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L'application d'autosuivi StudyTracker et sa relation avec la procrastination des personnes étudiantes universitaires

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Article abstract

Procrastination is a prevalent issue among university students and leads to long-term negative impacts on academic performance as well as mental health and quality of life. This paper investigated StudyTracker, a self-tracking digital application (app) that we developed for university students to use to track their study sessions. The app provided feedback to the student in the form of text and charts. We investigated the impact that StudyTracker had on procrastination habits, and explored how students interpreted their feedback data from the app. Results indicated that both the control group (N=9) and the experimental group (N=8) experienced a significant decrease in procrastination scores, however there was no significant difference between the two groups. The design implications of our findings are discussed.

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Abstract

Procrastination is a prevalent issue among university students and leads to long-term negative impacts on academic performance as well as mental health and quality of life. This paper investigated StudyTracker, a self-tracking digital application (app) that we developed for university students to use to track their study sessions. The app provided feedback to the student in the form of text and charts. We investigated the impact that StudyTracker had on procrastination habits, and explored how students interpreted their feedback data from the app. Results indicated that both the control group (N=9) and the experimental group (N=8) experienced a significant decrease in procrastination scores, however there was no significant difference between the two groups. The design implications of our findings are discussed.

Keywords: personal informatics, procrastination intervention, self-tracking, time management, university students

Résumé

La procrastination est un problème répandu chez les personnes étudiantes universitaires et entraîne des répercussions négatives à long terme sur les résultats académiques ainsi que sur la santé mentale et la qualité de vie. Cet article porte sur *StudyTracker*, une application numérique d'autosuivi que nous avons développée à l'intention des personnes étudiantes universitaires pour qu'elles puissent l'utiliser pour suivre leurs séances d'étude. L'application fournit une rétroaction à la personne étudiante sous forme de texte et de graphiques. Nous avons étudié l'impact de *StudyTracker* sur les habitudes de procrastination et exploré la manière dont les personnes étudiantes interprétaient les données de rétroaction fournies par l'application. Les résultats indiquent que le groupe de contrôle (N=9) et le

groupe expérimental (N=8) ont connu une diminution significative des scores de procrastination, mais il n'y avait pas de différence significative entre les deux groupes. Les implications de nos résultats sur le plan de la conception sont discutées.

Mots-clés: informatique personnelle, intervention sur la procrastination, autosuivi, gestion du temps, personnes étudiantes universitaires

Introduction

Procrastination, the voluntarily postponing of an intended course of action on a task, is a widespread problem in higher education (Schraw et al., 2007). Studies vary as to the percentage of students who procrastinate. Steel (2007) estimated that between 70–95% of undergraduate students procrastinate to some degree. A study by Rahimi and Hall (2021) estimated that 46% of undergraduate and 60% of graduate students problematically procrastinate, where the procrastination resulted in negative outcomes. Several studies link academic procrastination to lower grades and lower academic performance (Balkis, 2013; Kim & Seo, 2015; Qaisar et al., 2017; Saplavaska & Jerunkova, 2018; Tice & Baumeister, 1997). Studies exploring the correlation between completion times and assignment grades showed that the earlier assignments were completed, the higher the grades (Cerezo et al., 2016; Yilmaz, 2017). In addition to academic performance, procrastination has significant negative consequences for emotional wellbeing, including shame, depression, stress, and anxiety (Rahimi & Hall, 2021). Our research began with the question of whether technology could be leveraged to help reduce academic procrastination in university students.

Persuasive design applies a variety of theories from areas of social psychology to alter attitudes and behaviours. Persuasive technology has been developed for this purpose (Fogg, 2003). Digital designs of these technologies include gamification (i.e., adding game-like elements such as points and badges), nudging (subtle cues that steer users towards a decision), triggers like notifications, and social proof (such as demonstrating how others have behaved, like leaderboards in games) (Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2009). These features provide motivational affordances, which are designed to satisfy a user's intrinsic motivational needs (Zhang, 2008). Developing motivational affordances around positive behaviours may result in increased enjoyment and positive reinforcement. Technology has been shown to persuade individuals to reduce unwanted behaviours (Asmah et al. 2022). We were therefore initially inspired by the literature on persuasive design and its role in self-awareness and self-reflection.

Technology-based interventions for procrastination have recently become a growing area of academic interest (Lukas & Berking, 2018). There have been several Internet-based attempts to reduce procrastination, including email-based reminders (Zaveleta Bernuy et al., 2021), chatbots (Pereira & Díaz, 2021), and self-reporting apps (Bellhäuser et al., 2023). To study procrastination by medical students, Wäschle et al. (2014**)** used an online self-report that displayed a dynamic line chart that adaptively visualized each student's course progression and self-reported previous procrastination. The findings revealed that presenting visualized feedback to the students resulted in a significant decrease in future procrastination behaviour.

