‘Don’t Waste My Time’: Use of Time Information Improves Focus

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ABSTRACT
Maintaining work focus when on a computer is a major challenge, and people often feel that they use their time ineffectively. To improve focus we designed meTime, a real-time awareness application that shows users how they allocate their time across applications. In two real-world deployments involving 118 participants, we examined whether greater awareness of time use improves focus. In our first deployment, we provided awareness information using meTime, to both office workers and students. Exposure to meTime reduced use of social media, email, browsing and total time online. However increased awareness didn’t affect time spent in productivity applications. A second educational deployment largely replicated these results and showed that meTime also reduced users’ perceptions of their ability to focus effectively. Changed perceptions were associated with higher class grades. We discuss practical and theoretical implications as well as design principles for use of time applications.

Author Keywords
Focus; awareness; use of time; intervention; productivity; task switching; behavior change.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Maintaining work focus when using a computer is a major challenge. Computers support many different applications, and users may be unaware of the accumulated time they spend in non-critical activities. Repeatedly checking IMs, texts, email or social media can compromise productivity [1,5,6,10,33] and induce stress [9,19,20,31]. To improve work focus, we developed a real-time awareness application called meTime. MeTime presents users with a simple visualization of their recent use of time across different applications (See Fig. 1). We explore whether greater awareness of time use can change behavior, improving people’s focus when using computers.

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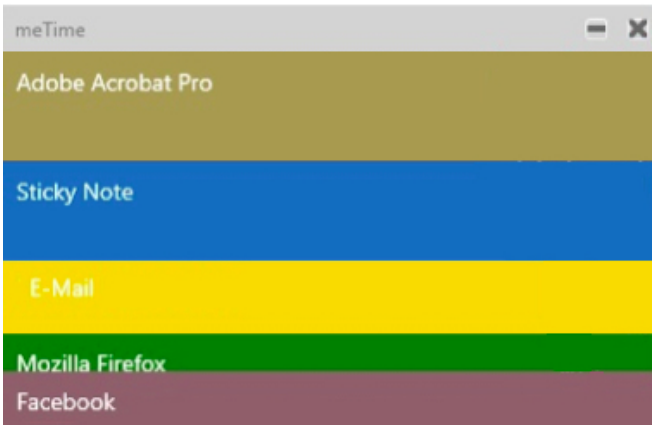

Figure 1: meTime screenshot showing use of applications in the last 30 mins. Row height shows the relative time in each application. Most used applications are Acrobat, Sticky Note and E-mail, with Firefox and Facebook being used less frequently. Application is always visible on screen.

Many work tasks require access to multiple sources of information. Maintaining focus is often difficult when users have to integrate information across applications [13]. Writing a document might involve opening a word processor, accessing email, conducting web research and incorporating spreadsheet data [13,17].

However, application switching is still commonplace even when information integration is not *required* by the work task [1,5,31]. Users frequently interrupt their current task for non-critical activities. They check email, texts and social media even when there is no informational requirement to do so [17,19,32]. More significantly, these *optional* focus shifts reduce productivity. Research in educational settings shows that students who access instant messages, texts, videos or Facebook during work sessions show reduced understanding, lower memory for class materials, poorer quiz scores and lower grades [5,6,24,25]. For example frequent texting during class reduces memory for lecture content by 27% [10].

This prior work documents the prevalence and consequences of lack of focus, but less attention has been paid to how these negative effects might be mitigated. Early promising interventions include behavior modification, such as email fasts [19] and mindfulness training [15]. Our approach is different. Instead we use technology to provide users with real-time awareness data about how they spend their time online, and we examine whether such awareness information improves user focus.

Despite technology contributing to the focus problem, there are reasons why technology might help. It is relatively easy to design automated methods to provide detailed awareness information about use of time. Many existing applications provide use of time data allowing people to audit their computer activities [2,11,12,22,27,28,29]. However these are commercial products and there are few evaluations of their effectiveness, or explorations of how and why they might help focus. We therefore designed, deployed and evaluated our own awareness application. MeTime is a simple always-on visualization showing how much time users have recently spent in different applications.

We evaluated MeTime in two real-world deployments, involving office workers and students. Our first goal was to examine whether awareness information changed people's use of computer time. Does knowing how much time you spend in Word or Excel change how you allocate time to those applications? And does information about time in non-critical activities like Facebook lead participants to more actively focus on work? A second goal was to see whether awareness information changes people's perceptions of their work habits and whether awareness changes habits and performance. A final goal was to identify design principles for use of time applications.

We explore whether providing people with awareness about their use of time:

- Improves work focus by reducing the time users spend in social media, browsing, email, and overall time online;

- Changes people's perceptions of how effectively they use time and whether these changed perceptions relate to improved work performance.

Our contribution is to provide increased understanding about the challenges of online focus and how awareness might address these. We provide a technical solution in the form of an awareness application that helps focus. We offer evidence for its success in reducing the time users spend in non-critical activities and we state new guidelines for the design of use of time applications.

