GymInf – Final Thesis

August 6, 2022

# planBar

## A Time Management Tool for Swiss High School Students


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Informatikausbildung für Gymnasiallehrkräfte

Formation en informatique destinée aux enseignant·e·s au gymnase

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**Project period:** October 2021 - August 2022

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# Acknowledgements

*planBar* is built from scratch and does not reuse any existing applications. In the context of this final *GymInf* project paper, finding out about the programming process was just as important as taking the first research steps in software engineering. Additionally, we wanted to be able to freely extend, modify, and personalize the application's features and integrate design principles that we met during the study program. *planBar* has not been open-sourced as of this point.

We want to thank the people who supported us in the developing process: Our project supervisor, Prof. Dr. Thomas Fritz, for providing valuable guidance, the students from *Kantonsschule Menzingen* and *Kantonsschule Beromünster* for their study participation and honest feedback, our families and loved ones, for putting up with us being stuck behind our screens .

# Abstract

School stress is widespread among high school students. It is caused by stressors such as the pressure to perform academically, the number of assignments, obligations from outside school, and, quite significantly, constant time pressure. Feeling unable to manage time can lead to frustration and decrease academic performance. Neither school administration software nor commercial digital planning tools successfully help students tackle this problem. We address this shortcoming and provide a digital approach to help students improve their time management.

In our work, we followed a three-step approach: First we conducted an initial survey (N=33) to elicit students' workload perception, coping strategies, and what features they expect from a digital time management tool. Based on our findings and previous work in the area, we developed the web application *planBar*. Finally, *planBar* was evaluated in cognitive walkthroughs (N=4) and a field study (N=13).

Although the field study only delivered a limited amount of data, our qualitative analysis allowed us to identify 16 development goals, such as considering the time needed for completing an assignment, offering granularity in the visualization of workload, or being able to register personal obligations. These development goals provide a starting point for researchers and developers interested in raising students' awareness of their workload and decreasing students' negative perception of school stress.

# Zusammenfassung

Schulstress ist bei Lernenden an Gymnasien weit verbreitet. Dieser wird durch Stressfaktoren wie akademischem Leistungsdruck, der Gesamtanzahl von Aufgaben, ausserschulischen Verpflichtungen und v.a. ständigem Zeitdruck verursacht. Das Gefühl, die Aufgaben in der verfügbaren Zeit nicht bewältigen zu können, kann zu Frustration führen und die schulischen Leistungen beeinträchtigen. Weder gängige Schulverwaltungssoftware noch kommerzielle digitale Planungstools helfen den Lernenden erfolgreich bei der Bewältigung dieses Problems. Unsere Arbeit fokussiert auf dieses Problem und bietet in einem digitalen Ansatz, der den Lernenden helfen soll, ihr Zeitmanagement zu verbessern.

In unserer Arbeit verfolgten wir einen dreistufigen Ansatz: Zunächst führten wir eine erste Umfrage durch (N=33), um die Wahrnehmung der Arbeitsbelastung durch die Lernenden, ihre Bewältigungsstrategien und ihre Erwartungen an ein digitales Zeitmanagement-Tool zu ermitteln. Auf der Grundlage unserer Ergebnisse und vorangegangener Forschung auf diesem Gebiet entwickelten wir die Webanwendung *planBar*. Schliesslich wurde der Ansatz in kognitiven Walkthroughs (N=4) und einer Feldstudie (N=13) evaluiert.

Obwohl wir nur eine begrenzte Menge an Daten aus der Feldstudie sammeln konnten, ermöglichte unsere qualitative Analyse, 16 "Development-Goals" zu identifizieren (z.B. das Berücksichtigen der Zeit, die für das Erledigen einer Aufgabe benötigt wird, die Granularität bei der Visualisierung der Arbeitsbelastung oder die Möglichkeit, persönliche Verpflichtungen zu erfassen). Diese Development-Goals bieten einen Ausgangspunkt für Forscher:innen und Entwickler:innen, die daran interessiert sind, das Bewusstsein von Lernenden bezüglich Arbeitsbelastung zu schärfen und deren negative Wahrnehmung von Schulstress zu verringern.

# About the Authors

Both Roman and Jonas are teachers at Swiss High Schools (Gymnasium). Together, they have been working at eight different schools in six Swiss counties. Their joint teaching experience amounts to 20 years of practicing in the field as tutors and subject teachers for Maths, English, History, and Computer Science. They currently take on the role of head of faculty, work in school internal IT development and support teams, and plan their school's timetables.

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# Chapter 1

# Introduction

School stress is a widespread phenomenon experienced among high school students [OECD, 2016; Pascoe et al., 2020; Martinek and Carmignola, 2020; Lohaus et al., 2007c]. It is not only caused by the pressure to perform academically but also by the overall number of assignments and obligations adolescents face in their everyday lives [Martinek and Carmignola, 2020; Lohaus et al., 2007b]. Failing to maintain clear assignment overviews and inefficient time management are key reasons why students feel as if they are unable to cope with their workload successfully [Kaluza, 2015; Lohaus et al., 2007b]. Further, failing to feel able to cope with stressful situations can cause frustration and therefore end in decreasing academic performance [Pascoe et al., 2020]. On the other hand, a situation considered stressful does not automatically imply that the situation is perceived negatively depending on the feeling about the ability to cope with it [Kaiser et al., 2021]. Therefore, besides the overall workload also coping strategies are a relevant parameter when it comes to the definition of stress. Thus, it is an important educational goal to invest in developing students' functional coping skills [Pascoe et al., 2020].

## Problem

Although there are school administration software (henceforth SAS) products or time management tools that allow registering assignments, they fail to comprehensively take students' workload into account: While assessments[1] are usually registered in SAS systems, homework assignments or personal obligations are not recorded. The estimated time required for the completion of these assignments is not considered. As a result, students and teachers often cannot see what the actual workload situation is. The workload can accumulate, learners struggle to keep track of their assignments, and planning becomes a conundrum that causes widespread stress and frustration.

This stress and its longer-term impacts raise increasing concerns, as outlined in a recent research review by Pascoe et al. [2020]. Offering ways to facilitate better time management should (a) make it easier for students to plan their assignments throughout their work week, and (b) make it easier for teachers to see the amount of work their students need to accomplish.

