I usually can only go [to the gym] in the morning, or I lose motivation. But with the app, I've been putting a time for me to go and then saying, okay, I actually do have enough time today to go do it.*" Others noted that they felt their time management generally improved (B5), they started planning with more detail (A3,5,7,9,B8), were more aware of how long tasks took (A1), and were better able to avoid distractions (A8) as a result of incorporating times into their plans more consistently.

5.2.4 Adding a reminder. A few participants also mentioned that the ease of adding a reminder to a plan item led them to do it more often and also helped to keep them on task. A11 previously used a paper planner and would sometimes set reminders on their phone for tasks, but noted, " *…being able to set a reminder super easily was an advantage because having to go through the extra step of you know, moving from my physical planner to my phone to set that alarm …is just an extra step that sometimes I forget about or just am too lazy to do. So having that built-in was definitely an advantage.*" A8 also began using reminders with tasks after using a word processing document previously and found it made a large impact that they said they would find another application to provide reminders if they had to stop using the prototype.

5.2.5 Scope of planning. While the domain-specific interactions with plan items were nearly universally appreciated, the plan scope

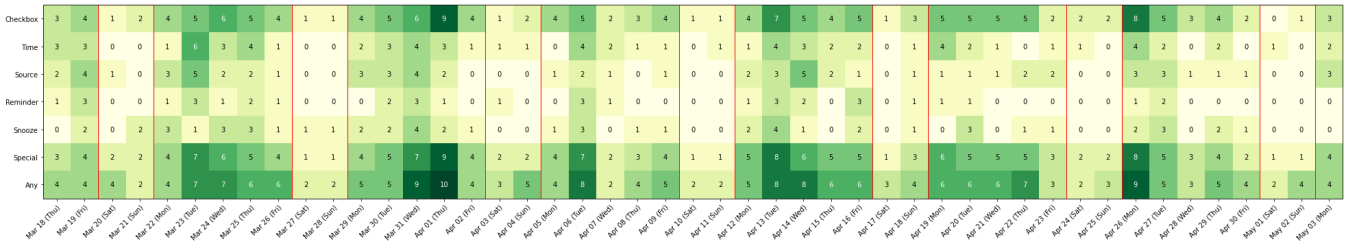


Figure 3: A heatmap showing aggregate participant usage of features in the prototype over the duration of Phase 2 (March 18 - May 3). Each action has its own row, with an aggregate row below the individual features, and a final row showing how many users used *any* action on that given day for comparison. Weekends are separated from weekdays by vertical lines. The drop in usage on weekends is particularly clear. Participants did not start all on the same day so increases in the first 7-10 days may be artificial.

enforced by the interface was somewhat divisive for users. The primary interface of *Plan* is a single text box labeled with a date - indicating that the plan is for one particular day. Plans from days before or after that date can be viewed by navigating with arrows at the top, but only one day at a time and the interface will only ever allow one plan to be viewed at once. Some participants felt this was a strength of the application because it kept them focused on the day at hand or made things less overwhelming (A3,6,8,B1,7,8,10). Several others noted that the design made it difficult to refer to previous days or think about how their time to work on tasks could be allocated over multiple days as they were accustomed to doing (A1,4,6-8,B5,6,9,11). A6 noted that in response to this they, "*...pretty much changed everything to daily planning ...daily planning instead of weekly.*" A common suggestion, even from those who preferred a single-day view, was to include a multi-day or weekly view of plans to aid users in considering the broader context of the week.

5.3 RQ 3: Engagement with a planning tool over an extended period

We observed that participants had personal choices and "rules" that influenced their engagement with time management planning and any supporting tools. In particular, we found that the context of the application (mobile and digital) and the interactions users had used previously impacted their willingness to adopt a TMP tool more than we expected. Their usage also varied at the lower, day-to-day level based on complex cost/benefit analyses.

5.3.1 Adopting a tool was more about compatibility than functionality. The tool provided a varied experience for participants concerning factors such as availability, perceived freedom, and even self-image. While many users felt having *Plan* on their phone made both the activity of planning and their actual plans more accessible (A3,5,8,9,11,B1,2,7), others did not. These participants remarked that they don't refer to their phone as often as they want to refer to their plans (A1,2), don't rely on it for notifications (A2), or actively try to prevent usage when working on tasks during the day (A1,2,B4,10). B4 explained preventing smartphone usage with, "*I think my one issue with making plans on my phone ...has been I like to interact with technology as little as possible because I tend to get very easily distracted on there.*" B10 similarly found it challenging to use *Plan* consistently because they would leave their phone in another room when working on homework. Additionally, others felt the multiple steps to open an application on their phone was an inferior experience to viewing a sticky note or other paper versions immediately visible on their desk (A1,2,5,B6).