RELATED WORK

Use of Time Technology

Many recent applications attempt to improve work focus by providing information about personal use of time. Applications include simple timers, blockers of undesired distracter activities, promoters of desired activities and hybrid applications that combine these.

Timers: Simple timer applications like *FocusBooster* [12] aim to facilitate focus for a set interval. Users specify the time for which they intend to focus. They are alerted when that time is over, but no attempt is made to track what they actually do during the interval.

Audits: Other simple programs track and visualize online activities. *Tracktime* [29] audits overall time spent in each application. It also provides a timeline to show when shifts occur between applications, to alert people to frequent multitasking. However the main goal is to assist in logging billable hours rather than to promote real-time awareness.

Distracter Blockers: Other applications like *Anti-Social* [2] prevent access to pre-specified distracters. Some blockers can also be configured to block distracters for a specified interval during which people want to focus (e.g. *no Facebook for next 30 mins*). Other blockers such as StayFocusd [27] allow users to specify daily thresholds that limit the cumulative time users can access distracters. Users might therefore specify a maximum of 45 minutes per day in Facebook after which the site becomes inaccessible.

Hybrids: These applications combine timers, blockers and activity promoters. *Focus* [10] combines activity blocking and promotion. It allows users to privilege some applications while downgrading others. Selecting a predefined 'writing' activity might therefore allow word processing and notes programs but shut down email and browsers, setting IM status to 'away'. *RescueTime* [22] combines multiple use of time features. It provides targeted audits for time spent in predefined 'challenging' activities such as emails or meetings, alerts for time spent on a specific activity, website blockers to maximize 'productive time', daily 'highlights', and daily and weekly audits. *Timestats* [28] audits time spent on websites, providing alerts and blockers if user-defined thresholds are exceeded.

Despite this impressive range of use of time applications, few are in widespread use, and one aim of the current paper is to understand reasons for this lack of uptake.

Empirical Studies of Time Use: The Prevalence, Causes and Consequences of Attention Fragmentation

Prior empirical research has explored time use, particularly focusing on online multitasking in the context of multiple media. This research concludes that online attention is fragmented; people seldom focus on a single application for more than a few minutes. Other research examines *why* attention shifts are so common.

Prevalence of Attention Fragmentation: Many recent studies of time use reveal frequent application switching both at work [13,17,19] and at school [5,6,23,25]. For example Gonzalez and Mark [13] showed that office workers spend about three minutes on an application before switching, shifting between unrelated projects every 12

minutes. Rosen et al. [25] found the average time between application switches for high school and college students was 6 minutes when doing homework.

Consequences of Fragmentation on Work Performance and Mood: Many correlational studies show relations between fragmented attention and decreased work performance. Most of these studies examine students who self-interrupt to monitor social media during homework or class. Students who often use Facebook during homework sessions have lower GPAs than non-users of Facebook [5,25]. Those who often text or IM during homework also have reduced GPAs [6]. Experimental studies confirm these results. Several studies compare memory for lectures between groups of students who were required to respond to texts during class, with others who had no access to texts. Students responding to 3 texts during class remembered material worse than students who did not [10], although other studies required more intensive texting to demonstrate negative effects [24]. Students accessing Facebook or IM during class also perform worse on tests than those prevented from access [5]. Students who watch background videos while studying demonstrate impaired homework and memorization performance [18].

The relationship between multi-tasking, social media use and mood is complex [31]. Short social media breaks improve mood, but more frequent media usage reduces productivity, inducing greater stress and negative mood. And people who often multi-task show increased stress and reduced positive affect [20].

Causes of Fragmentation: Task switching often occurs at work because complex tasks require data integration across multiple applications [13,17]. And workers who collaborate intensively have to frequently access communication tools, which can distract as users are tempted to respond to off-task messages [9,19]. Other times, people may self-interrupt because they are frustrated or bored by their current task [1,17,32], as evidenced by the fact that task switching occurs during low rather than high workload [3]. Fundamental attentional biases may also make it hard for some people to focus. Ophir et al [21] investigated media multitaskers, defined as those who typically access multiple concurrent applications. Media multitaskers have fundamentally different attentional processing from those who tend to focus on a single application. Media multitaskers are more distractible; being less able to filter irrelevant environmental stimuli or suppress irrelevant information from memory. Strikingly, they are also less able to switch tasks when required to do so.

Improving Focus: While much research documents the extent and causes of fragmentation, fewer studies attempt to *improve* focus. Some interventions aim to improve focus by blocking access to distracters, e.g. by imposing email 'fasts'. Blocking email helps people to focus longer on tasks, plan more and it reduces stress [19].

