Universiteit Leiden

Supporting Self-Regulated Planning: A Digital Tool for First-Year Computer Science Students

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Bachelor Thesis– Informatica

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August 17, 2026

Abstract

The transition from high school to university is difficult for many first-year students, especially when it comes to managing their own study time. This is relevant in Computer Science, where a large part of the study load consists of programming assignments that students have to plan themselves and whose duration is difficult to estimate. Existing tools generally support self-regulated learning, but do not specifically target the difference between students' predicted and actual study time. This thesis addresses that gap by developing a prototype digital planning tool, based on Zimmerman's model of self-regulated learning. It lets students plan assignments, split them into subtasks, estimate how long each subtask will take, and reflect on their approach. The tool was evaluated in a first-use study with 19 participants, where most of them were students in Computer Science or a related IT programme, using a survey with Likert-scale and open-ended questions. Participants generally found the tool easy to use ($M = 4.12$) and useful for planning their study tasks ($M = 3.71$). The subtask breakdown was the feature they found most useful. However, participants also reported usability issues, mostly related to navigation and interface design rather than the core functionality. Participants from Computer Science and IT programmes rated the tool lower than participants from other programmes, although the small sample means this difference should be interpreted with caution. These results suggest that the main idea behind the tool was received well, but that the current implementation still needs refinement.

Contents

1 Introduction

1.1 Problem Statement

The transition from high school to university is often a hurdle that students struggle with. Higher education expects students to manage their own learning and study time independently. This is often described in terms of self-regulated learning (SRL). Zimmerman [21] defined SRL as a cyclical process in which learners go through three phases: the forethought phase (analyzing and planning), the performance phase (implementing approaches and executing tasks), and the self-reflection phase (evaluating outcomes and adjusting approaches). In terms of time management, the forethought phase involves analyzing when to work on which tasks and how much time is needed, the performance phase involves checking whether tasks are staying on schedule, and the self-reflection phase involves evaluating whether time was used effectively and how time management can be improved for next time.

However, understanding that SRL is important does not mean students actually regulate their learning. David et al. [4] found that first-year students could recognize what good study planning looks like, but that existing habits still led them back to ineffective approaches. Bjork et al. [2] added that learners often suffer from "illusions of competence": they misjudge the amount of study material there is, and underestimate how much time it will take them to complete certain tasks. Di Benedetto and Zimmerman [5] found that students often fail in the third phase, self-reflection, since they do not look back at whether their planning and time estimates were realistic. This causes them to stay in a cycle of ineffective study planning.

This is a particularly important problem for first-year students, since the transition to university is a period in which self-regulation and planning skills are still developing. Van der Meer et al. [18] showed that many first-year students struggle with time management, and argue that students need to be explicitly introduced to effective planning behavior, rather than being expected to already know how to plan their studies.

These challenges are not always the same in every study programme. In Computer Science, a large part of the study load consists of programming assignments, which students have to work on outside of scheduled lectures, sometimes in teams. Which means that students need to plan the study load themselves. These tasks are hard to estimate, because of the amount of work that not only consists of working together to make one assignment, but also of debugging and problem solving. Which does not always follow a pattern. Loksa et al. [9] argued that programming is unique enough from other tasks that findings about self-regulation cannot simply be transferred to it and that self-regulation is still an underdeveloped part of programming education.

National registration data shows that keeping up with the pace is not straightforward in this programme. For the Computer Science bachelor at Leiden University, 63% of first-year students continue to to second year within the same programmes [16] and only 31% get their degree within four years, while the duration of the programme is three years [16]. These figures do not show why students fall behind and part of the difference is explained by students switching to another programme. Still, the numbers show that completing the programme at the intended pace is quite hard, which makes first-year Computer Science students a relevant group to look at when it comes to supporting study planning.

Existing tools generally support self-regulated learning, but do not specifically target the gap between students' predicted and actual study time, which is exactly the gap that this thesis aims to address by developing and evaluating a digital planning tool for first-year Computer Science students.

1.2 Research question

The main research question is:

RQ: How do students perceive a time management tool designed for first-year Computer Science students for supporting their study planning and estimation of study time?

The related sub-questions are:

- **SQ1**: To what extent do students perceive the tool as helpful for planning study tasks and reflecting on their time use?
- **SQ2**: What usability issues and improvement suggestions do students report after their first use of the tool?

1.3 Thesis overview

The thesis is structured into different sections. Section 2 discusses related work on self-regulated learning, time management and existing planning tools. Section 3 describes the methodology used to design and evaluate the tool. Section 4 presents the results of the study, and Section 5 discusses these results in relation to the literature and the limitations of the study. Finally, Section 6 concludes this thesis.

2 Related Work

2.1 Self-regulated learning and time management

2.1.1 Zimmerman's model of self-regulated learning

The transition from high school to university brings a significant change in the expectations placed on students [18]. Compared to high school, where teachers typically organize students' schedules and monitor their progress closely, university requires students to manage their own study time with far less guidance [20, 18]. Students are expected to engage in more learning activities on their own time and under their own direction, while the course material itself tends to be more complex and time-consuming than what they encountered before in high school [20].

Self-regulated learning (SRL) refers to an active, cyclical process in which learners take control of their own learning [17, 21]. A key aspect of SRL is that learners are aware of what they want to achieve and how they plan to achieve it, while also reflecting on their progress [17]. One of the most widely used frameworks for explaining SRL is Zimmerman's model [21]. This model conceptualizes learning as a process consisting of three phases. In the forethought phase, students analyze their tasks and plan their approach before they begin studying. In the performance phase, students carry out their tasks while monitoring their own progress. In the self-reflection phase, students evaluate their outcomes by comparing results against their earlier goals, and use this evaluation to adjust their approach in the future [21]. Zimmerman's model presents learning as a self-regulated process in which successful students actively plan their work in advance, monitor their progress, and use reflection to improve future study behavior [21].

2.1.2 Time management as part of SRL

The importance of time management is shown in research on self-regulated learning and student success [20]. From a self-regulated learning perspective, time management is not only a practical skill, but also a process of how students plan and adjust in order to meet their academic goals [20]. Students are not always accurate in predicting how much time and effort a task requires, which can lead to ineffective planning decisions [2, 20]. Within Zimmerman's model, time management can occur across all three phases of self-regulated learning [20]. In the forethought phase, students make their study planning by analyzing their tasks and estimating how much time each will require [21, 20]. In the performance phase, students will do their tasks and follow their planning, while also monitoring themselves and adapting their time management if needed. In the self-reflection phase, learners evaluate how effectively they have made their time estimates and planning, by comparing their expectations with actual outcomes [21, 5, 20]. They will then use this information to improve future planning [5, 20].

The first phase, forethought phase, is important, because it is particularly vulnerable to misjudgments. Bjork et al. [2] show that learners often suffer from "illusions of competence". In other words, they may misjudge how much study material there is and underestimate how much time it will take them to do certain tasks [2]. Inaccurate time estimates or unrealistic planning may therefore set students on the wrong path before studying even begins [2, 20].