## Research Questions

The following research questions result from the above:

[1] In the following, we will use the term "assessment" to describe marked assignments such as exams, short tests, projects, presentations, etc. in the following.

**RQ-1** What is the current situation for students at (two) Swiss high schools concerning (a) how high their workload is, (b) whether their workload varies throughout a school year, and (c) how students cope with their workload?

**RQ-2** Can a new digital tool capture students' workload comprehensively so that students (a) are able to use it, (b) gain higher awareness of their workload, and (c) develop a less negative perception of stressful situations?

To answer these research questions, we followed a three-step approach: First, we conducted an initial survey on how students perceive their workload, what coping strategies they employ, and what they would expect from a digital tool addressing issues related to school stress. Second, we developed the application *planBar* based on development goals we had identified from the related literature and our findings from the initial survey. Third, *planBar* was tested during a user test phase that consisted of cognitive walkthroughs (N=4) and a field study (N=13). We used the results from the cognitive walkthroughs to refine our approach with the idea that our application then allows investigating RQ-2. Although we could only collect a limited amount of data from the field study to properly answer RQ-2, our qualitative analysis allowed identifying 16 development goals (cf. Section 6.5). These development goals provide a starting point for future approaches aiming at raising students' awareness of their workload and improving students' time management.

## Structure

The paper at hand first draws on existing work to provide background information on school stress, coping strategies, and related software design aspects. From this, we identified eleven development goals for an approach to help students manage their time. The second section presents results and key findings from the initial surveys. Both parts allowed us to develop *planBar*. Chapter 4 showcases *planBar*'s main concepts and components to explain how the development goals were implemented. Our evaluation of this approach is then introduced and discussed in the remaining sections.

When developing *planBar*, we chose an iterative, feedback-driven development approach to familiarize ourselves with students' expectations and the programming environments we had used (cf. Section 4.1). Figure 1.1 visualizes the development process (the parts covered within the scope of this project are highlighted in blue):

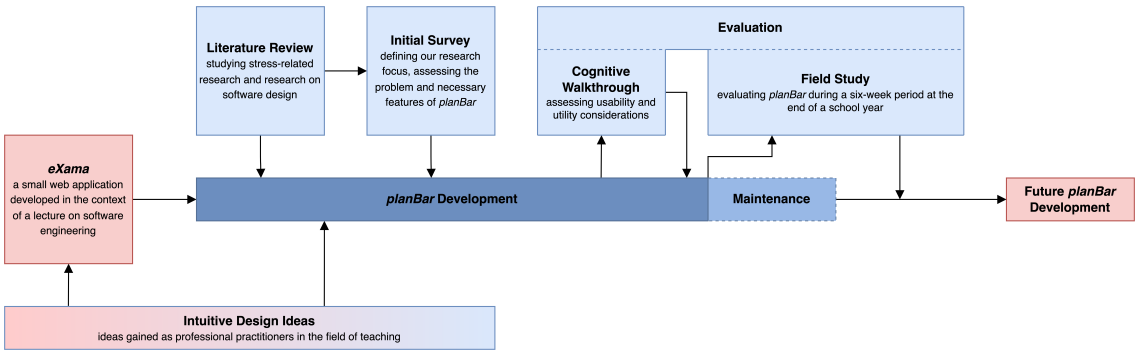


**Figure 1.1**: Development process of *planBar*

We provide open-sourced, supplementary material [Balsiger and Pfäffli, 2022] which contains a more detailed list of our survey and interview questions, high-resolution figures shown in this paper, the necessary *planBar* application files for demonstration purpose as well as screenshots of what *planBar* looked like at different stages of its development.

# Chapter 2

# Related Literature

We reviewed previous studies on stress during adolescence, coping strategies, and related software development practices to identify development goals for an approach to help students in high school improve their planning skills. Stress-related research focusing on adolescents is extensive in both psychology and pedagogy. Given the context and scope of the paper at hand, we will only refer to some core concepts, and our selection of related literature focuses on Swiss and German educational contexts.

## 2.1 School Stress during Adolescence

By definition, the term "school stress" describes students' subjectively perceived work overload [Zollneritsch, 2007]. An OECD [2016] study revealed that school stress is an international phenomenon and studies by Lohaus and Ball [2006] in the 1990s already indicated that this is a widespread phenomenon among this peer group: Out of 342 students aged 8 to 18, 72% of the participants aged 7-11 and 81% of the participants aged 12-18 reported that they experience stress. The more recent study by Martinek and Carmignola [2020] confirms these findings. In addition, 19% of Martinek and Carmignola's respondents report feeling pressured by time constraints at school due to both the number of assignments and the density of assignment deadlines. Time pressure is the most frequently mentioned source of stress besides the assessments themselves, which highlights the importance of efficient time management in education.

Interestingly, however, while Pascoe et al. [2020] show the negative impact of school stress on academic achievement, Kaiser et al. [2021] come to different conclusions: They could not confirm the thesis that time pressure infringes students' "experience of autonomy", which in turn causes frustration and, thus, decreases their academic performance. Kaiser et al. try to explain this by pointing out that time constraints "can be perceived as pressure, but they simultaneously structure the work process. Structure (in turn) is important for learning" [Kaiser et al., 2021, p. 1419]. Meyer's [2014] widely acclaimed principles of good teaching also stress the importance of structure for successful learning.

Kaiser et al.'s [2021] findings show: If a situation is experienced as stressful, this does not automatically imply the situation is perceived negatively.[1] Students who know that they have three days left to study after the announcement of an assessment and who also know how to revise effectively will perceive the announcement differently than others who do not have adequate

[1] Lohaus et al. [2007a, p. 7] define the negative perception of a situation as "Stressempfinden" and clearly distinguish it from experiencing stress per se.

strategies to use the time given. Therefore, Lohaus et al. [2007a, p. 7] consider a second parameter to be equally relevant in their definition of "stress": coping.[2] An individual's evaluation of a stressful situation depends on the individual's coping abilities and whether one feels as if the situation can be coped with. If so, the situation takes on the character of a challenge and loses its menacing connotation. Yet, Zollneritsch [2007], as well as Lohaus et al. [2007b] show that stressful situations in connection with school assignments are evaluated negatively by more than 80% of the surveyed students [Lohaus et al., 2007a, p. 18]. Students, thus, predominantly do not recognize their ability to cope with these situations (enough). Figure 2.1 illustrates which situations adolescents perceived as particularly stressful.