There are also many recent gamified apps that attempt to tackle procrastination as part of a wider life-goal-setting strategy, including TaskHero (Beta version) by Whetware (2024), WaterDo (Version 3.9.0) by Seekrtech (2024), Habitica (Version 3.12) by HabitRPG (2024), EpicWin (Version 1.0.17) by Supermono (2016), and Habit Hunter (Version 1.5.0) by Tien Long Nguyen (2024). The efficacy of these apps to impact academic results or procrastination is not known. In 2024, Kirchner-Krath et al. explored gamification's impact on procrastination. Lukas and Berking (2018) developed a mobile-based app called MT-PRO, which used gamification principles to reduce procrastination by asking users to either avoid dysfunctional stimuli (e.g., pictures showing typical alternative activities such as a student sitting in a study environment but engaging in social media activities; negative study-related statements) or to approach functional stimuli (e.g., pictures of a student sitting in a study environment engaging in academic tasks; positive study-related statements). Results showed that using the app reduced both general and academic procrastination behaviours.

Drawing on elements of goal-setting theory, self-determination theory, and operant conditioning, gamification often underpins many of the practical approaches to tackling procrastination, but these have not been the only approaches (e.g., Irwin & Edwards, 2019). When it comes to smartphone apps, there have been several approaches to reducing procrastination that include goal setting, reminders, time management tools (W. Zhao et al., 2023), timer-based strategies like Pomodoro technique (S. Zhao et al., 2023), cognitive behavioural therapy (Lukas & Berking, 2018), and therapist-guided self-help interventions (Rozental et al., 2015). These interventions have an impact during the study periods, however long-term impacts are unknown.

Theobald and Bellhäuser (2022) had students complete daily electronic survey-based learning diaries. Their findings showed that automated electronic feedback (either informative, directive, or transformative informative) positively impacted student procrastination habits, self-regulated learning, and goal-achievement, and students in the feedback group received better grades on the final exam. However, motivation and self-efficacy were unaffected by the feedback. A subsequent study by Bellhäuser et al. (2023) created a goal-setting app to enhance self-regulated learning that provided daily automated, adaptive feedback, based on responses to daily electronic learning diaries. They found that their intervention increased goal setting and self-efficacy, but motivation, procrastination, and effort were unaffected. It is unclear why students in the first study (Theobald & Bellhäuser**,** 2022) experienced a decrease in procrastination, whereas students in the second study (Bellhäuser et al., 2023) did not, as both studies used learning diaries paired with similar combinations and types of feedback.

Apps with regular reminder notices focused specifically on online-only learning platforms increased adherence to deadlines (Bartuskova & Krejcar, 2014; Romero et al., 2016). Other apps focused on reducing distracting behaviours via playing games, using the Internet or smartphones (Foulonneau et al., 2016; Jacobsen & Pedersen, 2021; Kovacs et al., 2019; Schwabe, 2020). These apps were shown to have limited effects when the problem was not a specific distraction, but a general desire to be distracted by anything other than the task at hand (ibid.).

Proccoli is an app that combined Pomodoro-style timers, progress reporting, charting, notifications, self-evaluation, and goal setting (S. Zhao et al., 2023). While the study found that the app

had positive results on procrastination for some participants, it is not known which of the app's design features had a significant effect, although competition between classmates may have been a key factor. Missing in the existing research is a dedicated focus on a single design feature to understand digital procrastination interventions, e.g., the role of behavioural tracking or self-tracking as a motivational affordance in procrastination apps.

Self-tracking, in which individuals monitor, measure, and record data about their body and life, has been practiced for a long time with the use of pen and paper (Ayobi et al., 2018). Recent advances in wearable technology have resulted in a resurgent interest in self-tracking, since devices like the Fitbit and mobile heart rate monitors easily facilitate the process of collecting and analyzing data. Although self-tracking is often referred to as quantified self, non-quantifiable data such as daily activities, moods, and relationships, can also be tracked. By tracking habits over time, insights into time management, increased self-observation, and improvements in self-reflection can be gained.

Fogg (2003) refers to self-tracking as one of the foundational persuasive technology techniques, where the technology can remove the tedium of tracking performance. Gimpel et al. (2019) found that entertainment was a large motivator for self-tracking. They reported that self-tracking users enjoyed playing with their collected data, considering it entertaining. As a result, these users were more likely to be dedicated to their self-tracking practice. They observed that users who adhered to their self-tracking practice often realized that it was helping them take responsibility, optimize their lives, and be more self-disciplined, regardless of their motivation for tracking.

Self-tracking technologies are beneficial for the user (Stiglbauer et al., 2019). Several studies involve self-tracking technologies and academic productivity. For example, Wohn and Lee (2020) explored how tracking and reflecting on study habits impacted study behaviour and grades. Participants were in one of five conditions: (1) control group (no tracking or reflection), (2) tracking only, (3) tracking and self-reflection, (4) tracking and social reflection, and (5) tracking, self-reflection, and social reflection. Participants in the self-reflection conditions wrote a journal entry once every two weeks reflecting on their tracking data, performance in class, and general study habits. Participants in the social reflection conditions shared those reflections with a small group during class. The participants who combined tracking with active self-reflection received significantly higher grades on their final exams than participants who combined tracking with social reflection, although there were no other statistically significant differences between groups thus making it unclear how much of a positive impact self-reflection alone had on student study behaviours. Notably, Wohn and Lee did not assess the impact that tracking and self-reflection had on procrastination. A study by Tabuenca et al. (2015) explored the impact that self-monitoring and notifications had on self-regulated learning and showed that self-monitoring study time may have a positive impact on time management skills.