In the second phase, performance phase, time management consists of the students to notice whether tasks are taking more or less time than expected [20]. Students may need to adjust their pace or strategy when unexpected obstacles arise [2, 20].

Di Benedetto's study [5] found that students often fail in the last phase, the self-reflection phase. They do not look back at whether their planning and time estimates were realistic, which causes them to stay in their cycle of ineffective study planning. Time management can therefore be seen as more than a practical skill, it is a self-regulated process where planning, monitoring and reflection are involved together [21, 20].

This thesis focuses on this process in the context of Computer Science students, where most of the study load consists of assignments that need to be scheduled mindfully.

2.2 Students and how they learn

2.2.1 Students transitioning to university

As mentioned before, the transition from high school to university brings a significant change in the expectations placed on students [18, 6]. At university, first-year students face a more complex study load within an environment that offers far less structure than high school [20]. Beyond their studies, they also navigate broader personal changes, such as separation from family and friends and the need to build new social networks [20].

From a developmental perspective, it is important to consider what stage first-year students are in. Most students starting university are around 18 years old, placing them in a period that

Arnett [1] described as "emerging adulthood". This is a phase where increased independency and freedom starts, but also with instability and a lack of adult roles. During emerging adulthood, the brain is still developing, particularly in areas related to planning and decision-making, which do not fully mature until the mid-twenties [10]. This means that young adults in this developmental stage still struggle with abilities such as calculating risk and thinking further than the moment. In the context of university, this developmental stage has direct consequences for how students approach their studies. Since skills such as independent decision-making, self-regulation, and planning are still developing, first-year students may find it harder to manage their time effectively. This does not mean that first-year students are incapable of planning, but rather that these skills cannot be taken for granted and may need more support than is often assumed.

2.2.2 Students and time management

These broader challenges with decision-making and self-regulation also occurs in more specific academic struggles, such as estimating how much time a task will take and creating a realistic study plan. Research on first-year students has shown that this transition can be difficult, especially to those that are not yet accustomed to manage their own studies independently [18, 6]. Van der Meer et al. [18] argued that many students were realistic about the study load and that they need to plan their work accordingly, however they struggled to regulate their study planning and keep up with the material. Students were often uncertain about how to organize their studies in actual time. The study suggested that first-year students need to be explicitly introduced to effective study behavior. Jansen and Suhre [6] showed that study skill preparation in high school is effective and has a positive impact on first-year study behavior. However, this preparation alone is not enough to make a student ready for the expectations of university [6]. These findings matches with the outcomes from the emerging adulthood research. Since planning and self-regulation skills are still developing at this stage, it is unrealistic to expect first-year students to navigate university independently without external support. Rather than assuming students arrive prepared, universities should have an active role in helping them build these skills.

A problem that often arises in literature is that students misjudge how much time their tasks will require. This connects to the concept planning fallacy [3], which describes the tendency of underestimating how long tasks will take, even when previous experiences suggest otherwise. This means that students may create study plans and assume it is realistic, when it is actually underestimated. This is also related to the "illusions of competence" discussed earlier [2], students not only misjudge their study load, but also misjudge their ability to be able to finish it. Khiat et al. [7] further showed that students who do not regulate their time effectively tend to fall behind in a study pattern. If students are unable to compare their time predictions with their actual time use, they may repeat inaccurate planning patterns across tasks.

2.2.3 Computer Science students

The challenges above apply to first-year students in general, but there are other reasons to look at Computer Science students exclusively. As mentioned before, Loksa et al. [9] reviewed research on self-regulation in programming education and argue that programming is unique enough from other domains that findings about self-regulation cannot simply be transferred to it and that self-regulation in this context needs it own research.

Time management plays a big part in programming projects. Ramírez-Echeverry et al. [13] studied the learning strategies students use in computer programming courses and found positive correlation between meta-cognition and practice, problem solving and time management. The study also found that organizing and structuring their ideas as the least used strategy, suggesting that students need more support in structuring their approach. Dividing an assignment into subtasks can be seen as a form of structuring an approach before starting

Estimating the duration of a programming assignment can be challenging, since the time completing one can be affected by debugging, unexpected errors, not completely understanding the requirements and other difficulties that only appears during the work itself. Ramírez-Echeverry et al. [13] similarly stated that programming problems often take longer than planned and effective time planning requires attention towards task difficulty and the concepts needed for solving the problem. These make the planning fallacy and the "illusions of competence" discussed in Section 2.1.2 more likely to occur in this group. First-year Computer Science students have to combine low planing experience with tasks that are difficult to estimate, which makes support in estimating and reviewing study time especially relevant for them.

2.3 Tools supporting SRL and time management

2.3.1 Interventions

A systematic review of interventions to improve self-regulated learning in first-year university students shows the challenges students have to face during the transition [15]. The review consists of 23 relevant studies, and highlights that common approaches including workshops, tutoring and different tools integrated into courses tend to be more successful, than standalone supports. It also suggest that consistency is important, since short and isolated interventions may not be enough to make an impact on the development in self-regulated learning [15].

Among the studies, Schippers et al. [14] found that a short structured goal-setting exercise, in which students wrote about their academic goals and plans, lead to a 22% increase in academic performance compared to a control group. It did not matter whether students wrote about academic or non-academic goals. What seemed to make the difference was the process of writing and planning itself. Similarly, Perander [12] implemented a 2 × 3-hour workshop targeting first-year students. Students reflected on their study habits and time management through journals, and most reported gaining practical insights they planned to apply in their studies. An important outcome was that students found it helpful to hear that others struggled with the same challenges. However, the study acknowledged that it remained unclear whether these insights actually led to lasting behavioral change. Wang et al. [19] showed that time management skills can be effectively developed in first-year students through sustained, practice-based approaches. Over three design cycles, students who repeatedly tracked, reflected on, and adjusted their time use showed clear improvements in planning and task completion.

Together, these studies suggest that active engagement, whether through writing, reflection, or firsthand practice, is more effective than simply providing information. At the same time, they raise an open question. Even when students gain awareness or short-term improvements, it is not always clear whether this translates into lasting behavioral change.

2.3.2 Planning tools

Within the interventions discussed in Section 2.3.1, several studies have focused specifically on developing and testing digital planning tools to support students' academic plannings. Lobos et al. [8] developed the *4planning* app, a mobile application designed to help students plan their study tasks and track their use of self-regulated learning strategies over time. The app was integrated into a program, meaning students used it as part of their coursework rather than as a standalone tool. Students were guided to plan their study tasks and track their self-regulated learning strategies throughout the course with the app. The results showed that with consistent use, students improved their application of self-regulated learning strategies, suggesting that integrating the tool directly into the curriculum played an important role in its effectiveness.

Khiat et al. [7] took a similar approach by integrating an automated time management enabler system within a learning management system. The system targeted study behavior through four components: a visual study plan, adaptive release of learning materials, personalized email reminders when students fell behind, and motivational messages for their progress. The experiment showed that students who used the system spread their learning more evenly across the course duration and procrastinated less compared to students who did not. Importantly, course completion rates were significantly higher in the intervention group, at 82.4% compared to 47.4% in the control group.