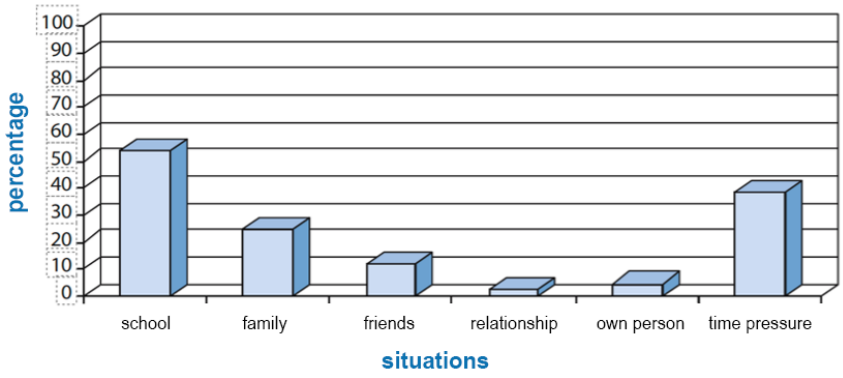


**Figure 2.1**: Situations Year 5 to Year 12 students perceive as stressful [Lohaus et al., 2007b]

Figure 2.1 reveals the significance of school and time pressure compared to other sources of stress for adolescents. The most significant source of stress (33%)is generated by the educational setting itself. Slightly more than half of the respondents mentioned this source of stress. Both internal factors (such as cognitive overload) and external factors (such as time pressure or pressure to perform academically) were named as causes. Time pressure resulting form assessments and homework assignments is another key contributing factor that participants explicitly mention in Lohaus et al.'s [2007b] study.

## 2.2 Coping Strategies

Stress-related research shows the close connection between the ability to structure workload, time management, and adolescents' negative perception of stressful situations in the educational context.

Like many other authors, Carver et al. [1989] further explored Lazarus' concept of coping. They categorize various coping strategies in a catalog still referred to in current research [Klapproth et al., 2020]. We used this as the basis for our initial survey in this project. Carver et al.'s catalog introduces an interesting distinction between functional coping strategies, which are considered constructive, and dysfunctional coping strategies [Carver et al., 1989, pp. 268-271]. In the following, four of these strategies are examined more closely in terms of how they enable

[2]This second parameter relates Richard S. Lazarus' [1966] concept of "coping" which he understands as an attempt to tolerate, mitigate, or avoid stressful situations (cf. [Semmer and Zapf, 2017])

people to cope with stressful situations and which development goals we can derive from these strategies.

### 2.2.1 Time Management

In the educational context, time pressure is a stressor[3]. Kaluza [2015] sees being pressed for time as an omnipresent background stressor: "Constant time pressure, the chronic feeling of lack of time, and rushing are [...] frequent triggers for [negative] stress reactions" [Kaluza, 2015, p. 64]. When time management is considered in therapy, practitioners ask clients to reflect on how time is handled "so that they can recognize their own behaviors and attitudes as contributors to the problem and find suggestions for better time management" [Kaluza, 2015, pp. 168–169].

To explain the phenomenon of constant time pressure, Kaluza names various factors: bad planning, procrastination, dwelling on unimportant things, not setting clear priorities, working excessively long hours, not taking breaks, frequently switching from one task to another, leaving no room for the unexpected, disregarding one's own rhythm, or poor structure [Kaluza, 2015, pp. 253–254]. Successful time management realistically assesses the time required and sets time limits for each task. The latter helps people control their expectations and perfectionism.

Connecting to this range of factors causing time pressure, Lohaus et al. [2007b] introduce another aspect: personal obligations from outside school. Many young people do not only face a packed schedule due to school duties but also because of appointments at sports clubs or practicing musical instruments. Moreover, many adolescents use their free time to earn pocket money. In their study with a total of 1957 students, Lohaus et al. [2007b, p. 51] found that Year 11 and Year 12 students spend an average of about 7 to 8 hours a week, a substantial portion of available free time, on earning money. To manage time successfully, Lohaus et al. [2007b, pp. 161-163] therefore recommend filling in a weekly schedule so that the times that are not already filled by school duties, i.e., the times in the evening, on weekends, and in between classes, are used efficiently.

Based on these studies, we identified the first set of development goals (DG) for an approach to support students in their time management:

**DG-1** Users can set time limits for assignments.

**DG-2** Users can register personal obligations from outside school.

**DG-3** Users themselves can define when they want to start working on an assignment.

### 2.2.2 Prioritizing

Not every time management problem, however, can be solved by cleverly redistributing tasks on the timeline. Sometimes it is necessary to reorganize tasks in a new, better order. A simple "to-do list" can already be efficient [Kaluza, 2015, p. 256]. Yet, setting priorities is a more sustainable solution to gaining control over time. Setting priorities filters, evaluates, and organizes activities. In practice, the distinction between "importance" and "urgency" of tasks has proven useful: "The importance of a task derives from its significance to reach one's own goals. [...] Urgency of a task derives from the amount of time in which a task ought to be completed." [Kaluza, 2015, p. 254]

[3]"Stressors" are external influences that trigger a stress reaction. They vary in form and can be anything from an accident at school, an assessment evaluation which is perceived as unfair, overheated classrooms to school material that was forgotten at home.