Other promising interventions suggest that increasing people's awareness about their use of time may also help focus. People focus better if they are automatically alerted when they switch tasks [26]. And monitoring use of time on social networking sites both reduces stress and increases satisfaction about using those sites [7]. These findings are important because they suggest that people *lack awareness* of how they are allocating their attention. Results imply that technology interventions that improve awareness may be beneficial, which is what we explore in our current study. However actively alerting people when they shift attention may itself be distracting. Our prototype, meTime, therefore presents people with an always-on display depicting how they are currently allocating their time. We evaluate whether this increased awareness improves work focus.

REQUIREMENTS ANALYSIS TO MOTIVATE THE DESIGN OF THE BASIC METIME PROTOTYPE

To inform the design of meTime, we carried out 12 semi-structured user interviews to better understand problems with online focus and time use. We also wanted to solicit reactions to a simple awareness prototype that we had designed. Interviewees were 5 office workers (aged 26-53) and 7 university students (aged 20-26). Office workers' occupations included scientific research, management, university teaching and software development. Students were drawn from science, social science and humanities.

Dissatisfaction About Use of Time

Participants found it difficult to track how they spent their time, expressing dissatisfaction with their overall use of time. They also complained about losing focus. Often this was because they spent too much time on non-critical activities. Specifically they reported a lack of awareness when using social media, browsing or email. One action leads to another, and before they realize it participants discover that large amounts of time have been lost:

(P4) It's very difficult to be aware of things, you dip into email for 10 minutes but you might be unaware that half the day has gone in there if you keep doing it…With the browser it's easy to get absorbed in a cumulative aspect when you start on one page and then several links down the road you have wasted an hour or so.

These shifts to non-critical activities are sometimes triggered by a lack of progress on a core work task. Participants are blocked, and so 'take a break' to access email or social media, confirming other work on motivations for task switching [1,3,32]. These breaks often consume far more time than expected:

(P7) a lot of time when I switch, it's because I am blocked, and rather than face that block it's easier to do something else. The switching is bad for me, if I cant solve a problem then I do something else more pleasant, but you have to know that you've got to get back on task after a bit.

meTime Design Features

To address focus problems, we elicited feedback from interviewees to an early working prototype that showed a simple visualization of recent use of time data. We began with this minimal design rather than more complex designs that included activity blockers/promoters. Our belief was these more complex designs presuppose that users have insight into their use of time - insight they may lack. For example, users may not know enough about their common distracter activities in order to program blockers. In our later deployments we do however elicit user reactions to these more complex designs.

On the basis of user feedback we iterated our design to arrive at a minimal application to support awareness about use of time. Fig. 1 illustrates the final meTime design. It shows time spent in the five most active desktop applications in the past 30 minutes. When a new application is launched, it appears as a uniquely colored band at the top of the display. While an application window remains in active focus the height of its corresponding band increases, such that the height of each band represents the percentage of time spent in its associated application. meTime continuously monitors active application window titles, and extracts the application name from these. For web browsers, each browser tab is monitored individually to disambiguate between different browsing activities. Social media and popular email sites are displayed as individual applications (e.g. Facebook or Gmail) while other sites are grouped in the display in terms of browser (e.g. Firefox).

Our prototype contains the following design features. We present user comments motivating each feature.

Recent activities: 11/12 interviewees wanted to know about *recent* time use, as opposed to long-term cumulative weekly or monthly audits. MeTime therefore shows the last 30 mins. of activity, based on user estimates about their optimal monitoring interval. Although 9/12 participants were also interested in long-term time use, they saw lack of awareness about *current* activities as their primary problem: *(P9) Sometimes I am in a painful mode of denial. I seem to be totally unaware that I am off track, I wake up and realize than I have been on Amazon for 45 mins!*

Simple interface presenting high-level information: All 12 interviewees agreed that they did not want the interface to distract from productive work, so it was designed to be simple, showing high-level, rather than potentially distracting detailed information. To reduce complexity, we showed the relative usage of 5 applications without detailed statistical or numerical information: *(P10) Browser, word processor, email, social network, spreadsheet – that would do it – I want to see basic feedback about those.*

Always on: The UI was continuously visible, as we did not want users to have to activate it themselves. Deciding to activate the application requires awareness about focus, which interviewees said they often lacked. Deliberately deciding to activate the application might also distract from work tasks thus defeating the overall purpose: *(P5) I want a continuous display not something I have to think about* and *(P12) it can't be covered by other windows, otherwise there's no benefit.* Consistent with this desire for an always-on display, 10/12 interviewees also rejected attention-diverting popups (e.g. 'you have been in Facebook for 18 minutes'). Participants felt these would reduce focus*: (P1) if it was a popup it would be another interrupt*.

A final important characteristic of meTime was that we did not want participants to feel that their activities were being publicly monitored. Activity logs were therefore stored locally on users' machines. Later we discuss how users shared their logfiles for our study.

Our next goal was to deploy this simple prototype to see whether awareness information changed people's use of computer time and work habits.