2.3.3 Reflection and tracking tools

As discussed in Section 2.1, planning alone is not enough; students also need to reflect on their time use and compare it against their expectations. Khiat et al [7] showed that visualizing time use to students through monitoring and feedback led to more effective study behavior. Ng et al. [11] also found that tools providing continuous feedback on students' progress, helped students stay engaged over time.

However, David et al. [4] stated that even when students are provided with the knowledge of effective SRL strategies, deeply rooted habits can still prevent them from actually changing their behavior. In their study, first-year students understood what good planning looked like, but bad habits still caused them to go back to ineffective approaches. This suggested reflection tools need to do more than present information, they also need to actively engage students to realize the gap between their intentions and their actual behavior.

2.3.4 Short comings in existing tools

Although the results of several tools and interventions were promising, important limitations still remain. As David et al. [4] showed in Section 2.3.3, knowing effective strategies does not automatically translate to behavioral change. This shows a gap between what students learn from interventions and what they actually do in practice. A review by Simón-Grábalos et al. [15] further noted that several interventions only led partial success and that being consistent is still a struggle for many students.

Another limitation is that most existing tools focus on SRL without targeting the gap between students' time predictions and their actual time use. As discussed in Section 2.1.2, students often misjudge how long tasks will take, and Wang et al. [19] noted that developing time management skills require students to practice estimation and reflection repeatedly over time. Most existing tools do not directly support this. This gap motivates the present study, which aims to develop a tool that specifically tracks students' predicted and actual study time. As well as having short reflections, to make sure the students are aware of their time predictions.

Most of these tools were not developed and evaluated with Computer Science students in mind, even though this group is often working on tasks that are hard to estimate, as presented in Section 2.2.3.

3 Methodology

3.1 Design

This study used a first-use evaluation design to assess a prototype digital planning tool aimed at supporting student time management. The study followed a mainly quantitative survey design, with added open-ended questions to provide qualitative context to the quantitative findings. Quantitative data was collected through 13 survey questions with Likert-scale questions addressing usability and clarity, and usefulness. Qualitative data was collected through 5 open ended survey questions, which allowed participants to elaborate on their experiences and provide feedback for improvement. These questions led participants to share more detailed feedback besides the fixed response items, helping the qualitative data add meaning to the quantitative results.

Rather than measuring long term behavioral change, this study focused on participants' first impressions of the tool after a short interaction. Participants were asked to use the tool to complete a small planning exercise that reflected the intended use of the application. In this way, the study aimed to assess students' first impressions of the tool: specifically, the extent to which they perceived it as helpful for planning study tasks and reflecting on their time use (SQ1), as well as the usability issues and improvement suggestions they came across after their initial interaction (SQ2).

3.2 Participants

Participants were recruited through convenience and snowball sampling. Personal contacts and students who were enrolled in higher education were contacted. The study was also shared through WhatsApp groups of different study programmes. This recruitment approach was chosen because it allowed participants to be recruited within the available time and resources for this study.

A total of 19 participants took part in the study. Before starting the task, participants were asked to provide informed consent by agreeing to the consent statement at the beginning of the survey. This confirmed that participation was voluntary and that their responses could be used for this research.

3.3 Tool

The tool used in this study was a prototype web application developed in Python using a Django framework. It was designed to support student planning and reflection by allowing users to input assignments and split them into smaller and more manageable subtasks.

The design of the tool was based on the gap identified in Section 2.3.4 generally support self-regulated learning. However they do not specifically focus on the difference between students' predicted and actual study time. The tool was designed around three main stages: planning, monitoring actual time use and reflecting on the difference between the predicted and actual time. These stages were based on Zimmerman's model of self-regulated learning. The main functionalities of the tool were designed to support the three stages.

The assignment and subtask structure was included to help students break larger tasks into smaller and more manageable steps. This was based on previous research suggesting that vague time estimates can contribute to the planning fallacy [3]. The predicted time field was added to make students estimate how long each subtask would take. The actual time and status fields were included to help students keep track of their progress and compare their actual time use with their initial estimates. Finally, the reflection questions, such as what worked well, what caused delays, and what could be done differently next time, were included to encourage students to reflect on their planning and time estimates. This was also based on the findings of how David et al. [4] found that students may know effective planning strategies, but are not always applying them.

The prototype was built step by step. First , the main functionalities of the application were determined based on the focus of planning, time estimations, and reflection. These functionalities included creating assignments and dividing them into subtasks, entering predicted amount of time, recording the actual time spent and answering short reflection questions. During development, the structure of the tool was kept simple, focusing on functionality rather than visual design. The goal of the study was to evaluate the basic usefulness and clarity of the tool.

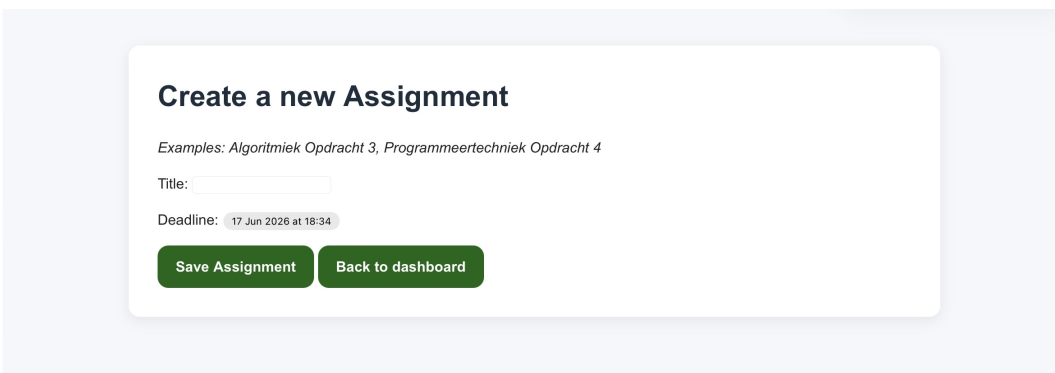

Figure 1: Create assignment page

Instead of adding a login system, users entered a participant code which was stored in the database and used to connect them to their data during the usage of the application. After entering this code, users arrived at a dashboard where they could view and create their assignments, see figures 1 & 2. Each assignment consists of a title, deadline, and subtasks, see fig. 3. For each subtask, users can enter a start moment and a predicted amount of time in minutes. Subtasks could later be updated with a status, the actual time spent, and several short reflection responses about what worked well, what helped, what caused delay, what the main obstacle was, and what they would do differently next time, see fig. 4.