Being able to distinguish between the importance and urgency of a task is of great importance for setting priorities adequately. Therefore, Kaluza develops the following matrix (2.2) to organize tasks into four priority levels:

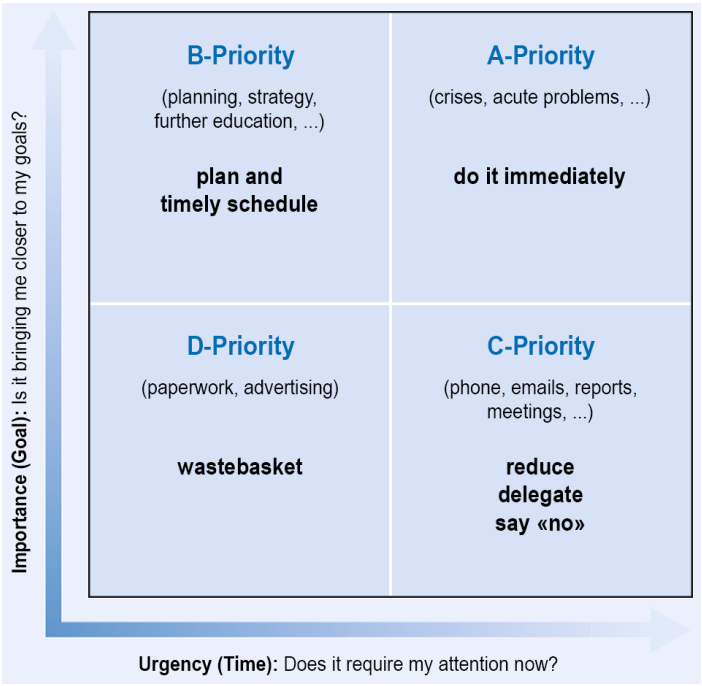


**Figure 2.2**: Prioritization in Kaluza's priority matrix [Kaluza, 2015, p. 254]

Kaluza's prioritization technique, also known as the Eisenhower Matrix, is used when stressful situations are not predictable and the controllability of the situation is limited [Kaluza, 2015, p. 65]. This is true for students, who cannot independently control how many assignments they must complete. In this respect, their workload is determined by teachers. Kaluza's prioritization strategy aims at increasing controllability in this situation:

- The "A-priority" is seen as the highest priority because tasks in this group are both important and urgent.
- "B-priorities" are tasks that are important but not urgent (yet). It is these tasks that are often neglected in everyday life, although they are the tasks that lead to success and satisfaction in the long run due to their personal relevance.
- This contrasts with the "C-priority" tasks: these seemingly urgent but unimportant or less important things (such as e-mail requests, etc.) cause what Kaluza labels as the "dictate of urgency" («Diktat der Dringlichkeit») because they feign a "fake urgency" and "fake importance" [Kaluza, 2015, p. 255].
- The lowest priority ("D-priority") is attributed to tasks that are neither important nor urgent. These are things that we should give up, cancel, or delegate.

Once prioritized tasks have been completed, Lohaus et al. [2007b, p. 169] suggest one should celebrate the moment when crumpling up a task note and throwing it in the wastebasket. This creates the feeling that something has been accomplished and motivates people to continue working.

Taking Kaluza's approach into account, the following development goal was identified:

**DG-4** Users are encouraged to sort assignments into different priority groups.

### 2.2.3 Procrastination

Cassady and Johnson [2002] investigated another coping strategy: "procrastination", i.e., the delaying of tasks. Carver et al. [1989] categorize this strategy as dysfunctional. Researchers have been able to prove the relationship between procrastination and lower academic performance [Akinsola et al., 2007; Cassady and Johnson, 2002; DeRoma et al., 2003]. Lohaus et al. [2007b, pp. 161-163] also consider procrastination when making suggestions about reducing school stress. They conclude: "The most important study technique is to start studying." Those who delay their work for as long as possible expose themselves to stress as they give away controllability.

From the above, we identified another development goal that aims at reducing procrastination:

**DG-5** Users are warned when there is not enough time to complete their assignments.

### 2.2.4 Follow-up Inspection

Finally, the importance of follow-up inspection as a coping strategy ought to be considered. Systematically reviewing what one has accomplished provides a motivating sense of accomplishment (when completed items can be crossed off) and the opportunity to reconsider uncompleted tasks or unrealistic expectations. The learning effect improves time management, planning skills, and insight into the personal work rhythm [Kaluza, 2015, p. 256]. Software development research on self-monitoring and productivity tracking in the workplace come to similar conclusions [Meyer et al., 2017]. Productivity can be increased through self-awareness about one's productivity. The following chapter will discuss what this means for designing web applications. Given the usefulness of follow-up inspections concerning productivity, we identified the following development goal for an approach to support students in their perception of work progress:

**DG-6** Users can follow up on their work progress to see how well tasks have been completed.

Overall, active time management, structured task management, and reflection on the work process are essential to avoid the negative perception of school stress. These coping strategies increase controllability and reduce uncertainty due to a lack of clarity. Good planning is, therefore, a central element for learning success. Lohaus et al. [2007d] and Pascoe et al. [2020] conclude that it is an important educational goal for the future to invest in developing students' functional coping skills.

## 2.3 Software Development Context

School administration software (SAS) such as Centerboard's *schulNetz* [Centerboard, 2022] as well as software products in the field of time management (e.g., *RescueTime* [RescueTime, 2022]) or task management (e.g., *TickTick* [TickTick, 2022]) continue to evolve at a fast pace. While Meyer et al.

[2017] found that many existing commercial self-monitoring tools only provide little room for personalizing and customizing, these tools seem to undergo ongoing change (based on our observations during this project). Observing how self-awareness through self-monitoring increases user productivity in the workplace, Meyer et al. [2017] derive design recommendations for self-monitoring tools. Based on their work, we identified the following recommendations as development goals for an approach to support students in their time management:

**DG-7** The application presents diversity in the set of workload-related measurements.[4]

**DG-8** The application offers granularity in the visualization of workload.[5]

**DG-9** The application allows users to fill in brief and periodic self-reports.

**DG-10** The application makes specific, actionable recommendations to motivate behavioral change.[6]

Similar research on the use of SAS has not been conducted, but Meyer et al.'s findings can be related: market-leading tools like *schulNetz* still fall short in allowing data personalization and practical high-level visualization, let alone offering a variety of measurements or actionable recommendations.[7] A plausible reason is that SAS solutions are predominantly designed to facilitate administrative processes, a colossal task by itself [Däniken, 2022], rather than usability for students or teachers.

On the other hand, more user-focused task and time management software, c.f. *TickTick* [TickTick, 2022], has started to implement design recommendations as outlined by Meyer et al. A symbiosis of the three software application areas, however, has not occurred. While SAS data remains static and incomplete, task management tools do not consider how time needed to complete tasks influences the workload. Time management tools, in turn, relate to professional workplaces and track activities on electronic devices. This concept revolves around the sole use of these devices and, therefore, does not accurately mirror the students' work situation, which is still analog and digital [Grogorick and Robra-Bissantz, 2021]. This lack of symbiosis allowed us to identify another development goal:

**DG-11** The application builds on existing data from the school administration software.

[4] Meyer et al.'s [2017] projects participants wished to gain insight into correlations of all sorts of measurements reaching from positive or negative productivity to the impact of collaborative behavior or the impact of aspects such as sleep and exercise.