The practice of self-tracking using digital technologies is also referred to as quantified self (Abend & Fuchs, 2016) and personal informatics (Zuckerman & Gal-Oz, 2014). Studies have shown that these technologies can be used to effectively change people's behaviour when it comes to physical activity (Zuckerman & Gal-Oz, 2014) and mood (Bakker & Rickard, 2018). Visualization is the main method of communicating this information to the user and helps in self-reflection. Data visualization

improves academic performance (Aguilar, 2018) and motivation (Huang, 2022; Velázquez-Iturbide et al., 2017). To increase usability, Oh and Lee (2015) recommend making user input simple and automated, thereby reducing time or mental effort to record data. However, Choe et al. (2014) suggest that self-tracking tools should maximize the benefits of manual self-tracking, because automated tracking may reduce awareness and self-reflection. Manual tracking requires users to actively input their data, creating a moment for them to engage in analysis and reflection. The act of recording data manually not only increases awareness but may also encourage individuals to consider what the data reveals about their performance, allowing them to identify opportunities for behaviour change. Therefore, it is important to find a balance between automated and manual data collection to increase usability, while still preserving user awareness of the data.

This paper investigated whether self-tracking, in the absence of intentional gamified or social elements, could be an effective tool for reducing procrastination in university students. StudyTracker, an app that students could use to track their study sessions and visualize their data, was developed. An initial exploratory study was conducted to understand students' general thoughts on the app, followed by a six-week randomized controlled trial to examine whether the app had a positive impact on procrastination habits. The overall research question was whether participants in the experimental group would report a greater decrease in procrastination compared to participants in the control group.

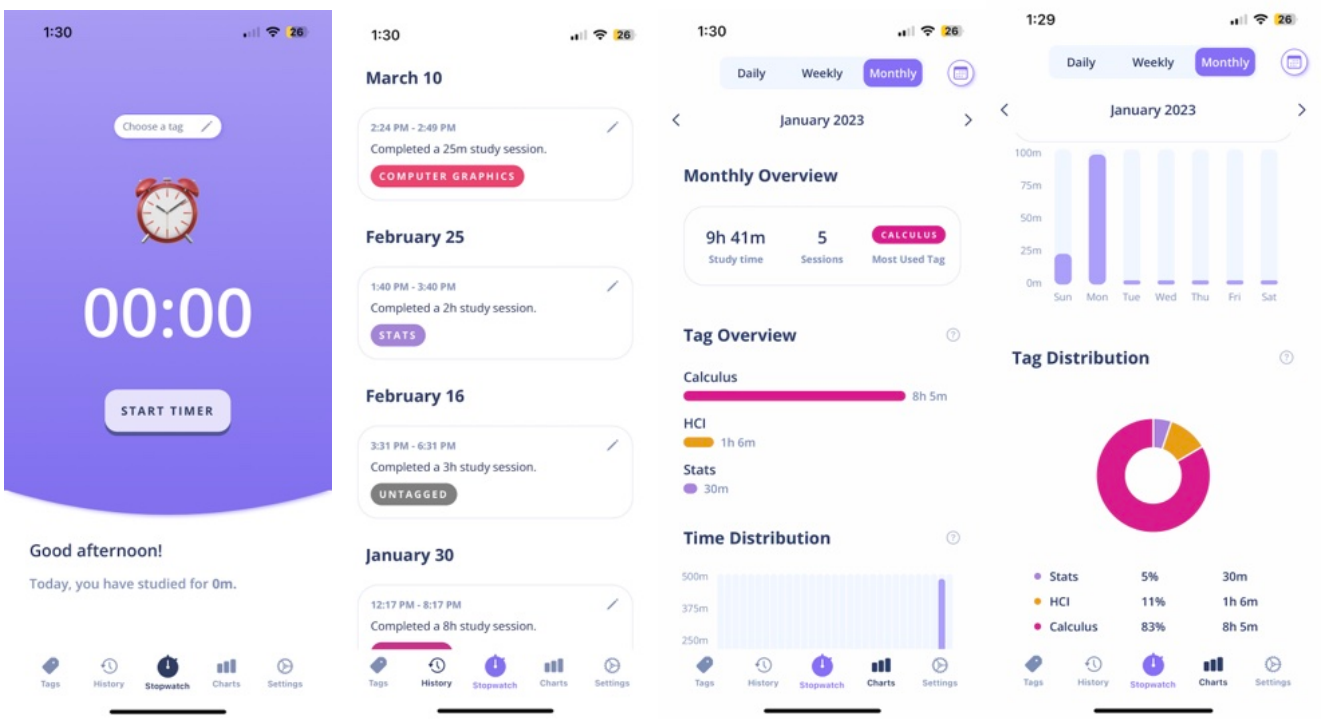
The StudyTracker App

We designed our StudyTracker mobile app to focus on self-tracking and visualized feedback, without intentional gamification or social elements. It is important to note that our StudyTracker app is distinct from Korata Software (2024) Study Tracker (Version 2.4.8), or any other available app with a similar name. Our StudyTracker app was specifically implemented for this study and is not publicly available.