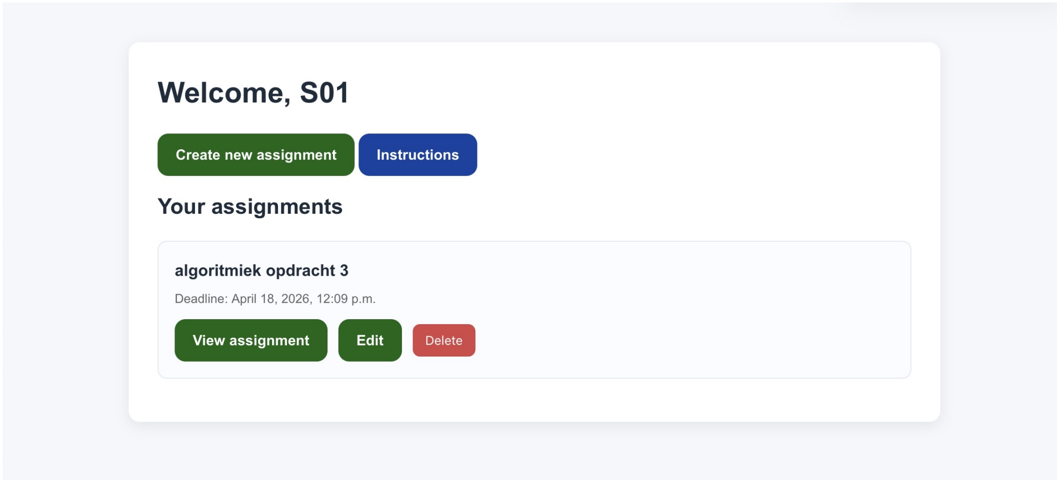

Figure 2: Overview of assignments

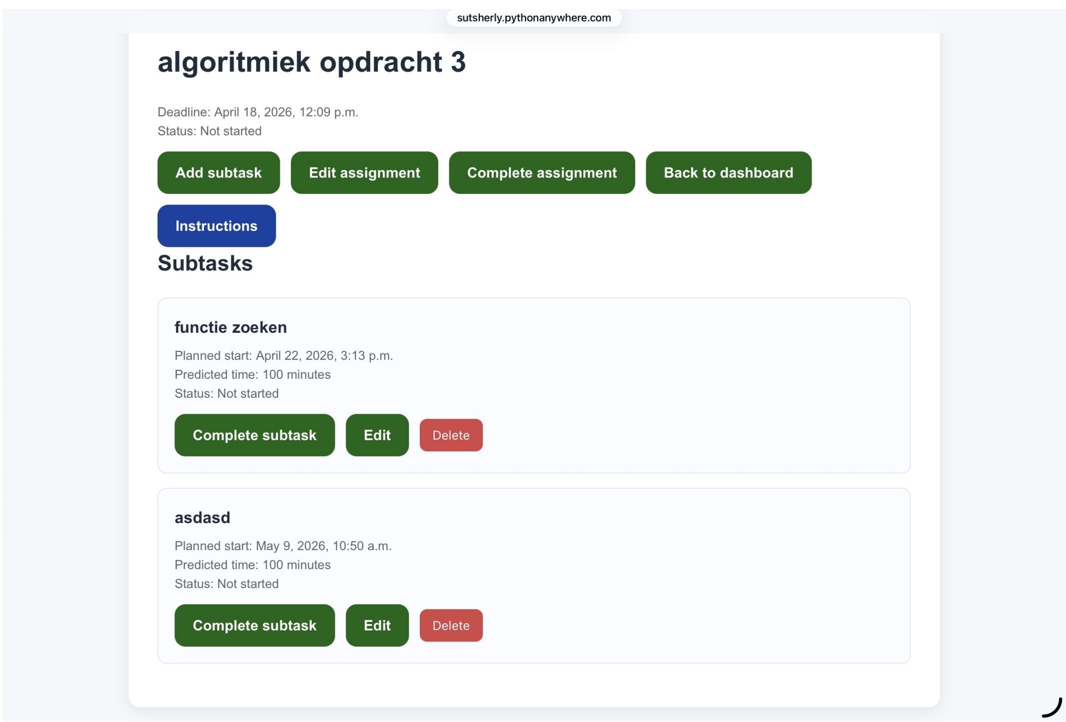

Figure 3: Overview of assignment

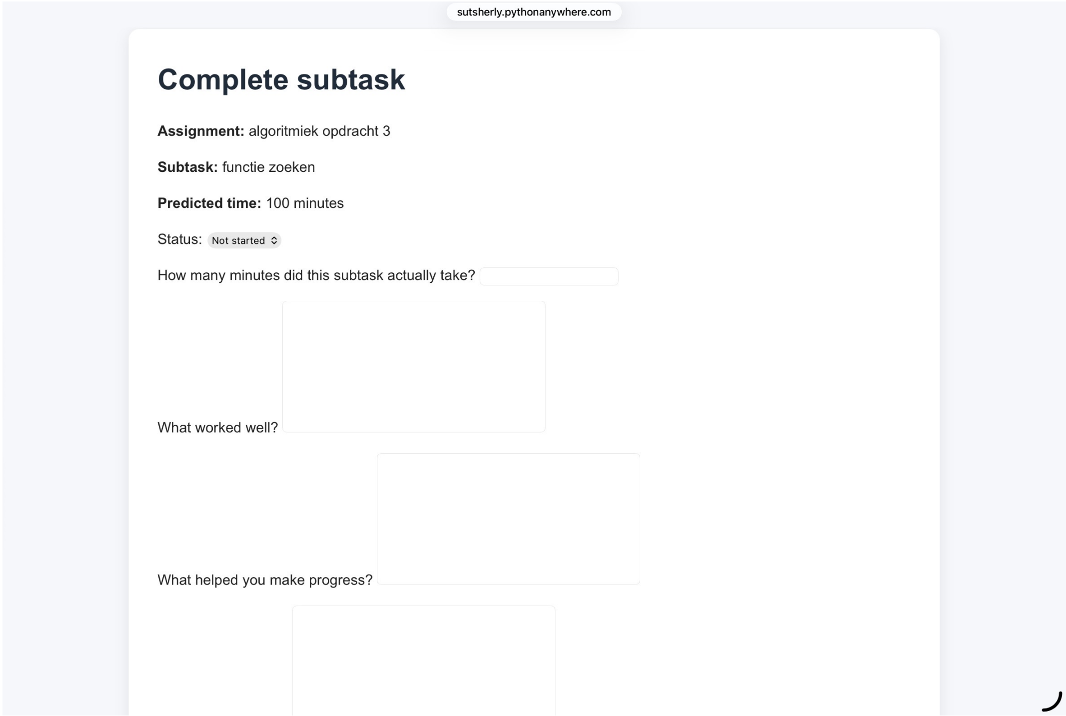

Figure 4: Reflection questions for finishing a subtask

The interface of the tool was designed around a simple task flow, see fig. 5. First, participants created an assignment, then added subtasks to that assignment and finally completed or updated subtasks. The flow was structured this way to reflect main stages relevant to self-regulated planning. It lets the user prepare the work beforehand, monitor their progress and reflect afterwards.

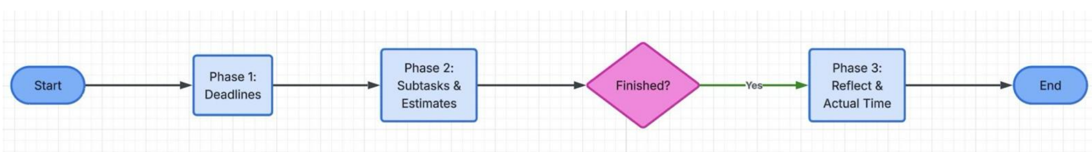

Figure 5: Task flow of the tool

3.4 Empirical Study

The study consisted of a first-use evaluation of the planning tool. Participants completed a brief task-based exercise during a single session. The aim of this experiment was to evaluate participants' first experiences with the prototype and to assess whether they found it helpful for planning academic work.