INTERVENTION 1: METIME AWARENESS REDUCES NON-CORE ACTIVITIES, BUT DOES NOT INCREASE WORK TIME

We wanted to determine whether increased awareness about time use changes how people allocate their time. We deployed meTime in a real-world work setting. To explore the effects of awareness information, we compared computer usage for two types of workdays: (a) *intervention* days where people had access to meTime awareness data and (b) *non-intervention* days with no awareness data. We logged all online activities in both contexts.

We examined two different populations: students and office workers. Both groups were engaged in everyday work. We assessed whether using meTime affected how they allocated their computer time. Specifically, did awareness information prompt participants to reduce time spent on non-critical activities and increase time on work tasks?

Method

We recruited two sets of participants, 17 office workers (mean age=37.4, Female=5) and 44 students (mean age=21.4, Female=32). They were asked to use their computer for two complete days with awareness information and two days without. We logged all activities on those four days. Students were recruited from an HCI class and received credit for participation. Office workers were recruited from a software development company. They included software developers and designers.

Participants installed meTime after we had given them a quick demonstration. On *intervention* days, they ran the meTime application, which was constantly visible showing their recent activity across different applications. On *non-intervention* days, participants didn't have access to awareness information about their use of time. However on non-intervention days we still automatically logged all their activities. This meant that we could directly compare participants' activities with and without awareness information. Participants were aware that their activities

were logged on *non-intervention* days. All data (whether from intervention or non-intervention days) was collected on weekdays rather than weekends, as we wanted to assess the effects of awareness on work-related behaviors.

Participants were asked to work normally, whether they were running meTime or not. To respect participants' privacy when sharing personal data, we followed an approach taken in other similar studies that collected personal data [16]. We showed participants how to access their logfiles which were simple editable textfiles. Before participants shared logfiles with us, we encouraged them to review those files, removing information they did not wish to share. Although this meant that records were occasionally incomplete, we felt this was a reasonable compromise to satisfy privacy. To control for possible order effects, half the participants (N=31) began with two intervention days and half began with non-intervention days. We included the entire 24-hour day in our analyses. We considered analyzing only the core workday, but it proved difficult to define this exactly. Pilots with participants who completed activity diaries indicated that, consistent with much recent research [28], people often work irregular hours around the clock, making it hard to define a consistent core period that represented work time across all our participants.

Participants completed a post-intervention interview, which probed how they used meTime and how it changed their work-related versus non-critical behaviors. We also asked how meTime's design might be improved.

Results

Data analysis

Logfile analysis using Python allowed us to compute for each participant per day: (a) which applications were active and (b) how long each application was active. Overall, participants used a huge variety of applications, including productivity apps (e.g., Word), email, IM, social media, browsing, programming environments, music, videos, photographs and so on. The majority of tracked applications were used by a very small number of participants. Our analysis focused on the most common applications used by at least half of the participants.

To analyze these more frequent applications, we first ranked all applications in terms of their frequency of usage across all participants. This allowed us to identify the most frequently used 11 applications. We chose these 11 because each was used by more than 60% of participants, whereas the next most used application was used by just 40% of participants. We sorted these 11 applications into the following categories: (1) productivity (2) browsing, (3) email, (4) social media (Facebook) and (5) reading. *Productivity* applications included word processing, presentation and spreadsheet software. *Browsing* involved three browsers (Chrome, Firefox, Explorer, no-one used Safari). *Email* involved both corporate email and personal accounts (Gmail and Yahoo! Mail). Web-based email and Facebook usage were treated separately from other web-based activities, with *Facebook* treated as its own category and web-based email incorporated with other email data. *Reading* was assessed by the use of Adobe Acrobat. Our analysis excludes music and video. Program tests showed that meTime underestimated usage because, as our participants confirmed, these applications were usually run in background mode once initiated, and were thus not continuously detected by meTime. Another important characteristic of our data is that participants were often multitasking, which is confirmed in our surveys. Including browser tabs, on average participants had 12.18 applications open during each 30-minute interval.

Metime reduces time in non-critical applications and total number of applications used

Table 1 shows how meTime affected computer usage. Overall time data are similar to other studies that record online media usage [23]. We conducted a 2 *awareness* (meTime/nomeTime) X 2 *order* (meTime first/second) X 2 *role* (student/office worker) repeated measures MANOVA with the dependent variables being time in each application type (Facebook time, email time, browsing time, reading time, productivity time and combined time in all other applications). *Awareness* is a within subjects variable.