[5] I.e., the application creates aggregated, high-level overviews such as charts that quickly reveal to the users what is going on, but which are interactive so that users can drill down into detail.

[6] Meyer et al.'s [2017] participants recommended ideas ranging from pop-up recommendations all the way to blocking certain services for a period of time.

[7] The only visualization that *schulNetz* offers has been introduced during the course of this project and is an exam schedule which does not manage to comprehensively visualize students' workload.

# Chapter 3

# Initial Survey

To see whether students' ideas about a digital planning tool to help with time management confirm the development goals identified in Chapter 2, we conducted an initial survey with a test group from two Swiss high schools (N=33). The objective of this survey was to assess the current situation of the participants regarding workload, the associated stress perception, and students' coping strategies related to stress. In addition, we investigated whether and how the participants already use digital planning tools and which features they think a new approach would have to offer. This allowed investigating RQ-1.

## 3.1 Participants

Initially, the survey participants included 42 students (F=23, M=18) from two Swiss high schools (Kantonsschule Menzingen, N=21; Kantonsschule Beromünster, N=21) aged 15 to 19 (Years 9 to 12). All participants attend classes taught by one of the authors of the study. Prior to the survey, permission to conduct research had been granted by both school boards. It was agreed that the following had to be provided to ensure that the study does not pose any ethical concerns:

- Participation in the study is strictly voluntary; the participants can drop out at any point without needing to explain themselves
- The survey is conducted anonymously to make it impossible for the authors to trace who does (or does not) participate

## 3.2 Method

Our questionnaire was divided into five main sections. It was not possible to navigate back to a section once finished it:

1. Consent and personal information (age, grade, sex)
2. Workload amount and stress perception (RQ-1 a)
3. Workload distribution within a school year (RQ-1 b)
4. Work organization and digital tools (RQ-1 c)
5. Coping strategies regarding stress (RQ-1 c)

The questionnaire consisted of five-point Likert scale questions like *In my view, the workload is evenly distributed throughout the school year (Q13.1)* or *I often realize how many different tasks I have to deal with too late (Q15.3)*. In these questions, the participants indicated their level of agreement. We decided to give the participants room to elaborate on their answers by asking open questions like *If possible, please explain why you have chosen the answers in the previous set of questions (Q14)* or *How do you organize yourself when the workload is heavy? (Q16)*.

The questionnaire was first tested on a pilot group to ensure that the questions were understandable.

Participants were interviewed during a regular school week and they completed the online questionnaire while sitting in a classroom. We supervised the participants during the interview.

## 3.3 Data Analysis

First, all participants whose answers indicated that they had not seriously completed the questionnaire were excluded. Specifically, this concerned one participant where the response to the question about what services a digital tool should provide said: "provide inspirational quotes by Shakespeare".

Second, for the sample to be representative within each survey group, a participation rate of 80% was defined. Two of the four groups, Year 10 (N=20, 90.9%) and Year 11 (N=13, 100%), satisfied these requirements.

Third, a significance level of .05 was set for the quantitative analysis. After labeling of responses to the open questions and frequency analysis, the data was tested on normal distribution before further analysis. The tests showed that the data was not normally distributed ($p<.05$)[1]. Hence, we used the correlation coefficient Spearman-Rho.

## 3.4 Findings (RQ-1)

### Workload and Stress

81.8% of the participants state that their workload is rather or not at all evenly distributed throughout their school year (RQ-1 b). They experience the uneven distribution of workload throughout the school year in an accumulation of exams before vacations and when project deadlines collide. Poor planning on behalf of the teachers is often mentioned:

> *We always have periods with many exams and others with just a few. The assessments are not well distributed. The teachers do not coordinate.*

> *There are often periods that, from the student's point of view, are poorly organized by the teachers: many projects deadlines accumulate, and all language subjects hold oral exams.*

However, students also see themselves as a contributing factor:

[1]The null hypothesis of the two tests for normal distribution (Kologorov-Smirnov and Shapiro-Wilk) is *the data is normally distributed*. With a $p<.05$ for all items, the null hypothesis is, thus, rejected.

> *I do everything at the last minute, and then I often have one or two days to deal with a lot and cannot always accomplish everything.*

> *During weeks without exams, I often do not do anything for school instead of using the time to already prepare for the next week. I usually forget to include evenings when I come home late for studying in my planning.*

Students' answers revealed that spending up to 30 minutes a day on school work outside class is seen as rather little to normal. Spending more than 60 minutes is perceived as a lot. Furthermore, participant responses show that if students need to work for more than 60 minutes a day, they perceive the workload as stressful. Coping with a daily workload smaller than 30 minutes is manageable. A moderate correlation (rho=0.542, p<.05) between the amount of time spent on school work outside class and participants' perception of work effort supports the validity of these findings. Additionally, the participants' negative perception of stress moderately correlates (rho=0.458, p<.05) with how much effort they think they had put into their work.

Students' average daily workload of 53 minutes of extra work outside classes also varies greatly (min=10, max=180, sd=42.3). (RQ-1 a) In terms of exam preparations, the data reveals that the amount of time spent on assignments varies greatly (within each survey group and between both schools).

Interestingly, participants spend an average of 117 minutes (sd=77.975) preparing for an exam. When five assessments are due in a work week, which is not uncommon in the authors' experience, the average daily workload spread across seven days adds up to 83.4 minutes, excluding other assignments. Based on our findings, the resulting workload is stressful for most students.[2]

## Coping with Workload

75.8% of the participants account that they have a good to a very good overview of their workload. 75.7% state that they can estimate the time needed to complete school work well to very well. Only one respondent indicated that she or he uses follow-up checks. All the other participants (97%) indicated that they do not employ a systematic follow-up. conducted to find out if the initial time estimate was correct. (RQ-1 c)

To organize their work, the participants mainly write to-do lists (63.6% sometimes to very often), prioritize to-do list items (65.9% sometimes to very often), and keep a homework book ("Hausaufgabenheft") (75.8% sometimes to very often). According to student responses, the main benefit of these techniques was the overview that they provide over the upcoming assignments:

> *[B]ecause [when writing to-do lists] I have an overview over the whole week. I always highlight exams and appointments using a specific color. That way, I can see when a busy period is coming up.*

Sometimes motivational aspects were mentioned too:

> *[I]t is a great feeling when you can cross off everything.*

A problem frequently referred to in this respect was that the homework book is often incomplete because students find it difficult to consistently make entries throughout the day.