During the session, participants were asked to use the tool to complete a short planning exercise. They created one assignment, divided it into at least three subtasks, and for each subtask entered a planned start moment and a predicted amount of time in minutes. Participants were also asked to update at least one subtask by changing its status, entering the actual time spent, and filling in the reflection fields. In this way, participants interacted with the core features of the prototype in a structured and comparable manner.

3.5 Measurements

After completing this short interaction, participants filled in a survey consisting of 22 questions in total. The survey opened with four background questions, covering the participant code, study program, year of study and prior experience with digital planning tools.

This was followed by eight Likert-scale items addressing usability and clarity of the interface (e.g., "The tool was easy to use," "The structure of the tool was clear," "I understood the difference between assignments and subtasks") and five Likert-scale items addressing the perceived usefulness of the tool (e.g., "I found the tool useful for planning study tasks" "I found the tool useful for reflecting on time use"). All Likert items used a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Finally, the survey finished with five open-ended questions (Q18–Q22), covering what participants found most useful about the tool, what they found unclear or difficult, what they would improve, whether they would use the tool for their own study tasks, and any additional comments or suggestions. These questions allowed participants to give feedback in their own words, instead of being limited to the Likert-scale categories.

3.6 Analyses

Because this study was exploratory, focused on first use and involved a relatively small sample, the survey data was analyzed descriptively rather than with inferential statistics.

For the Usability and Clarity items (Q5–Q12) and the Usefulness items (Q13–Q17) the Cronbach's alpha was calculated separately to check the consistency of each category. And for both categories, mean scores, standard deviations and frequency distributions were calculated per item, in order to recognize a coherent outcome.

The answers to the five open-ended questions (Q18–Q22) were analyzed and grouped into themes. This was done in four steps. First step, all answers were read to get a grasp on the general experience. Second step, each answer was given a short label describing what it was about (for example, "liked subtasks" or "navigation was confusing"). Third step, labels that were similar were grouped together into themes (for example, all comments about navigation problems were grouped into one theme). Fourth, each theme was checked again, to make sure the grouping were still adherent to what participants actually said. This was done manually, due to the small number of responses.

To connect both types of data, the number of participants per theme was compared with the quantitative scores. For example, it was checked whether participants who mentioned navigation problems were also the ones with lower usability scores.

4 Results

4.1 Tool Development & testing

4.1.1 Deviation from the original study design

The original research proposal for this thesis planned a three-week study, in which first-year Computer Science students enrolled in the courses Algorithms, Databases, and Automata would use the planning tool over several weeks. This design was meant to track how students' time predictions changed over time and to answer the original research question and sub-questions, which focused on how students' time estimations change during use of the tool (SQ1), and the strategies and obstacles they report across multiple tasks (SQ2).

However, during recruitment it turned out to be difficult to find enough participants who were willing to commit to using the tool for three weeks. Several reasons likely played a role in this. First the study asked for a big time commitment, spread out over multiple weeks, while students already had a busy course load. Second there was no compensation for participating, which may have made students less willing to commit to a multi-week study on top of their normal work.

Because of this, the study design had to be adapted. Instead of a three-week study, a first-use evaluation was conducted in which participants used the tool once during a single session. As a result, the research question and sub-questions also had to be adjusted, from measuring how time estimation changes over multiple weeks, to measuring students' first impressions of the tool's usability and usefulness after one interaction. This is an important limitation of this study, and is discussed further in Section 5.

4.2 Development challenges

During the development of the tool, implementing the core functionalities went smoothly. The challenges were mainly related to visual design and navigation. For example, the colors of the buttons were not refined and the placements and ordering of the buttons on each page were not thought through due to time constraints.

The reflection section was not refined as much as it was intended. To get to this page, participants had to press the complete a subtask button. They were then asked to select a status (e.g., completed, in progress) for the subtask and to answer the reflection questions. These elements were not connected well, which made it unclear how selecting a status related to answering the questions.

Navigation between pages also had some inconsistencies. For example, editing an assignment from the dashboard would lead to the assignment edit page, but pressing the "return to assignment" button would then redirect the user to the overview page of the assignment, instead of redirecting back to the dashboard. In general, the connection betwen different functionalities and visual design choices such as color and button placement, are elements that could use further refinement in future designs.

4.3 Data Overview

In total, there were nineteen complete responses. Twelve participants were in their third year or higher, three were in their second year and four were in their first year. Fourteen participants studied a Computer Science or IT-related programme (e.g., Informatica, Computer Science, Data Science and AI, HBO-ICT) and the remaining five studied other programmes (e.g., Law, Pharmacy, Psychology).

4.4 Perceived Usability, Clarity and Usefulness

The Cronbach's alpha values were $\alpha = 0.87$ for Usability and Clarity, and $\alpha = 0.93$ for Usefulness (both above the .70 threshold), and the items in each scale can be combined into one average score per participant. The average combined scores were $M = 4.12$ ($SD = 0.78$) for Usability and Clarity and $M = 3.71$ ($SD = 1.18$) for Usefulness (both on a 1-5 scale).

Table 1 shows the average score for each individual item. All items scored above the middle of the scale (3). The Usability and Clarity scale scored higher than the Usefulness scale. The standard deviation was also larger for Usefulness, $SD = 1.18$ compared to $SD = 0.78$. The item that scored the highest was understanding the difference between assignments and subtasks ($M = 4.58$) and the item that scored lowest was how useful the tool was for estimating study time ($M = 3.32$).

Item	**Mean**	**SD**
Usability and Clarity	*4.12*	*0.78*
I found the tool easy to use	3.79	1.40
I found the structure of the tool was clear	3.84	1.26
I understood the difference between assignments and subtasks	4.58	0.84
I found it easy to add information in the tool	4.05	1.13
I found it easy to update information in the tool	3.95	1.18
I found the terms used in the tool clear	4.26	0.87
I found the instructions clear	4.26	0.65
I found the reflection questions clear	4.21	1.13
Usefulness	*3.71*	*1.18*
The tool helped me divide tasks into smaller steps	3.95	1.31
I found the tool useful for planning study tasks	3.68	1.42
I found the tool useful for estimating study time	3.32	1.29
I found the tool useful for reflecting on time use	4.00	1.11
I can imagine using a tool like this for my own work	3.58	1.46

Table 1: Mean and standard deviation per scale and per survey item (1-5 scale, $N = 19$)

The distribution of the answers per item is shown as stacked bar charts in Figures 6 and 7. Most participants gave a 4 or 5, while a small group gave a 1 or 2. The item on estimating study time is the clearest exception, where the answers were spread more evenly across the scale and only three participants chose the highest option.

In the Usability and Clarity scale there were sixteen ratings of 1 or 2 given in total, of which thirteen came from three participants. In the Usefulness scale there were 20 ratings of 1 or 2 given, of which fourteen came from three participants. The remaining participants gave almost no negative answers.