As we expected, *awareness* (i.e. using meTime) reduces total time across all applications (Pillai's trace, V=6.090, $F(6,54)=26.427$, p=.00006). Table 1 shows means, standard deviations and effect sizes. Univariate analyses for each application show that using meTime reduces time in *Facebook* ($F(1,59)=4.195$, p=.045), *Email* ($F(1,59)=21.392$, p=.0002), and *Browsing* ($F(1,59)=5.344$,p=0.024). MeTime reduced overall time by 28%, *Facebook* time by 44%, *Email* by 30% and *Browsing* by 21%, and these effect sizes were medium to large. However, contrary to our expectations, meTime did not reduce time in *Productivity* applications ($F(1,59)=0.185$, p=.669). MeTime did not reduce *Reading* either ($F(1,59)=0.346$,p=.559). There were no order effects ($F(1,59)=0.219$,p=.641).

The MANOVA also suggested that meTime had different effects on office workers and students. There was an interaction between *role* and *awareness* ($F(6,54)=5.901$, p=.0009), with workers reducing their total time online (*M1*=697.992, *M2*=932.247) more than students (*M1*=513.127, *M2*=704.693). A post hoc Tukey test on the univariate analysis showed a significant difference at $p<.05$ between students and office workers in using email when running meTime, with meTime reducing time in email for workers but not students. No other univariate analysis showed interactions.

A second analysis examined whether meTime reduced the total number of applications used. We conducted a 2 *awareness* (meTime/nomeTime) X 2 *order* (meTime first/second) X 2 *role* (student/office worker) repeated measures ANOVA with the dependent variable being total

		Facebook	Browsing	Email	Reading	Productivity	Total time
Awareness Information	Avg # mins	15.690	124.211	48.688	141.484	57.048	569.143
	Standard dev	*9.663*	*40.248*	*26.856*	*69.163*	*43.776*	*278.754*
No Awareness Information	Avg # mins	28.079	158.403	69.086	194.406	55.376	787.753
	Standard dev	*19.635*	*52.254*	*43.776*	*69.124*	*26.856*	*443.761*
F		4.195	5.344	21.392	0.346	0.185	26.427
Significance: p value		**0.045**	**0.024**	**0.002**	0.559 (ns)	0.669 (ns)	**0.00006**
Effect size η^2		0.068	0.083	0.266	0.006	0.003	0.746

Table 1: Awareness information reduces time in Facebook, browsing, email and total time online. Table shows average times in minutes per day in different applications with and without awareness information, as well as standard deviations, statistical tests and effect sizes for comparison between awareness and no awareness. Significant results are in bold.

number of applications, and with *awareness* being a within subjects variable. MeTime reduced the total number of applications participants used by about 27% (Pillai's trace, V=5.872, F(1,59)=24.364, p=.00007, *M1*=24.194, *SD1*=1.813, *M2*=35.725, *SD2*=2.144, η^2=.292). Again there was an interaction between *role* and *awareness* (F(1,59)=23.627, p=.00009); workers used fewer applications with meTime. There were no order effects (F(1,59)=1.57, p=.214).

Follow-up Interviews: meTime Reduces Time on Non-Critical Tasks and Aids Focus

We next analyzed responses to follow-up interviews, where we asked participants to describe their use of meTime and to contrast their behaviors before and after the intervention.

Almost all participants noted the general benefits of increased awareness to better track what they were doing on their computer: *(P13) I was able to see what I spend most of my time doing* and *(P7) It helped me keep track of what I was doing.* Consistent with our quantitative data, meTime offered obvious insights to participants about non-critical activities. MeTime in particular helped students to reduce non-critical 'breaks' and focus better during longer intervals allocated to work*:*

(P34) I did learn a lot. I really learned that if I want to take a break it can't be using other applications on the computer because I get too distracted and lose track of time.

The fact that meTime monitored their activities helped some participants to control their impulse to wander off-task: *(P2) I stopped going into 'inappropriate' sites because it was like I was being watched.*

For office workers, meTime helped keep track of time spent in email. Many comments echoed the following:

(P53) when I am working, I have a lot of distractions and check my email constantly but I have no idea how much time I spend doing that. With [meTime] I can tell how much of this chunk of time was spent doing email.

However, meTime provided other benefits in addition to detailed breakdowns of recent time use. meTime also helped clarify people's current goals, serving to better motivate them. One participant stated that the mere fact of seeing the meTime display reminded her that her current aim should be to focus on work:

(P44) I did notice experiencing heightened awareness of my work practices. Seeing the meTime window reminds me that now is a time when work should be done ... that change of mindset has effects that are separate from benefits obtained from analysis of the data produced by meTime.

Overall, our first meTime intervention suggests that providing awareness about use of time changes online behavior. With meTime, participants reduced time in email, social media and browsing activities. They also spent less time overall using their computer, and used fewer applications. However, greater awareness did not increase time in productivity activities. This failure to increase work time may occur because participants are already very aware of time spent on their work tasks. Instead, their problems may lie in tracking time spent in non-critical activities. Differences between students and office workers may result from students receiving fewer emails, making this less of a distraction.