StudyTracker used semi-automated self-tracking, in which the user was required to manually start and stop the timer before and after study sessions. Timings would then be stored and visualized automatically by the app in the form of charts and text feedback. The app featured a timer, charts, tags, a log of sessions, and settings. Like other productivity apps, the timer was on the home page making it easily accessible to the user (Figure 1). There was a start-timer button that the user could press to start timing their session. Upon clicking the button, it toggled to the stop-timer button. The timer ran in the background even if the user closed the app. Tags were added to allow the user to organize their sessions by topic. The data from the tags were used to provide additional feedback to the user. The user could select a tag when they started a new session or edit the tag of a session afterwards, including the options to change the label, colour, and add or remove tags from a session. A history section provided a log of previous sessions. Users could select recorded sessions and edit the start time, end time, and tag associated with that session. A charts section included visual feedback for the users. Charts were inspired by popular apps, such as Seekrtech (2024) Forest (Version 4.79.0) and Pixo (2024) Focus Keeper (Version 2.8.4). The charts included a daily, weekly, and monthly view.

Figure 1

The Implemented StudyTracker App, Version 1.0



We first conducted a usability study on a high-fidelity prototype of the app (Version 1.0), with eight participants to ensure that the application design was usable. We used the System Usability Scale (SUS), a common measure of usability assessment consisting of a 10-item questionnaire. Lewis (2018) provides a thorough historic overview of the SUS. The mean average SUS score was 83.75 (out of a possible 100; Lewis and Sauro (2018) rate this in the top 90th to 95th percentile of scores), indicating that the application design was usable and effective.

Following the usability study, one researcher implemented a working version of StudyTracker (Version 1.0), made available for download on iOS devices through an invite link. This article presents findings from two studies: a pilot study conducted to evaluate the app's functionality, and a randomized trial aimed at exploring the relationship between app usage and changes in procrastination behaviour among university students. In both studies, participants received instruction on how to download StudyTracker onto their devices and about the features available. Students were then asked to use the app during academic-related tasks (e.g., studying, completing assignments) by timing their sessions. Regular app usage however was difficult to enforce, and determining whether participants were actively reflecting on their data was a challenge. Therefore, a more qualitative approach to data collection and analysis was taken, focusing on participant experiences with our StudyTracker app.

A Pilot Study into StudyTracker's Functionality

The pilot study was completed to ensure that StudyTracker was working as expected and to gather students' initial thoughts about the app. For this study, student feedback on the StudyTracker 1.0 app was sought. Through social media, seven participant students at the university were recruited, five of whom self-identified as women, one as a man, and one as other. Ages ranged from 18 to 51 years (M=27.43, SD=11.21). Four were undergraduate students and four were master's students. Five participants had experience using self-tracking technologies such as fitness trackers, however, none of the participants had prior experience using self-tracking apps for studying.

Participants used StudyTracker during academic-related tasks for 10 days, after which semi-structured interviews were conducted and included questions about the app's functionality, features, user interface, and the participants' overall experience using the app. Participants were also asked if they felt their procrastination habits had improved from using the app. Study participants were compensated with a $25 Amazon e-gift card for their participation.

A thematic analysis on the interview transcripts was performed. Overall, participants noticed positive changes in their study habits and procrastination. Four themes emerged from the interviews:

Increased Focus and Productivity: Four participants mentioned that the app helped them focus when they would have otherwise gotten distracted. Specifically, P5 said that their focus had increased because it felt like they were being managed.

Time Management: Five participants said that the charts helped them better plan and manage their time in some way. From analyzing the data in the charts, they were able to see which topics they spent the most time on and what times of day they were most productive. With this information, these participants were able to optimize their study sessions. P1 said that the charts and tag feature helped them think more critically about how they were spending their time.

Accountability: The app helped participants feel more accountable for their schoolwork. Three participants described that keeping a "record" of their study sessions enforced the fact that they should study. If the timer was running, these participants wanted to be studying. P1 described that having the timer running made it feel like somebody was watching. P3 stated that starting the timer acted as a "pledge" to begin studying.

Entertainment: The app made two participants feel like they were playing a game: Seeing their feedback made them want to compete against themselves and get higher "scores." P2 explained, "this is actually a good app because it makes me productive because I want to beat the timer. I want a large number on the timer." Interestingly, even in the absence of intentional gamified design features, two students still gamified the app on their own, perhaps indicating a desire for more gamified elements.

Participants had several suggestions to improve the app. A common problem was forgetting to start or stop the timer. Four participants suggested that a notification would help solve this problem, however students further indicated that daily reminder notifications were not preferred. Three participants said that they felt that more variety in the charts section was needed.

The results of this pilot study showed that there was potential for self-tracking technologies to act as an intervention for procrastination. All participants expressed that they enjoyed the app in some way and felt it had a positive impact on their academic procrastination habits. All participants reported experiencing improvements in at least one area—time management skills, focus, productivity, or accountability—supporting the possibility that the app may have a long-term positive impact on procrastination.