Another nuanced dimension was simply that the application is a dedicated time management tool. B2 felt this was a barrier for them because, "*any piece of software has a vision that the software developer wants you to use it in that way ...so when I'm in Plan, and I want to add a new grocery list, my brain is expecting the app to have a place for that because that's how apps work.*" They contrasted this experience to a notebook, which does not have an "opinion" about how it should be used, "*it's just a paper, you know, there's nothing in there. There's no intent behind it.*" Additionally, A2 was hesitant to adopt a planning application long-term because they didn't feel like they were really serious about time management. In other words, having a dedicated application implied that time management was something they needed support with or was an integral part of their life which felt at odds with their self-image. Similarly, others noted that they have a "good memory", are not a "planning person," or aren't a "tech person" as reasons they didn't feel the application was an excellent fit for them (B10,11). This was interesting and somewhat surprising, as this was a voluntary time management planning study, and it was advertised as such. Yet, despite the similarities to a "notes" app, the domain-specific framing of *Plan* seemed to be enough to lead to an aversion. Conversely, some participants noted that they might prefer to use *Plan* because they valued the environment and disliked wasting paper (A1,B5,8).

5.3.2 Nuances in interactions with plans. There were differences in how people used their plans once they were created. Some participants stated that they did not refer to their plans during the day, or if they did it was infrequent (A2,4,7,8,B2). While sometimes this was due to simply forgetting, most felt it wasn't necessary because they could remember what they had planned (A2,4,7,B2). The value of planning was primarily the mental exercise of determining their tasks or schedule for the day. For others, the plan served as a guide throughout the day. They would check off tasks as they were completed (A1,3,6,B7,9,10), add new items (B9), revise the time of events or tasks as needed (A9,B1,9), and continually refer back to see what they should be doing next (A3,6,B1,8,9).

5.3.3 Daily planning does not happen daily. For nearly all participants across Phase 1 and Phase 2, there was an initial burst of usage as users installed and experimented with the features. Their prototype usage then declined and settled on a consistent, albeit acyclic, level of use. Particular days of the week and even times of the semester (consider approaching finals vs. after finals) influenced how participants used the prototype or whether or not they used it. Similar to Lund & Wiese's study of TMP practices of graduate students [29], we observed that none of our participants engaged in planning every day. For most, planning was a strategy for coping with additional busyness as needed rather than a daily habit. Choosing to plan (or not) varied with workload, the participant's mood, the day of the week, and the type of tasks they had.

We observed three main patterns of use among our participants:

(1) Experimentation, then abandonment: Participants who briefly experimented with the prototype, but ultimately only planned once or twice (A9,10,12, B06,11). Two participants found the tool useful; however, abandoned it due to external factors and a lack of experience with planning (A9,10). Two participants intentionally abandoned the prototype after the first few days, with no intention of returning (B6,11). However, both felt confident in their ability to complete tasks on time and planning felt unnecessary to them. Finally, A12 is included in this group, although (as previously noted) their data was largely removed from analysis due to the apparent falsification of their usage. However, the logs show that they used the prototype on the first and last days of the study - largely in line with this group's general pattern of experimentation and quick abandonment.
(2) Consistent, (nearly) everyday use: Participants who engaged in planning with the prototype consistently throughout the study (A1,3,4,6-8,B1,9). For both this group and the next, it was difficult to accurately group participants from Phase 1 since they only used the prototype for 1 full week. We categorized the participants as consistent users if their usage logs and plan exports confirmed they created a plan for every day, excluding up to two consecutive days for the weekend. This approach has obvious weaknesses, most clearly illustrated by the fact that the usage from Phase 2 over multiple weeks reveals that a participant might use the application consistently for the first week and then settle into a less frequent pattern of use (e.g., B2 or B10). Subsequently, the number of participants in Phase 1 represented in this group is likely inflated. All participants in this category had some prior planning practice, generally a concrete practice of creating a daily task list or schedule. Although everyone in this group found use in the prototype, not all intended to continue using it following the study. Notably, A1,4,7 specifically said they did not intend to use it again in any capacity because they preferred their prior methods. However, some intended to use it consistently as their primary planning tool (B1,9), while others described ways they would use it in specific situations or in tandem with other tools they were already using (A3,6,8).
(3) Off and on as needed: Participants who used the prototype off and on as needed (A2,5,11, B2-5,7,8,10). These participants planned semi-regularly, but not every day or even in a consistent pattern. Some did not open the application for several days or merely reviewed it without creating a plan, but then started using it again the following week with detailed plans. B4 had an interesting pattern where they consistently created detailed plans in three-day chunks. These chunks were always consecutive weekdays, and then usage would drop off for 3-4 days until the next spike.