INTERVENTION 2: AWARENESS CHANGES STUDENTS' PERCEPTIONS OF FOCUSING ABILITIES WHICH RELATE TO HIGHER GRADES

We next explored whether: (a) greater awareness of use of time would change people's subjective evaluations of time use and (b) such changed perceptions relate to measurable improvements in work performance. A final question addressed whether awareness needs to be provided computationally, or whether manual journaling induces equivalent effects. To explore this last question, we tested two different methods for supporting awareness, (a) *automatic*: by running meTime and (b) *manual logging* where participants entered activities into a diary. We explored all questions in an educational context, measuring student productivity by assessing their end-of-quarter grades. Specifically we evaluated whether changed perceptions of time use related to better class grades.

Method

Participants were 57 students (mean age=20.8, Female=39) enrolled in a Computer Mediated Communication class. The study involved three phases: a Pretest Survey to assess participants' initial perceptions of their ability to focus (*Use of Time Survey*); an intervention where students worked with and without awareness information; and a Posttest on the Use of Time Survey. As before, during the intervention, participants monitored their activities for two workdays while carrying out everyday computer activities, and

worked for two days without awareness information. Thirty-four participants monitored using meTime and 23 monitored manually by entering use of time data into a journal. We collected students' final course grades to see whether changed perceptions about time use related to improved class grades. As before we collected logfile data.

Pre Intervention Measures: We developed a short questionnaire we called the *Use of Time Survey* to assess participant perceptions of: (a) *Strategies* for staying on task: participants gave Likert responses to the statement '*I have specific strategies for helping myself stay on task'*; (b) *Time on task*: participants stated how long in minutes they typically worked on a task before shifting their attention elsewhere; (c) *Multitasking* effectiveness: Likert responses to the statement '*I am good at multitasking'*.

Awareness Interventions: All participants worked two complete *intervention* workdays when they actively monitored their activities, and two *non-intervention* workdays when they did not. This allowed a within subjects comparison. We also compared *manual* and *automatic* awareness as a between subjects comparison. Students assigned to the manual intervention kept a diary of their work habits. They set a timer and manually logged their activity at 20-minute intervals throughout the day, while they were awake. They wrote a phrase describing their activity for that interval ('researching journalism essay', 'watching a movie'). We chose a 20 min. monitoring interval to trade-off compliance and awareness. Shorter intervals would have reduced compliance but longer ones reduced awareness. Students assigned to the automatic intervention used meTime. Half the participants (n=29) carried out awareness monitoring before their two regular days, and half monitored after their two regular days.

Post Intervention Measures: In addition to administering the post-test *Use of Time* survey, we recorded students' final grades on the class. After the course, participants completed a survey where we asked them to write about whether and how awareness changed their work habits.

Results

Monitoring Changes Perceived Ability to Focus

Table 2 shows survey responses before and after the intervention, indicating that the intervention changed participants' perceptions about their ability to focus. After the intervention, they judged themselves as having less effective strategies to stay on task (*Strategy*) ($t(56)=2.302$, $p=.025$) and were less confident about their ability to multitask effectively (*Multitasking*) ($t(56)=-2.491$, $p=.019$). However there were no changes in perceptions of uninterrupted *Time on Task* ($t(56)=-1.549$, $p>0.05$). MeTime and manual logging were equivalent with no differences between awareness method for any of the questions (all ps>0.05).

Changes in Perceived Effectiveness of Focusing Strategies Correspond With Better Grades

We then using linear regression to: (1) evaluate the relationship between changed perceptions of time use and final grades; and (2) whether there were grade differences between participants using meTime compared with those who manually logged. For each participant, we computed the changes in their responses to the 3 survey questions following the awareness intervention. We regressed these changes against final grade, coding awareness method (meTime vs diary use) as a dummy variable. The overall regression was significant ($R^2=.085$, $p=.041$), with students who reported fewer strategies for staying on task having higher grades ($t(55)=2.174$, $p=.034$). Other survey responses were not related to grade. Manual (diary) versus automatic awareness (meTime) also had no affect on grade ($t(55)=.341$, $p>.05$).

Monitoring Reduces Time in Off-Task Activities

We analyzed logfiles for the 34 students who used meTime for monitoring. We used the same analysis techniques as Study 1. Consistent with the student sample in Study 1, a MANOVA showed *awareness* (i.e. using meTime) reduces total time across all applications ($F(6,27)=3.147$, $p=.018$, $M1=543.26$,$SD1=153.31$,$M2=603.48$,$SD2=168.64$, $\eta^2=.07$). Univariate analyses for each application show that using meTime reduces time in *Facebook* ($F(1,32)=4.633$, $p=.039$, $M1=32.28$, $M2=53.25$) and *Email* ($F(1,32)=4.737$, $p=.037$, $M1=52.33$, $M2=98.39$). Again, meTime did not reduce *Productivity* application use ($F(1,32)=0.113$, $p=.739$, $M1=85.34$, $M2=84.28$). There were no order effects ($F(1,32)=0.047$, $p=.828$).