Several feature suggestions were taken from this pilot study and implemented within the app. First, a notification feature was added to remind users when the timer is running so they do not forget to turn it off. Also, the timer was set to automatically stop and record the session after eight hours. Daily notification reminders were not added because notifications have already been shown to impact student procrastination behaviours (Davis & Abbitt, 2013). Instead, one self-tracking feature was isolated to examine its impact on procrastination.

Randomized Trial to Test the App's Relationship to Procrastination

After the pilot study, and as suggested by the participants, the following features in the app, now called StudyTracker 2.0, were implemented: (1) a notification to remind users that the app is running, and (2) a button to display more information about each chart. A six-week randomized trial to explore the relationship between StudyTracker 2.0 and the procrastination habits of university students was conducted. It was anticipated that students in the experimental group would experience a greater decrease in procrastination than students in the control group. Also, there was an exploratory component to this study, which investigated how students interacted with and interpreted their data, as well as the overall impact that the app had on students' study behaviours. The following research questions guided our investigation:

(1) How does the use of the StudyTracker 2.0 app influence procrastination behaviour among university students?

(2) What insights do students gain from their study data and how do they use these insights to improve their study habits?

(3) What is the overall impact of the app on students' study behaviours?

Methods

Participants

Using the same eligibility requirements as in the pilot study, 18 participants were recruited through social media. Participants completed the consent form followed by a pre-study survey containing questions about their demographics and experience with self-tracking technologies. Participants were also asked what tools they had tried, or were currently using, to reduce procrastination. None of the participants had experience using study trackers.

Participants were assigned to either the control group or the experimental group using block randomization. The control group (N=9) included five self-identified women and four self-identified men. Ages ranged from 18 to 26 years. The experimental group (N=8) included seven self-identified women, one self-identified man, and one self-identified as other. Ages ranged from 18 to 24 years. Seventeen participants completed all phases of the study, because one participant withdrew after completing three of the weekly surveys. Their survey responses were used in the qualitative analysis, but their data were not used in the statistical analysis.

Procedure

Two instruments were used to measure participant procrastination habits. For overall procrastination levels pre-study and post-study measurements, the Academic Procrastination Scale (APS) was used (McCloskey & Scielzo, 2015) because it focuses on academic procrastination rather than general procrastination and is relatively short compared to other scales. The APS contains 25 items that are rated on a Likert-type scale from 1 (Disagree) to 5 (Agree). Both groups received the long form of the APS before and after the study. To monitor weekly procrastination habit changes, students responded to a weekly survey containing the Academic Procrastination Scale – Short Form (APS-SF) (Yockey, 2016). The APS-SF contains 5 items from the APS which are rated on a Likert scale from 1 (Disagree) to 5 (Agree) and was chosen to ensure that students had enough time to complete it in addition to their schoolwork. Weekly surveys included the short form which participants completed each week for the six weeks.

The experimental group received additional information including instructions on how to download the app onto their device through an anonymous link, thereby ensuring that information about their app usage was not received by us. Participants were instructed to use the app during academic-related tasks for six weeks. Every seven days, in addition to receiving the APS-SF, they were sent a survey about their experience using the app. At the end of the study, the experimental group was sent questions about the self-tracking app and feedback, in addition to the post-study APS.

Results

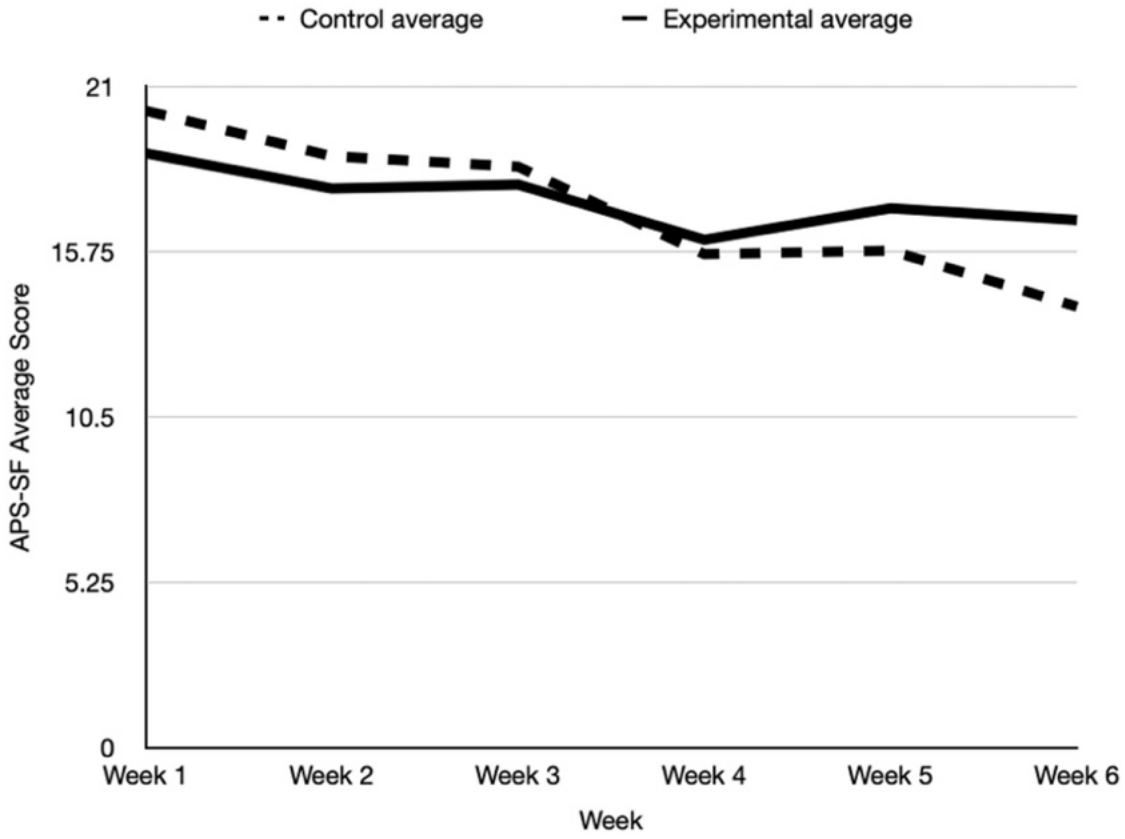
A paired samples t-test was conducted to determine the change in APS scores within the groups. Results showed that the control group experienced a significant decrease from their baseline scores (M=64.56, SD=8.31) to final scores (M=41.89, SD=20.2, t(8)=3.11, p=.007). The experimental group experienced a significant decrease from their baseline scores (M=56.38, SD=9.52) to final scores (M=42.63, SD=18.63, t(7)=1.98, p=.044).