5.3.4 Personal 'rules' for planning. Participants also explained different personal "rules" that they follow while planning. While these varied from person to person, the most common "rule" was that participants would generally not plan on weekends or holidays (A3,5,7,B1,2,4,9). Some participants felt planning wasn't worth the time since they had so little to do on weekends (A5,7,B2,9). Some participants intentionally resisted planning because the act of planning made the planned items feel more formal or made the day feel like it was a work-day rather than a day off (A3,B1,2,4,9). B9 explained this, "*it almost feels like I'm kind of stressing myself out ...when I don't need to and having that time to just kind of take a breather and relax ...the choice to not schedule is almost a way to give myself a break.*" Similarly, some participants avoided explicitly planning personal tasks even on weekdays because they did not want the tasks to feel like something they were obligated to do rather than something they wanted to do (B2,4).

The number of tasks for a given day or their general difficulty for the near future also commonly prompted participants to plan. Planning in these cases helped them remember what they had to do (A3,B3,4,7,8,10), start working on tasks early, or estimate the time needed for each task (B4,5,8,10). B8, for example, increased their engagement with planning when finals were approaching because, "*when a big event is coming up ...that's when I start to plan out thoroughly. When I'm notified or have a reminder, 'oh, your test is this week', then I start planning a little bit more thoroughly than I would a normal week.*" Participants also sometimes chose to avoid planning if they were not feeling productive (B5), were overwhelmed by a particularly stressful task (B2,4,9), or felt there weren't enough tasks during the day to plan around that taking the time to plan would be worth it (B2,7). Finally, some participants would plan for multiple days or even a week in the future, so their usage was concentrated on a particular day of the week and much lighter on other days (A4,6,B9).

6 DISCUSSION

In this work, we investigated the time management practices of students who use unstructured note-taking tools with the prototype *Plan*. Reviewing participants' comments about their experiences in interviews and their usage and the plans from application logs provide insight into how structure and features could impact people's planning behaviors, future opportunities for these design decisions to support users' interest in improving behaviors, and how lapsing can be better supported.

6.1 "Un"structure vs. control over structure

While we explicitly decided not to impose any particular structure on users, we found that, in fact, we implicitly did by defining what the editor represented - a single day's plan. Because the date was listed at the top of the plan, and the calendar source data was tied to the date of the plan currently in the editor, participants felt obligated to use each individual plan for a single day. This worked well for most and was cited as an advantage by some. However, it also made those with multi-day approaches to planning feel at odds with the application. In this case, our design decisions overstepped when trying to make planning easier and revealed that more flexibility should have been afforded. A potential revision might allow users to title the text box or leave the application as a collection of "notes" rather than a chronological sequence of plans. However, reducing the structure in this way might make organizing or referring back to previous plans more difficult. Another option is to provide a separate multi-day or weekly view where plans can be edited together across multiple days. This is an example of the difficult decisions designers of these tools must make when balancing flexibility and support.

Similarly, we decided to avoid making individual lines separate objects in the plan. While this makes rearranging items more complex (requiring copy-pasting rather than drag and drop), it leaves the text editing experience more natural and lightweight for users. The same effect could potentially be achieved in the future by providing a separate "view mode" — which some participants suggested — that converts the plan's text into a series of structured, manipulable objects. Based on similar suggestions from users for the option to temporarily convert their plan into a calendar-type view, it seems our participants were open to structure in general as long as they could easily switch between flexible editing and a more structured viewing if needed.

Other forms of structure could support participants specifically interested in improving their planning behaviors. While the empty text box in *Plan* was ideal for those with a clear idea of what they wanted to create, others struggled with identifying what tasks to include or even what a plan might look like. Support in the form of a suggested template with hours of the day or separate sections for events and tasks that users could paste into their plans might help address these situations. This way, the application can provide additional structure without enforcing its use or restricting other approaches. Users could also create their own templates or the system could infer them over time to make using a consistent approach or switching between a few recurring ones easier.