[2]Four assessments a week already accumulate to a daily workload of 67 minutes, excluding other assignments.

## Digital Tools

Although all participants work with smartphones and laptops on a daily basis, digital tools to manage time and organize assignments are used by only nine (27.3%) of the 33 participants (RQ-1 c). The most frequently mentioned applications are Microsoft's *To-do*, Apple's *Notes*, and Microsoft's *OneNote*.[3] According to the participants, these tools help them keep an overview of pending assignments. Participant responses mentioned that one drawback of analog organizational strategies is students often lose their handwritten notes or do not have their homework book with them when they need it (in contrast to their smartphones).

Except for four students, all respondents (87.9%) indicated that they would use a digital tool and compare it to their analog organizational technique if the tool satisfied their needs. The respondents were also asked what such a digital tool should be able to do so that they would use it. The most frequently mentioned suggestions from this open question are:

- providing weekly overviews [N=12]
- setting deadlines [N=11]
- providing the possibility to plan [N=8] and setting reminders [N=8]
- considering the amount of time needed to be complete an assignment [N=6].

## Summary

The survey reveals that students' workload varies significantly throughout the school year. The reasons almost exclusively relate to bad planning – on behalf of both teachers and students. Students perceive the average daily workload of 53 minutes for work outside class as normal, but it is close to their limit of 60 minutes - the point from which students perceive the workload as stressful. Due to the differences in the course of the school year, there are always times when students feel stressed. If these differences can be evened out, the effective workload can be brought closer to the average workload. This would mean that the workload would more often be perceived as normal and, in conclusion, manageable. An approach to help students improve their time management should take the most commonly mentioned problems (cf. Section 3.4, Workload and Stress) and the participants' suggestions (cf. Section 3.4, Digital Tools) into consideration:

1. Reduce workload peaks due to accumulations of assignments
2. Enable personalized organization and planning of assignments (DG-2, DG-6)
3. Consider the aspect of time spent on completing assignments (DG-1, DG-3)
4. Discourage dysfunctional coping strategies (procrastination) or bad planning due to a lack of clarity by providing clear high-level overviews (DG-5, DG-8)
5. Use assignments that are already registered in SAS to reduce the risk of incomplete assignment registration (DG-11)

In many ways, participant responses directly confirmed the relevance of seven development goals identified in Chapter 2.

[3] Even Microsoft's *Word* was found among the participants' responses.

# Chapter 4

# Approach: *planBar*

In Chapter 2 we identified practical development goals for an approach to support students in their time management (see overview below). Based on these goals, we developed the application *planBar*. First, this chapter presents technical aspects of the application and how it uses existing SAS data. Then, *planBar*'s main components are introduced to show how an approach could be developed. This second part is structured along development goals DG-7 to DG-10 (cf. Section 2.3).

**DG-1** Users can set time limits for assignments.

**DG-2** Users can register personal obligations from outside school.

**DG-3** Users themselves can define when they want to start working on an assignment.

**DG-4** Users are encouraged to sort assignments into different priority groups.

**DG-5** Users are warned when there is not enough time to complete their assignments.

**DG-6** Users can follow up on their work progress to see how well tasks have been completed.

**DG-7** The application presents diversity in the set of workload-related measurements.

**DG-8** The application offers granularity in the visualization of workload.

**DG-9** The application allows users to fill in brief and periodic self-reports.

**DG-10** The application makes specific, actionable recommendations to motivate behavioral change.

**DG-11** The application builds on existing data from the school administration software.

## 4.1 Technical overview

### 4.1.1 Frameworks

We used the Java-based *Spring Framework* to build the project's backend. Among other aspects, this open-source framework provides relatively simple ways for data access (*spring-data*, which supports *MySQL*), complex security management (*spring-security*), and the necessary components to build a REST API. The framework is well documented and used by several large tech projects.

One of the extensive open-source JavaScript libraries, *ReactJS*, was used to build the project's frontend web application. It, too, is well documented, allowing us to learn how to create a modern single-page application and integrate other libraries like *MUI*, which offer modern UI components.

As of July 2022, three private repositories have been maintained on *GitHub* for *planBar* to work at its current stage:

1. *mock_school-admin-api* is 100% Java-based and was mainly developed between October 2021 and January 2022.

2. *planBar_backend-api*, too, is 100% Java-based. We started developing this backend in September 2021. Once we decided to replicate an SAS in *mock-school-admin-api*, the current functionality of this repository evolved and we continuously developed this backend alongside the application's frontend. Both *planBar-backend-api* and *mock-school-admin-api* predominantly depend on *spring-project* dependencies along with *JUnit* for testing and *MySQL* and *JWTK* for web services.

3. *planbar_frontend* is 99,1% JavaScript based and we continuously developed it from December 2021 to May 2022. It relies on several *MUI* dependencies and other react-library components.

### 4.1.2 Deployment

Since a lot of the basic data (exam data, user data, or user-course relationships) used for the purposes of *planBar* is already administered by SAS, *planBar* ultimately intends to make use of this data. Because we could not find an SAS that provides an open API as of this point, we replicated *Schulnetz*, an SAS we both use in our professional lives as teachers. The deployment diagram, as shown in Fig. 4.1, illustrates the main components of our approach:

- A backend application service (PBAS) available as a secured REST API on a *planBar* server port[1] retrieves additional data via another secured REST API from the (replicated) school administration software server (SASS).

- A *planBar* database in which, contrary to the SAS database, no personal data is stored.

- A frontend application accessible on an *Apache2* web server via HTTPS requests.

[1] It was decided not to containerize the application as of this point because for the user test, one port was sufficient.