The participants who gave the lowest scores mentioned the following reasons: technical problem when editing an existing item; interface too difficult, but the concept useful; interface is clear, but did not see what tool added to their personal planning; and plans their work by task rather than time.

All ratings of 1 and 2 were given by Computer Science or IT students. None of the five participants from other programmes rated any question below 3. This is discussed further in Section 4.4.2.

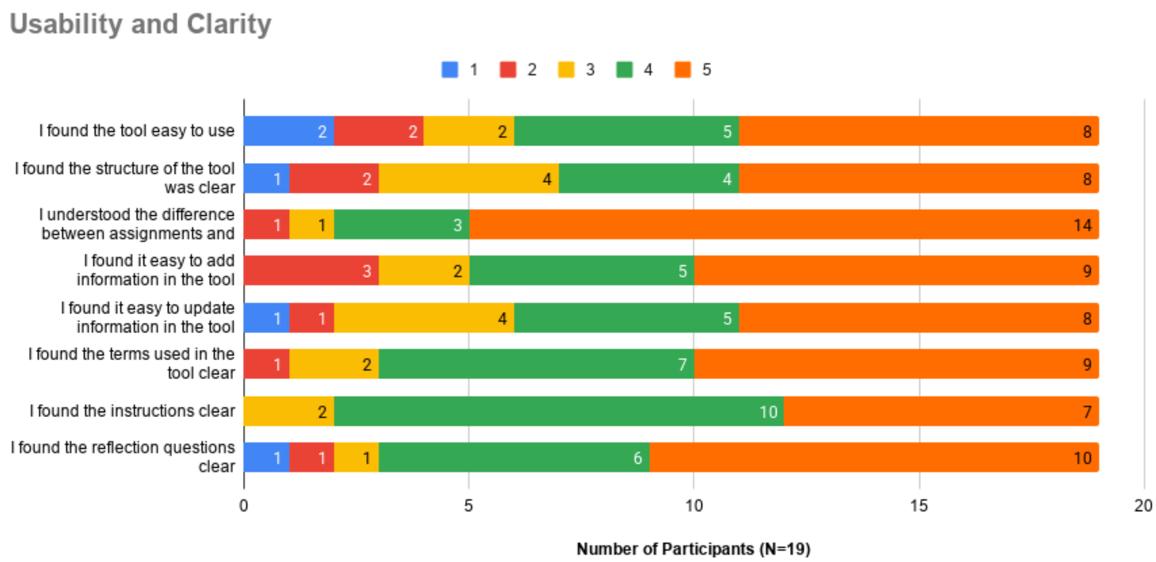

Figure 6: Stacked bar chart for Usability and Clarity

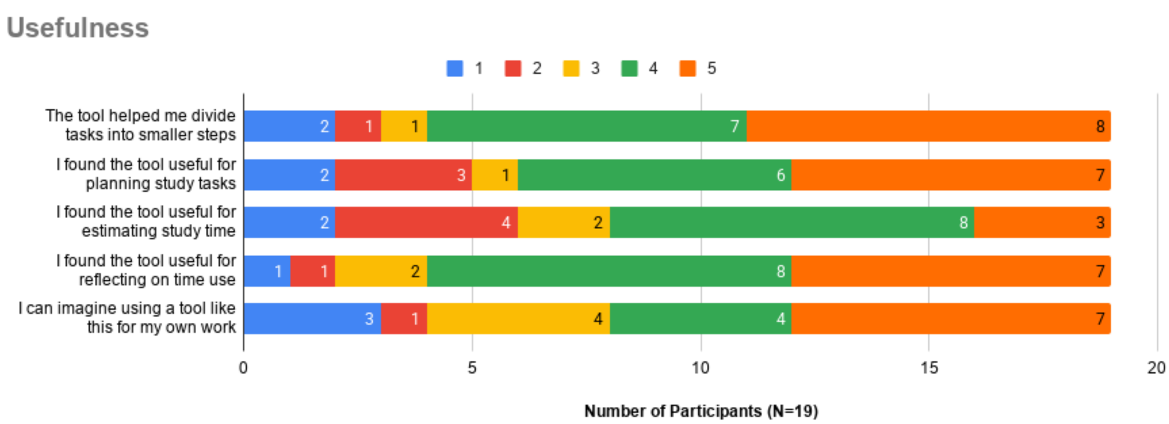

Figure 7: Stacked bar chart for Usefulness

4.4.1 Comparison by year of study

Group	N	Usability M (SD)	Usefulness M (SD)
1st year	4	4.41 (0.70)	3.80 (1.80)
2nd year and higher	15	4.04 (0.80)	3.68 (1.04)

Table 2: Mean scores and standard deviations by year of study

Table 2 shows the average scores split by year of study. These were not tested statistically, since the sample sizes were too small and unequal. The comparison is descriptive and only show a possible trend.

First-year participants ($n = 4$) had a higher mean on both Usability and Clarity ($M = 4.41$) and Usefulness ($M = 3.80$) than participants in their second year or higher ($n = 15$, $M = 4.04$ and $M = 3.68$). The standard deviations within both groups were larger than the difference between the two means, and were largest for Usefulness in the first-year group ($SD = 1.80$).

4.4.2 Comparison by study programme

Group	N	Usability M (SD)	Usefulness M (SD)
Computer Science / IT	14	3.91 (0.78)	3.36 (1.17)
Other programmes	5	4.70 (0.42)	4.68 (0.41)

Table 3: Mean scores and standard deviations by study programme

Table 3 shows the average scores split by study programme.These were not tested statistically, since the sample sizes were too small and unequal.

Participants studying a non Computer Science or IT-related program ($n = 5$) had a higher mean on both Usability and Clarity ($M = 4.70$) and Usefulness ($M = 4.68$) than participants from Computer Science or IT-related programmes ($n = 14$, $M = 3.91$ and $M = 3.36$). The standard deviations were smaller in the group from other programmes ($SD = 0.42$ and $SD = 0.41$), than the group from the Computer Science and IT-related program ($SD = 0.78$ and $SD = 1.17$).

4.5 Participants' experiences and suggestions

4.5.1 What did participants find most useful about the tool?

Eighteen participants answered this question. Nine out of these eighteen participants mentioned the ability to split assignments into subtasks as the most useful feature. Six out of eighteen mentioned having a clear overview or better organization of their tasks. One participant mentioned the date and time options specifically, and one participant said they did not see the point of the tool.

Some participants added an explanation why the subtasks were useful to them. One participant worte that the functionality of splitting it into subtasks makes them think about the small steps that were needed for a large assignment. Another participant wrote that creating subtasks was not a possible function in their normal agenda. Another participant noted that estimating time was useful, mostly for a moment of reflection, to see how long it actually would take and to lead to more realistic planning decisions.

4.5.2 What was unclear or difficult about the tool?

Seventeen participants answered this question. Four out of these seventeen participants said nothing was unclear. Four out of seventeen mentioned confusion about the navigation or menu structure. Four out of seventeen mentioned confusion around completing a subtask and its status. Three out of seventeen described difficulty with the planning process itself rather than with the tool. Two out of seventeen mentioned technical issues, such as fields being cleared when editing an existing item.