Additionally, suggesting text like Chang et al. did with their tool *Listpad* [11] might assist users in more easily inserting their tasks from the integrated sources, or potentially suggest broader categories of plan items that would be important to consider like upcoming assignments, self-care practices, etc. This mechanism of suggesting content could also be used to prompt users to assign times to lines with implicit times based on their position in the plan – a task in between an event ending at 11:00 AM and one at 12:00 PM might have a suggested start time of 11:15 AM.

6.2 Advancing time management tools

While some of the features implemented in *Plan* are not otherwise available in conventional notes apps, they would all be relatively easy additions to any such app. The results presented in this paper shed light on the ways participants used and appropriated these features, and can provide insight and design rationale for designers and researchers who are looking to integrate these features into their own tools. Furthermore, the features themselves provide insight into real-world, in-the-wild user behaviors that could be supported by any number of other yet-to-be-designed features.

A tension in the design of TMP tools like *Plan* is between supporting prior practices and lowering the barrier to or encouraging new ones. In this study, the snooze feature was included to support observed behaviors like delaying tasks which could be sub-optimal for planning since it facilitates procrastination in some instances. A different approach might be making tasks that were unchecked after 6 pm turn red or some other mechanism to encourage completion. While this could be an interesting approach, we found that explicitly supporting or formalizing the existing behavior of snoozing helped participants feel less guilty about doing it when they felt it was necessary, prompted reflection about why certain tasks were being snoozed repeatedly and helped them still use their plans effectively when feeling overwhelmed. In other words, supporting existing behaviors helped some participants save time and helped them think about those behaviors. This also demonstrates how a TMP tool served as a PI tool, prompting reflection and helping users to gain self-insight [28].

In addition, supporting these behaviors in the tool helps the system confidently detect when the user is engaging in them. For instance, snoozing may present opportunities for assisting users in breaking down tasks they are struggling to complete or evaluating why they are repeatedly put off. Similarly, the formatted times and checkboxes provide ways for the user to reliably communicate metadata about plan items while also making it easier to create the plan in the first place. This is preferable, compared with a structured approach where a user is asked to enter metadata in separate fields of a popup when trying to jot down a task or event for the day quickly.

6.3 Accounting for lapsing

Reasons for not using a planning tool consistently can range anywhere from preferring the feeling of paper to being frustrated with recurring unhelpful suggestions. The effectiveness of a tool for someone is not purely about the functionality or quality of the tool itself but also how it fits into the person's pre-existing habits, their collection of tools it must work within, and even how they perceive using the tool will reflect on them. As reported in Section 5.3, some participants liked the TMP tool; however, they would only use it following the study with a companion desktop version. Others ultimately opted for prior tools because they preferred the mobility and always-on nature of sticky notes – a feature set a mobile application is incapable of providing with current technology.

Besides more fundamental incompatibilities, our work shows that, for the planning domain, lapsing was a conscious choice for many users. They either felt they did not need the support planning provided, or they did not want to feel like support was required

(e.g., on weekends or for personal tasks). In other words, participants were not so much lapsing as they were only using the tool when needed. With this in mind, a TMP tool that can track when plans are created could help individuals reflect on what situations they regularly need support in to more accurately decide whether to plan. The system could proactively prompt people based on their prior patterns rather than aiming for everyday use.

Another important implication is that, for at least some participants, the value of interacting with planning came from plan creation rather than reviewing plans throughout the day. This suggests that the best opportunity to intervene or reflect with this group is when they are planning rather than looking back. Users might be prompted to consider how they would react if their plans were disrupted by something unexpected or to reflect on why they are making the plan the way they are or what things are most important. While an ideal intervention would come at just the right time to keep someone on track with their plans, it can be very challenging to identify that time accurately; if an intervention comes at the wrong time, it can have negative impacts on the user and may also result in a less useful tool.

7 CONCLUSION

We have shown that semi-specialized tools like *Plan* can be an effective next step beyond general-purpose tools. They can deliver the added value of specialized tools by leveraging domain conventions, making interactions easier, nudging users towards better practices, and centralizing and giving more informed context to a user's data. They can also do this without significantly altering the general-purpose style interface and affordances or requiring burdensome input methods and strict structuring that are significant barriers to users being willing to adopt tools specialized for their target tasks. They represent a valuable approach to exploring ways to better support individuals in tasks where people consistently opt for general-purpose tools even when specialized ones demonstrate clear utility.

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