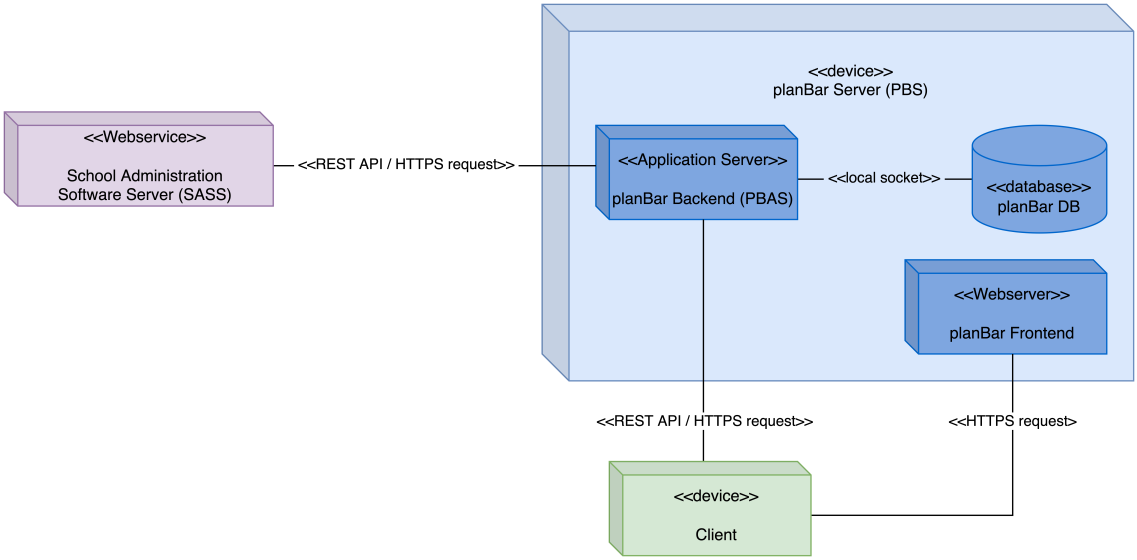


**Figure 4.1**: The *planBar* application deployment diagram

### 4.1.3 Using existing data and security logic (DG-11)

#### Login procedure and API requests

We used a *Spring Authorization Server* for this project. It provides an inbuilt OAuth2 Resource Server to protect the application's backend REST API with JSON Web Token (JWT) authentication. *Spring Security* allows customizing security settings to secure HTTPS endpoints via a role-based access control (RBAC). We implemented RBAC to grant access to *planBar*'s data and manage users' access to and navigation in the application. Working in an educational context, personal data protection needed to be considered. To further protect data retrieved from a SASS, we integrated the SASS's own authorization logic into the authorization process (cf. Figure 4.2).

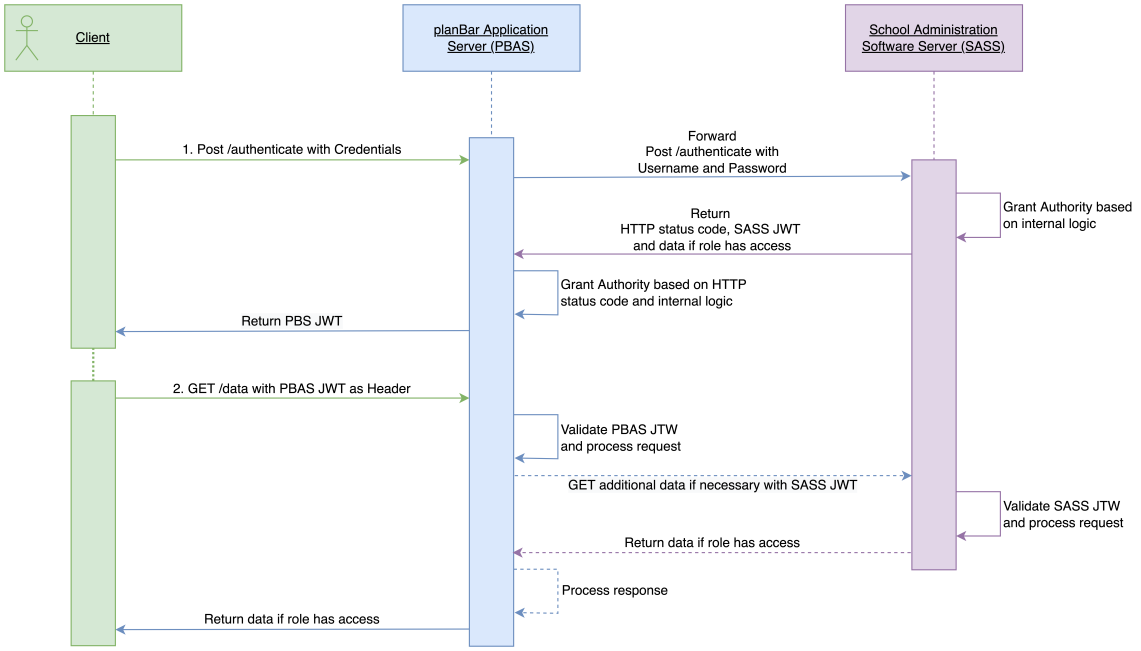


**Figure 4.2**: The *planBar* API request logic

Figure 4.2 illustrates that *planBar*'s authentication process is additionally protected by the SASS's internal access control logic. If the SASS returns a HTTP status code 200, the *planBar* backend application (PBAS) grants authority to continue. Consequently, the PBAS does not have to store users' personal data (name and e-mail) in its database. Given the internal logic, the SASS's JWT is not returned to the clients, which protects the data. Instead, the *planBar* backend server produces its own JWT. If clients make API calls during their session, the PBAS validates the PBAS JWT and processes the request. If necessary, an API call to the SASS is forwarded with the SASS JWT, which had been stored in *planBar*'s database. In this process, case-sensitive data fields are treated as transient by the PBAS, i.e., the fields are ignored and not mapped to any database column in *planBar*'s RDBMS. Thus, data considered sensitive remains protected.