	Pre-intervention Mean, (SD)	Post-intervention Mean, (SD)	t test	p
Strategy: I have specific strategies for helping myself stay on task (1=disagree, 5=agree)	4.403 (1.311)	3.818 (1.346)	2.302	.025
Time on Task: How long do you typically work uninterrupted on a work activity (minutes)	24.928 (12.788)	25.226 (14.137)	-1.549	.899 (ns)
Multitasking: I am good at multitasking (1=agree, 5=disagree)	4.017 (1.529)	4.751 (1.539)	-2.491	.019

Table 2: Effects of awareness on perceptions of use of time and wor strategies. Survey responses show awareness decreases participants perceived ability to multitask effectively, and their perceptions of th quality of their focusing strategies. There are no effects on self-repor task time.

Insights about Focus and Changing Long Term Habits

Participant comments in the exit survey corroborated the survey and logfile data, suggesting that both manual and meTime awareness changed people's perceptions of their use of time. As in Study 1, awareness reduced the amount of time spent on unproductive breaks. The following comments are from participant P26 who logged his activities manually:

(P26) On Day 1 [a non-intervention day] I did take a few breaks where I played chess or browsed Facebook, usually for 15-20 minutes. Day 1 was most consistent with my normal workdays pre-study, but ***reflecting on it did serve as an eye opener****. By the end of my first day of awareness logging****, I spent much less time engaging in unproductive breaks*** *and spent the majority of the time focused on task. Having to hold myself accountable through* ***recording a log made this epiphany all the more apparen****t. As a result, both [intervention] days had far fewer breaks and much more time spent on task.*

Participants talked about how the intervention caused them to change long-term work habits, including devising new methods to remain focused:

(P3) I ran meTime while studying for midterms, so I had an extra incentive to stay on task and find good strategies. Another strategy is to be able to ***recognize 'trouble' websites****, and* ***consciously make a decision to avoid them*** *while studying.*

Participants saw important benefits regardless of whether monitoring was manual or automatic. However one important difference was the perceived effort each required. Manual loggers felt that monitoring was onerous, adding another (potentially distracting) activity to their workload:

(P14) if the logging is not an automated program then it becomes a task in and of itself, and poses the same problems as multitasking. The manual method is less effective both from the standpoint of accomplishing work and logging itself.

Overall Study 2 replicates and extends Study 1. Again we found that awareness reduces times spent in non-critical activities. New results showed that monitoring interventions reduced participants' perceptions of their ability to focus. Reduced perceptions correlated with better grades. This may suggest that some people are better able to learn from their awareness experience and deploy this learning to improve work practice. However it may be that brighter students are also those with greater monitoring awareness.

Design Feedback

We also conducted semi-structured interviews with 23 participants drawn from both studies to explore reactions to the design. Participants largely judged the meTime design positively but made suggestions for improvement.

Our 'always on' design approach was judged as effective by 15 participants: *(P12) I like the interface because it's not intrusive. it's there doing its own thing. I can look at it when I want to.* However a minority of participants (8/23) felt this constant visibility to be distracting. MeTime couldn't be minimized and this sometimes required careful window management to execute complex tasks: *(P8) It contradicts [meTime]'s purpose of staying on task - sometimes I was only off task because I had to move the window.* We therefore asked participants whether they might prefer the application to run in background mode, with popups being triggered after a specific time. Supporting our original design goals, the majority of participants (17/23) rejected popups, recognizing the benefits of continuous information: *(P4) Popups would be annoying. I would probably just ignore [them].* Some participants noted that the constant presence of the application is itself a reminder to stay on task and to be more aware of time use: *(P18) Having it constantly there is good – it's like asking you: why are you not working?* However the fact that a small minority favored popups, confirms other work showing individual differences in awareness preferences [8].

Currently meTime tracks *all* activities, but 5 participants instead wanted meTime to focus on logging specific 'time-wasters' (e.g. Facebook or browsing specific media sites). These participants also stated that they would be willing to actively customize the application for this purpose. Five participants wanted goal-oriented tracking of critical tasks: *(P5) I'd like to set a goal and see how I did. I have difficulty estimating time, so if I could click into something that tells me I only wrote 3 decent pages during a time unit, or this long to revise, then I can plan around that.*

MeTime was designed as an information presentation application, leaving the user to decide what actions to take. Most participants judged this as appropriate, but a small minority (4/23) felt that meTime should also proactively block undesirable applications. Three participants requested conditional alerts associated with overruns of non-critical activities: *(P22) when I spend over 20% on email it should popup to tell me that I am wasting my time.* Just one participant wanted the application to actively shut down distracter activities if a predefined threshold was exceeded.