One participant wrote that it was difficult to think about how long they take for a task, and that the tool gave them a goal for finishing the task in time. Another participant answered this question by naming the struggle of thinking about how to divide a task into subtasks. Third participant wrote that it could be unclear how exactly to apply the tool to time estimation.

Two participants wrote that they found it hard to divide or estimate their tasks. And a third participant commented that they were not sure how to exactly apply the tool with their tasks.

The responses corresponding completing a subtask and its status were described by multiple participants. One expected the subtask to be completed after answering the reflection question, and did not notice that the progress needed to be changed. Another participant noted that the button named "complete subtask" does not complete the subtask is confusing. And a third mentioned the same point and added that the status option is difficult to find, because it is not placed under "edit".

Two participants also commented on the reflection questions. One wrote that they did not understand the question "What caused a delay", because their subtask took five minutes more than expected, which was not due to a delay. Another participant wrote that they were not motivated to fill in survey questions after finishing a subtask, but found the actual time spent interesting.

4.5.3 What would participants improve on the tool?

Seventeen participants answered this question. Six out of these seventeen participants suggested improvements to the visual design. Four out of seventeen suggested new features, such as a built-in calendar or labels for courses. Three out of seventeen suggested improvements to navigation, such as fewer page redirects. Two out of seventeen said no improvement was needed.

Responses around feature suggestions were specific. One participant listed multiple suggestions: Labels for different courses; priority options; filtering options, and sorting by deadline. Another suggested a dashboard for all subtasks, instead of only having it for tasks. A third participant suggested adding a break structure, for example a total of 120 minutes with two breaks of 10 minutes. Two participants suggested adding a tracker for your time estimates.

Several participants suggested a different interface. One participant noted that the reflection should feel visually optional and not be split into so many separate questions. Multiple participants asked for icons and different colour schemes. Another suggested using overlays instead of full pages, so it is easier to edit.

4.5.4 Would participants use the tool themselves?

All nineteen participants answered this question. Eight out of these nineteen participants said they would use the tool. Seven out of nineteen said they would not. Four out of nineteen gave a conditional answer.

The conditions of the four participants were all unique from each other. One participant noted they would only use the tool if it was easier to use. Another said they would use it, but only during busy periods. One said they saw it as a minimalistic tool and could use it if it had more functionalities. One said they were not organized enough to use it, even though it would be good for them.

The reasons of the participants that would not use the tool were also different from each other. Three of them wrote they have their own way of working: One said they already use their normal calendar, one said they do not plan in that much detail, and the other plan their work on task instead of time. One participant said they did not see the point, because other tools like obsidian and notion are more customizable and already integrated with their notes. The other three described the tool as too much work and not intuitive enough.

5 Discussion

This thesis started as an observation that first-year students are expected to manage their own study time, while their skills needed for this are still developing. It is especially more demanding in Computer Science, where much of the study load consists of programming assignments that students have to plan themselves and whose duration is difficult to estimate. Existing tools for self-regulated learning generally support planning. However, they do not focus on the difference between the time students expect to spend on their task and the time they actually used. To address this, a prototype planning tool was developed based on Zimmerman's SRL model [21], where students divide an assignment into subtasks, estimate how long each subtask take, report the actual time spent, and answer reflection questions. The tool was evaluated as a first-use study, where 19 participants completed a planning exercise and completed a survey with Likert-like and open-ended questions.

This section discusses the interpretation of the results. Four findings are discussed. First, the part of the tool that participants found most useful, which involved dividing assignments into subtasks. Second, usefulness of time estimation, which was the weakest part of the tool. Third, most of the feedback that mentioned the implementation more than the concept itself. Fourth, participants from Computer Science and IT-related programmes were less positive about the tool than participants from other programmes. After these four points, the section discusses the requirements for using the tool in practice, reflects on the limitations of the study, and considers directions for future research.

5.1 Creating subtasks was found the most useful

Participants found the functionality of dividing an assignment into subtasks the most useful. This feature was frequently mentioned as the most useful part of the tool. Participants who scored the tool low still named it as something they liked. One wrote that the subtasks made them think about the small steps first that were needed to finish a large assignment and another noted that this was a functionality that was not in their tool or agenda, which they normally use.

This corresponds to the reason why the feature was included. Buehler et al. [3] described the planning fallacy as the tendency to underestimate a workload. People tend to plan on a general idea of the work, instead of concrete steps they need to take. Forcing students to make those steps is way of working against this tendency. It also fits what Ramírez-Echeverry et al. [13] found in programming courses, specifically that students struggle to organize and structure their ideas and need support in their approach. For programming assignments, which steps to take first are not always clear from the beginning. This makes dividing tasks into subtasks a useful skill.

This suggested that the most liked part of the tool was a simple subtask implementation. The functionality supports the forethought phase of Zimmerman's model [21]. It is important to note this outcome, as simple features like this can still be useful for designing SRL tools

5.2 Prompting an estimate is not the same as supporting one

The second finding is the opposite of the first, participants were least positive about the usefulness of the tool for estimating study time. In the open-ended questions, some of the participants described their difficulties with their planning process rather than the tool itself. This is exactly the challenge the tool was meant to address.

One participant who noted dividing a task into subtasks as the difficult part also wrote that they would still use the tool. Since they usually do not make subtasks, they would not know how long a certain assignment would take to finish. For this participant the difficulty and the usefulness were the same thing. This suggested that a difficulty participants report is not always a problem that should be removed through design.

This aligns with the literature. Bjork et al. [2] described "illusions of competence", where learners misjudge how much material there is and how long it will take to finish it. Asking students to estimate the time needed highlights this problem, but it does not help them to make a better estimate. This problem can be seen again in the responses of the participants.

Di Benedetto et al. [5] found that students often fail in the self-reflection phase, since they do not look back at whether their planning and time estimates were realistic. Wang et al. [19] found that time management skills only improved when students tracked their time use over a longer period of time. The tool was designed to let students notice the difference between their estimate and actual time themselves but the two and their differences were never shown next to each other. This means a tool like this does not have to draw the conclusion for the student, but it does have to visualize the comparison.

5.3 The concept was more positively received than its implementation

The third finding is about the difference between the participants opinion of the concept and the implementation. They were more positive about the usability of the tool than its usefulness. The lower means stemmed from a small group with a clear negative opinion, rather than the whole group. Their open-ended answers showed that they had different reasons. One participant experienced a technical problem, another found the interface difficult to use but found the concept useful, and third said that the tool did not match the way they normally plan their own work. Another participant liked the interface, but did not see how the tool could add to their personal planning. This means low scores does not always mean the same thing. Interface problems could always be solved with a simple redesign, but problems with the concept itself is more complex.

Three participants described a similar problem with the button for completing a subtask. It took them to a page where they could also select the status "in progress", instead of directly completing the subtask. This created confusion around the pages and its purposes.