A repeated-measures ANOVA determined that the mean APS-SF scores within the control group differed significantly across the weeks (F(5,40)=5.79, p=<.001). A post hoc analysis showed that scores became significantly different during week four of six (M=15.67, SD=4.27), although the cause cannot be determined, except to suggest that changes in workload during the term likely influenced their ability to stay on track.

A repeated-measures ANOVA determined that the mean APS-SF scores within the experimental group did not differ significantly across weeks one through six ($F(5,35)=1.194$, $p=.332$). Average weekly scores are summarized in Figure 2.

Figure 2

Average Weekly Scores on the APS-SF



An independent samples t-test was conducted to determine the significance of the difference in baseline and final APS scores between the two groups. The results indicated that there was no significant difference between the groups ($t(15)=.88$, $p=.393$), although the control group ($M=22.67$, $SD=21.89$) experienced a greater decrease in scores than the experimental group ($M=13.75$, $SD=19.67$).

Frequency of Use and Procrastination Scores

The weekly survey asked experimental group participants how often they tracked their study sessions (0% of the time, 25% of the time, 50% of the time, 75% of the time, or 100% of the time). While there was a small positive correlation between the two variables, the relationship was not statistically significant.

Survey Responses and Reflections

Thematic analysis was used to examine all qualitative survey responses. Feedback from the app made three participants realize that they studied for less time than they thought, which resulted in various reactions; *seeing how much time I spent on tasks versus how much time I should be spending has been eye-opening.* (P15). For two of these participants, this information encouraged them to study more. For example, P7 wanted to stop studying, however, the timer helped them to realize that they had been studying for a short amount of time, which motivated them to continue studying. However, for P3, the realization that they study less than they thought was not enough to push them to study more. Gaining a sense of time spent also helped participants become more aware of the progress they were making. For example, P20 said, *[the app] helped visualize how much work I was doing even though it may have felt like I was not making progress*. Measuring progress helped participants recognize what they were accomplishing, giving them a sense of achievement and motivation to keep working, reinforcing positive behaviours.

Feedback from the app was considered informative with some experiencing a positive change to procrastination behaviours. Overall, the app helped participants increase their reported focus. For example, the app served as a reminder for P4 to not get distracted whenever they picked up their phone. In addition to the timer acting as a reminder for P4 to study, they also knew that the app was tracking them, and they did not want there to be any "false" data, which discouraged them from getting distracted. P20 felt similar effects, explaining that getting distracted meant they had to either deduct time from their data or stop the timer, which they wanted to avoid. Keeping their data accurate also allowed them to reflect on this data, helping them make changes to their study habits:

> *The more I spent tracking my productive tasks, the more it forced me to focus on the task. As if I started something else or got distracted, I had to stop the timer or subconsciously deduct time counted. This made me more focused, and on track instead of getting distracted with other things*. (P20)

Additionally, three participants said that using the app helped them study for longer periods of time, as explained by P7, *Maybe [the app did] not completely reduce procrastination, but more so improve my study retention time. I am able to study for longer and more concentrated periods of time.* For some participants, the app helped them get into a "study mindset," allowing them to focus on their work. P15 referred to tracking as their *study ritual*. P7 said that the app acted as a *signal* to their brain that they were going to start studying. An interesting and unexpected result was that the app could be considered a tool to prime a user to study. By encouraging greater self-awareness and self-reflection on study habits, the app became part of a study ritual, creating environmental and cognitive cues that help participants transition into a study mindset. The app could be a priming stimulus that signals to students the purpose of their session and reinforces study behaviour.