One clear limitation of meTime noted by 15/23 participants was its under-specification of web activities. Activities other than web-based email and Facebook were logged as generic browsing. These participants wanted to know more about what they were doing during a browsing session: (*P19) all it says is 'Chrome', but I want to know what I was actually doing all that time.*

MeTime targeted recent behaviors and this was viewed as effective by 15 participants. However 8/23 participants also noted the benefits of long-term analytics over entire work-weeks or comparisons between different times of day. They felt that such data could allow them to more efficiently manage their time, e.g. allocating important activities to times when they were most productive: *(P18) I would like*

self-calibration, so if I am inefficient at night then I would know that…At the moment I take a break in the middle of the day but is that most efficient? I don't know. Three participants wanted analytics to identify when they were behaving in unusual ways compared with their normal habits*: (P3) I want to compare myself – my grid today looks worse or better relative to other days etc.*

This design feedback generally vindicates our 'always on' information presentation approach. A few participants argued for more interventionist methods such as interrupts, active blockers, or alerts when off-task. However these participants were in the minority. The main perceived limitations arose from the lack of specificity about web activities and the absence of long-term data, which would allow reflections on productivity patterns or habits.

DISCUSSION AND CONCLUSIONS

Overall our results are promising. MeTime improved the efficiency of time use. In both deployments, a simple 'always on' application showing recent time use successfully reduced time spent in non-critical activities and overall time online. However meTime didn't increase the absolute time spent in productivity applications. Study2 also suggests a possible association between changed awareness and productivity assessed by grades.

Both studies show that awareness information reduces time in non-critical activities, but it doesn't increase productivity time. Clearly participants have difficulty tracking time when taking breaks or answering emails. However our interventions suggest that although participants exploit awareness information to reduce non-critical activities, they do not re-allocate that reclaimed time to work. This may indicate that participants set thresholds for how long they are prepared to work but are flexible about the total amount of time they spend online each day. However different system designs could draw attention to this choice. Such designs might motivate people to use reclaimed time for work, allowing people to be more efficient, spending less overall time at work by reducing breaks.

However our research has several limitations. Like much research on media, we have focused exclusively on computer usage. Many people now spend large parts of their day online using phones and tablets, and phones in particular are known to distract [5,23]. Future work needs to also collect data from these devices. Our logging measures could also be made more sensitive by tracking keystrokes or scrolling to signal engagement within an application. In addition, our analysis excluded multitasking involving video and audio, which is common [23] and may influence productivity [18]. We also need more sensitive outcome measures to assess the effects of time use on work quality. Study2 used class grades, but these have limitations. Future work needs to assess more general measures of productivity, and explore long-term effects. Study2 also used correlational methods, making results suggestive at best and controlled interventions are needed to establish causation. It is also possible that effects are due to simple mindfulness, with the intervention leading participants to become more aware of their use of time, rather than participants modifying behavior based on detailed information offered by meTime.

The two studies also increase our understanding of the reasons underlying lack of focus. Consistent with other work on behavior change [4,14], enhanced awareness promoted more effective behaviors. Both technology and manual awareness reduced time on non-critical tasks. This suggests that users may experience a general cognitive problem in monitoring time use. However Study2 indicates that this deficit may be reduced by exposure to awareness data, possibly allowing people to adjust work habits. Future work should also explore trade-offs between the benefits of active manual monitoring and the additional work this imposes. For example a less frequent monitoring interval could reduce monitoring workload while still maintaining awareness benefits.

Our findings also inform the design of use of time technology. We found that simple presentation of use of time information was helpful. This contrasts with many current commercial applications that aim to improve focus that incorporate more complex features such as alerts, blockers, habit comparison and temporal thresholds for time-wasters. Such applications are not widely used and our study offers some clues about why. One limitation of such designs is that they often need set-up, e.g. requiring users to specify which applications are time-wasters, or to determine optimal intervals for productive work or length of breaks. Having to engage in complex set-up may be a barrier. More importantly, however, such set-up presupposes that users have insight into their work habits – insight that our data suggests that users lack. For example, participants may not know optimal thresholds for breaks to 'quickly check' email or social media. It may be that extended experience with applications like meTime might provide users with necessary insights, allowing them to make more effective use of complex features. Such experience might also allow users to customize their tracking of different browsing activities, which were combined in meTime. In general however, our data support an awareness approach involving information presentation rather than interventionist designs in which the system actively alerts or blocks time-wasters.

Another promising area for future research might involve behavioral training to improve focus without involving technology. Such training might include manual logging to identify: distracter applications, goal setting, timing of, and upper limits on, breaks. It might also include daily organization around times of optimal productivity. Of course a hybrid behavior and technology approach might involve initial deployment of meTime to help understand and reflect on current practices, followed by a mixed technology and behavior change approach.

Overall then, our study provides a promising set of results addressing a pernicious problem. Our users were able to exploit a simple user of time prototype to change some work behaviors. Our results also suggest important ways in which people's experiences of using computers might be significantly improved. We propose new technology that might assist with such improvement.

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