These problems are mostly parts of the tool that connect the workflow of the model. This matters, because reflection was also the step participants were not motivated to complete. One participant wrote that they were not motivated to answer the questions, but found the time feature interesting. Participants rated the usefulness of the tool for reflecting on time use high. This suggested that they disliked how the reflection was implemented and not the idea of reflecting itself. David et al. [4] showed that students who knew what a good planning looks like can still fall back to their bad habits. If the implementation of the reflection is not intuitive enough, it is easier for students to do that.

5.4 Computer Science and IT students were more critical

The fourth finding is on how participants from Computer Science and IT-related programmes rated the tool lower than participants from other programmes. All ratings of 1 and 2 in the study came from this group. The participants from the other programmes did not rate any item below the middle of the scale (3). Due to the small and unequal sample sizes, this variable was not tested statistically which means this could only be seen as a trend. However, it is still worth discussing since the tool was designed for Computer Science students.

The open-ended questions could give three possible explanations. First, their expectations. Computer Science and IT students are able to build software themselves and work with different applications. Their answers to the open-ended questions are also phrased in technical terms, such as user flow, UI/UX design, and full pages instead of overlays. This group tend to see an unfinished prototype differently than the other group.

The second explanation is that the tool got compared to those that they already use. One participant wrote that they did not see the point of using the tool, since Obsidian and Notion are customizable and integrated with their notes. Students who already use something that works need a tool that is better for them or have added functionality on top of what they have.

Third is that the tool did not match the way they plan. One participant wrote that they do not plan in that much detail. Another participant wrote that they plan their work based on tasks rather than time. The tool is built around time time management, so it does not fit students who organize their study load in a different way.

These explanations are more of a general problem, rather than a design problem. This tool was made with first-year Computer Science students in mind, but most participants were in their third year or higher. Their feedback says more about how the tool works for students that have more experience in grasping their materials, than about whether it would help a first-year student. This kind of tool could be most useful at the start of the programme, which is also what Van der Meer et al. [18] argued. It also means that these results do not show that Computer Science students would not benefit from a tool like this.

5.5 What would be needed to use the tool in practice

The four findings above also say something about how a tool should be introduced to students. Finding participants for a three week study turned out to be difficult, and several participants noted that they would not use the tool, since they already use something else or their work did not fit the tool's concept. This means that the tool competes with the way students already work and requires for extra effort on top of their normal coursework.

A review by Simón-Grábalos et al. [15] showed that tools integrated into courses tend to be more successful than standalone support. The review also showed that short and isolated interventions are often not enough. The 4planning app of Lobos et al. [8] was integrated into a programme, so students used it as part of their coursework. The system of Khiat et al. [7] was built into a learning management system and sent reminders to students who fell behind. In both cases students did not have to decide to use the tool themselves.

For a Computer Science programme, this means integrating the tool into a first-year course with large programming assignments, so that students actually have to plan the assignments. The tool would no longer compete with other tools students already use and students do not need to clear extra time for a separate study. It would also be used repeatedly instead of once, which is what Wang et al. [19] found important for developing time management skills. The estimates would build up over multiple tasks, which makes the comparison between estimated and actual time useful. This means that a tool like this may work better when it is integrated into the course rather than used as a separate tool.

5.6 Personalized feedback as a possible extension

The tool in this study asks students for an estimate, but does not help them to make it. Personalized feedback could be a way to improve this. Ng et al. [11] compared a generative AI chat bot (SRLbot) with a rule-based chat bot and found that the generative AI tool had a more effective impact on the students. It supported the students' behaviors and study habits through personalized feedback. Although this study was conducted on secondary school students, the findings are still relevant for university tool design, since they show the potential of AI-based tools for supporting self-regulated learning. Feedback that responds to what a student has actually done is different from a fixed set of questions.

In the current tool the reflection questions are the same for every subtask. One participant wrote that not all reflection questions applied to their assignment. The same participant also did not understand the question about what caused a delay, since their subtask had only taken five minutes longer than estimated, which they did not perceive as a delay. Feedback based on a student's own estimates and outcomes would avoid this. It could also give students something to base a new estimate on, which is the problem described earlier in this chapter. This is a direction for future work.

5.7 Limitations

The most important limitation is the change in study design as described in Section 4.1.1. The original plan was a three-week study, in which first-year Computer Science students would use the tool for three specific courses. Unfortunately, not enough participants were willing to commit to using the tool for multiple weeks, which changed the study design to a first-use evaluation.

A second limitation is the sample size. Participants were recruited through convenience and snowball sampling. Most of them were Computer Science or IT students in their third year or higher. The aim of this study was to evaluate a prototype and not to produce results that apply to all students, so this is less of a problem for the usability scale. It does matter for the usefulness scale, since most participants already had their own way of planning, which is not the situation the tool was designed for.

Finally, due to time constraints during development, the visual design and navigation of the tool were not fully refined, which may have made the usability scores lower than they would have been with a more polished interface. The open-ended answers were coded by hand by a single researcher, which may have made the coding process subjective.

5.8 Future research

Future research should try to address the limitations described above. A study closer to the one originally planned would be useful to answer how students' time estimation and planning behavior develop when they use the tool over a longer period, as discussed in Section 4.1.1. As mentioned earlier, this study would be easier to carry out if the tool were built into a course instead of being offered separately.

Two extensions followed from the findings of this study. The first is to show students the comparison between their estimate and their actual time use, and to test whether this changes their future estimates. The second is to test whether personalized feedback could offer more help than the fixed reflection questions used here. Improving the interface, especially the connection between the subtask status and the reflection questions, would be needed for both.

6 Conclusion

This thesis asked how students perceive a time management tool designed for first-year Computer Science students to support their study planning and estimation of study time. To answer this, a prototype planning tool was developed based on Zimmerman's model of self-regulated learning [21] and followed by a first-use study with nineteen students.

Participants perceived the tool as helpful for planning their study tasks, but less helpful for estimating the study time (SQ1). This suggested that some parts of SRL are easier for a tool to support. For example, a tool can help students divide an assignment into subtasks by asking them to write down the steps they need to take. Estimating how long a subtask would take is more difficult, since the current tool does not help them in estimating time more accurately. Students also need to be able to visualize the difference between estimated time and actual time, so that they can use this information to improve their future estimates.

The usability issues participants reported were mostly about navigation and interface design, rather than the core functionality (SQ2). Most of them were around the workflow for completing a subtask and its status. The confusing workflow may have made the reflection step harder to complete. Some participants also reported that they were not motivated enough to complete the reflection questions.

Computer Science and IT students rated the tool lower compared to students from other programmes, although this was not statistically tested and can only be seen as a trend. Their answers showed that they compared the tool to applications they were already using and that some of them had already their own way of planning. This suggested that the timing to introduce this tool matters. This tool may be particularly useful to help students who still have not developed a planning routine. For Computer Science this means that such a tool should be introduced at the start of the programme, and even better when it is integrated with specific courses with large programming assignments.

This thesis develops a tool that specifically targets the gap between students' predicted and actual study time, which was identified in Section 2.3.4 as missing in most existing self-regulated learning tools. Future research should test the tool over a longer period, with first-year Computer Science students and integrated into a course, so that it becomes possible to see whether their estimates actually become more accurate.

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