Five participants mentioned that the feedback helped them identify on which topics they were spending time. This information allowed them to purposefully allocate their time across their various courses. Furthermore, the feedback encouraged P4 to get started on topics that they would have otherwise pushed aside:

> *The daily overview helped me see how long I studied in the day and how many exact sessions I needed and what courses along with the tag overview so it would be in an easier way to see which courses got the most focus in that day and it would encourage me to study for another course tomorrow (one that got less attention from the previous study session).*

Six participants said that the tag feature was their favourite. Three participants expressed support indicating that tags were useful when it came to allocating their time because they were able to compare the time they spent on each topic. Four participants used the feedback to understand when they were most productive, and then manage their time accordingly. P5 said that seeing when they are most productive helped them with future planning; *I like that it allows me to see when I am most productive or when I tend to do work. I could apply that when devising future plans*.

Additionally, four participants used the feedback from the charts to learn how much time it took them to complete tasks such as assignments, so they could plan their study sessions accordingly. For example, P15 expressed, *it also helped me see how much time I was spending on tasks, and I could more effectively plan and get my tasks done because I knew how much time the task required*.

Seven participants reported at least one instance of forgetting to start the timer when they began studying, whereas only one participant was easily able to integrate the app into their study routine. Another participant made a habit of using the app at the beginning of the study but began to forget to start the timer as they lost interest in the app. P1 and P7 recommended strategically timed notification reminders be added based on the users' peak study time data, to help remind them to track their study sessions. For instance, if a student successfully completed most of their focused study time between 7–8pm, then the app could send a reminder before 7pm suggesting study time be started. Similarly, P14 and P5 recommended general reminder notifications that the app exists.

Three participants valued the accuracy of their data and reported using the app as often as they could to keep their data accurate. Two participants expressed frustration because they would forget to start the timer while studying but remember once they had finished. As a work around, P5 stated they would run the timer afterwards to *make up* for the time they forgot to track. These participants suggested manual data entry as an effective solution to the problem of forgetting to start or stop the timer.

Three participants expressed boredom with the app, suggesting the interface was not engaging enough. P14 said that the app had *minimal functions*, while P3 said that it was *pretty bare bones*. The lack of features led P14 to stop using the app altogether stating, *towards week four I lost interest in the app, because there are very minimal features that I could use*. P7 suggested they would have liked to have more gamified and social features.

Within both groups, results showed a significant decrease in procrastination scores. However, between the two groups, there was no significant difference in scores. This result does not support our expectation that the experimental group would experience a greater decrease in self-reported procrastination scores than the control group. Furthermore, although the difference was found to be

statistically insignificant, the control group experienced a larger decrease in APS scores than the experimental group. There could be several reasons for this result.

First, three participants in the experimental group found that the app was not engaging enough, and it was hard to remember to start the timer whenever they began studying. Higher engagement with the app may have resulted in an overall higher decrease in procrastination scores within the experimental group. The app cannot help the participants if they do not use its features to their full potential, however there was no dependable way to ensure that participants were engaging with the app while doing schoolwork. Second, the natural progression of the semester may have had an impact on all procrastination scores. Since this study was performed over the course of a semester, two participants expressed that they noticed a positive change in their procrastination habits because they could no longer "afford" to procrastinate as midterms and exams approached. Regardless, it can be concluded that the self-tracking app was simply not enough to impact procrastination significantly, resulting in similar experiences between the control and experimental groups. Although the control group's procrastination habits may have been impacted by the weekly procrastination survey, the experimental group also responded to this same weekly survey. Overall, the effects of using the app would have been evident if the app was truly effective. Third, the fact that the control group was asked to respond to weekly feedback may have been enough to influence their results, since they may have felt accountable to the study.

Results aligned with the Wohn and Lee (2020) study conclusions that self-tracking is not enough to have a significant impact on student study habits and grades, although they did not examine procrastination specifically. Our results are contrary to Wäschle et al. (2014) that concluded that students who received weekly visual feedback experienced a stronger reduction in procrastination compared to students in a controlled condition. In addition to procrastination, how the app impacted study behaviour was also explored; finding that the app had a positive impact on time management skills, although this variable was not assessed quantitatively. This finding aligned with Tabuenca et al. (2015) where they also found that self-tracking study time may have a positive impact on time management skills.

Overall, the random trial of StudyTracker 2.0 shows that use of a self-tracking app was not enough of an intervention, to reduce academic procrastination in university students. However, the app helped seven participants gain new skills such as time management, which was a benefit that the control group did not experience. Regardless, this was not enough to significantly decrease procrastination scores when compared to the control group as measured by the APS and APS-SF. We suggest that students must have a strong willingness to change their procrastination habits for an intervention such as a self-tracking study app to make a positive impact. Otherwise, students will not commit to habitually timing their study sessions, nor will they invest time into reflecting on their study data. Future studies could consider pre-selecting participants who indicate a strong willingness to change their procrastination habits. Removing the willingness or motivation factor from the equation would therefore allow a future study to test the "effectiveness" of an intervention to change the behaviour.

Discussion and Design Implications

Through the app design and qualitative results from the pilot and randomized trial studies, insights on how students interpret their data and several design recommendations for productivity-focused semi-automated tracking apps were applied. Persuasive design practitioners may find the following recommendations and insights useful.

Recommendations and Insights

Reminder Notifications

Notification reminders are essential, however should be controllable by the user. Since the self-tracking feature was semi-automated, requiring some active user intervention, participants often forgot to start the timer when they began studying. This was particularly evident in the randomized trial, where seven out of eight participants in the experimental group reported forgetting to use the app at least once. This high rate of forgetfulness among university students may reflect their busy schedules or the cognitive load of managing multiple responsibilities. Interestingly, the control group also experienced a decrease in procrastination scores, possibly due to the reflective nature of responding to the weekly surveys. This suggests that a simpler solution, such as weekly surveys, might be more suitable for university students as they require less effort and impose a lower cognitive load compared to consistent app usage.

Despite the forgetfulness, three participants from the pilot study said that they considered reminders annoying. Only two participants from the randomized trial who reported at least one incident of forgetting to start the timer while doing schoolwork recommended designing general reminders into a future version of the app. However, another solution recommended by two participants was strategically-timed personal notifications sent after the app learned the user's peak study times. This may be difficult to implement, and therefore we recommend customizable notifications, where users control when and how often they receive notification reminders.

Ensuring that Data is Accurate

When self-tracking is semi-automated, requiring some active user intervention to start and stop the timer, it is essential to provide tools that allow users to edit and add data. Semi-automated tracking introduces the potential for human error. Six participants (three from the pilot study and three from the randomized trial) valued the accuracy of their data, supporting the suggestion to include options for data editing and manual entry in the self-tracking apps. Specifically, users should be able to edit the start and end times of existing entries and have the option to manually create new entries without running a timer.

Optimizing Data Visualizations

When analyzing charts, participants gathered specific insights to help them better manage their time. Three themes that classify the ways in which participants interpreted their data were discovered: (1) topic balance, (2) peak productivity times, and (3) task duration. Five participants from the

randomized trial often used the charts to determine which topics and tasks were taking most of their time, which allowed them to better allocate their time across different topics and tasks. Four participants used this information to plan study sessions because they had a better estimate of how much time was needed for each task and topic. Three participants from the pilot study stated that they would like a wider variety of chart options, specifically they would have liked the same information but displayed differently. In the randomized trial, there was a lack of pattern in the charts that participants preferred. This suggests that a variety of charts should be provided, since there is no universal preference. Ideally, we recommend that self-tracking apps include a customizable dashboard in which users can display their preferred charts. Future research could explore which data visualizations are most effective for driving behavioural change, considering factors such as user demographics and the target behaviour.

Tags

Participants found the tagging feature was helpful to determine topic balance and task duration.

Productive Time Tracking

Based on the time of day that participants logged the longest study sessions, participants were able to determine the times of day that worked best for them and plan to study during those hours. To help identify peak study times, charts that display time of day and average logged study times could be used and accompanied by textual feedback informing about peak productivity times, so users can easily interpret the data.

Limitations

Some limitations may have impacted the results of this study. One limitation was the smaller number of participants, and therefore, the results are not generalizable. Furthermore, the study only looked at one variable: procrastination. Future studies would benefit from looking into how self-tracking apps quantitatively impact additional variables such as general productivity, motivation, time management, achievement, and focus.

Another limitation was that results were self-reported rather than potentially measuring their academic achievement over time. It is difficult to know exactly how procrastination was impacted, since self-reported measures may be biased. Engagement data were also self-reported. Although participants were asked how often they tracked their study sessions, data were not collected on how often participants interacted with and reflected upon the app feedback. Future studies may benefit from investigating the impact of user engagement on effectiveness of self-tracking apps in promoting behaviour change more in-depth. Moreover, app analytics that learn user habits and make suggestions over time may also lead to greater improvements in study behaviours and behavioural changes in a wider context.

Despite the quantitative results being inconclusive, the qualitative results from the randomized trial showed that six students gained motivation and awareness, which as described are critical to self-

regulated learning. Future studies are warranted to investigate motivational affordances and to consider gamified and social elements.

Somewhat counter to the quantitative results, the qualitative results of the study suggest that self-reflection may be an important counter to procrastination habits, whether that self-reflection happens in the form of weekly surveys or through a data-tracking app, or both. Providing tools along with the data to facilitate such self-reflection on their habits could be the most important design features that could be incorporated into apps: Simple data tracking is not enough to sustain student engagement and motivation. More advanced features such as analytics, gamified elements, and artificially intelligent systems that can learn and provide recommendations as well as perhaps teach users how to read and interpret their data, may be necessary for continued engagement.

Conclusions

This study is an exploration of the StudyTracker app, a self-tracking tool designed to help university students reduce procrastination by providing visualized feedback on their study habits. The app intentionally avoided gamification and social elements, focusing instead on self-awareness and reflection.

Procrastination remains a significant challenge among university students, often leading to negative consequences for academic performance and mental wellbeing. This study showed that while both experimental and control groups experienced a significant decrease in procrastination scores, the StudyTracker app did not lead to a greater reduction in procrastination compared to the control group. However, qualitative insights revealed that the app fostered improvements in time management, focus, and self-reflection among some users, which are critical components of self-regulated learning.

These findings underscore the importance of further research into self-tracking technologies as potential tools for tackling procrastination, while emphasizing the need for features that actively engage users and sustain motivation.

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