## API Specification for a School Administration Software Server

For *planBar* to work with an SASS as outlined above, this API specification needs to be met:

- First, the SASS authentication POST request (table 4.1) containing user credentials in its body[2] needs to return a successful HTTP status code 200 and a valid JWT:

| Resource | POST |
|---|---|
| `/authentication/authenticate` | authenticates and returns JWT token for authorization and user information |

**Table 4.1**: API specification for POST requests to school administration software servers

[2]Example: `{ "email": "user.name@domain.ch", "password": "userPassword" }`

- Every other SASS API call sent from the PBAS contains a valid SASS JWT in its header:[3]
  `KEY:` `Authorization`
  `VALUE:` `Bearer` *`JWT token`*

| Resource | GET |
|---|---|
| `/faecher` | list of subjects of an authenticated user |
| `/faecher/{id}` | subject information of a subject with a specific *`id`* |
| `/faecher/id/kurse` | course information of courses from a subject with a specific *`id`* |
| `/kurse` | list of courses of an authenticated user |
| `/kurse/id` | course information of a course with a specific *`id`* |
| `/kurse/id/users` | user information of users that attend a course with a specific *`id`* |
| `/pruefungen` | list of exams of an authenticated user |
| `/pruefungen ?startDate=startDate ?endDate=endDate` | list of exams of an authenticated user inbetween two specific dates (*`startDate/endDate`*) |
| `/pruefungen/kurs/id` | list of exams from a course with a specific *`id`* |
| `/semester/date ?datum=date` | semester information of the semester of a specific *`date`* |
| `/users/id` | user information of a user with a specific *`id`* |
| `/users/id/kurse` | course information of a user with a specific *`id`* |

**Table 4.2**: API Specification for GET requests to school administration software servers

Successfully authorized and valid SASS API calls return the relevant data in a JSON response body and an HTTP status code 200. Otherwise, the API call is answered with HTTP status code 401.[4]

## 4.2 Main concepts and features

While developing *planBar*, we adapted the design principles for self-monitoring developed by Meyer et al. [2017] for this project. A screenshot of *planBar*'s dashboard with its four main sections (A to D) is shown in Figure 4.3.

[3]Note that SASS API calls exclusively send GET requests (cf. Table 4.2), which means that the original SASS data is never manipulated in any form.

[4]We hope that such a "one-sided" SASS API requirement approach, which leaves full control on the side of the school administration software, encourages permission to access to their data via an open SASS API.


**Figure 4.3**: The *planBar* dashboard

### 4.2.1 Interest in Diverse Set of Measurements (DG-7)

To allow diversity in the set of measurements (cf. Section 2.3), a first step was to refine the SAS's main assignment data types (`Exam` and `Homework`) by introducing a third, `Personal`, to allow users to register personal obligations from outside school (DG-2). Stress-related research found that such obligations influence adolescents' negative perception of school stress (cf. Section 2.2.1). Thus, taking their impact into account when organizing work weeks and visualizing students' workload seemed fundamental.

As shown in Figure 4.4, we built an abstract class `Assignment` in the backend application. This class inherits its core attributes from concrete assignment sub-classes. This adheres to Liskov's substitution principle as it leaves room for specification of the inheriting assignment types. For example, we extend the concrete class `Exam` by coupling it with `ExamType`, a class that allows taking different assessment types (oral, written, short tests, project work, or presentations and their respective impact on workload) into account. Not only is this last aspect a refinement of the set of measurements itself, but the approach also follows the open-closed principle: it allows room for future extensions of other obligations that bite into students' time budget too, for example, extracurricular activities.

Similar to the assignment types, `PersonalWorkWeek` modifies what is commonly considered a static work week and allows users to personalize their work hours. Knowing that students

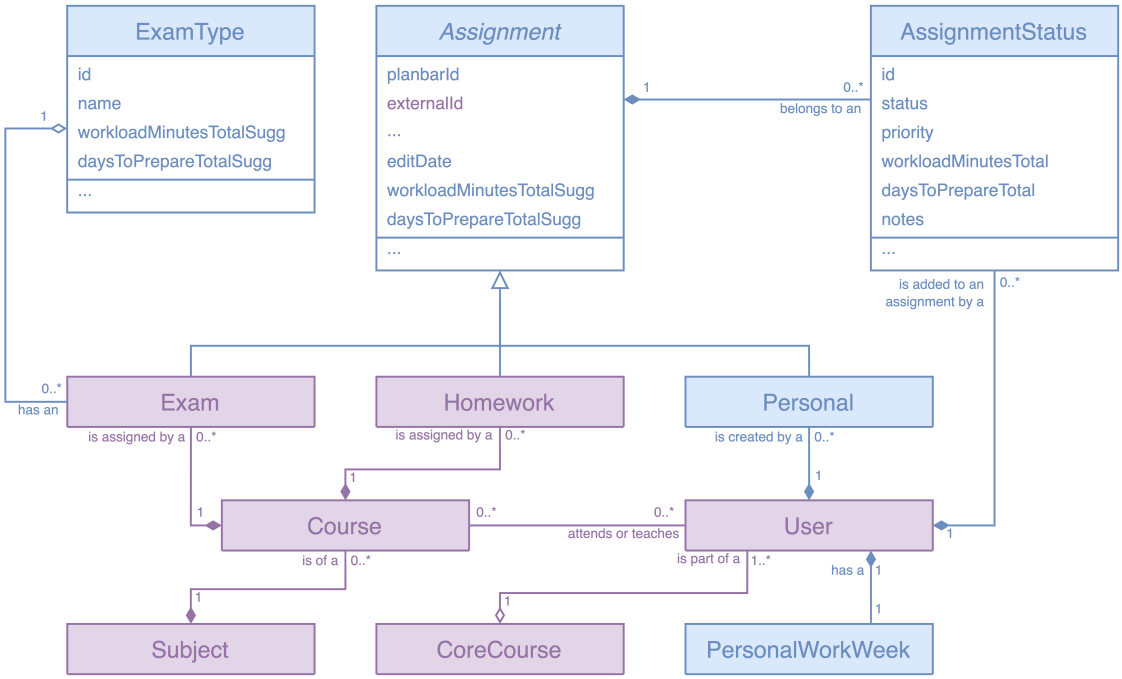


**Figure 4.4**: The *planBar* backend in a UML class diagram (purple: classes commonly administered in SAS, blue: *planBar* enrichment)

sometimes find little or no time to catch up with their school work outside classes (cf. Section 2.2.1), the application settings were refined so that users can modify their work week for days they have no time or think they are less productive. The green background color in the workload chart component (cf. C2 in the dashboard screenshot, Fig. 4.3) shows that the mock user has blocked work hours on Fridays and compensates for this on other days of the week when more time is available. The component's algorithm considers this when calculating the respective workload graph.

When it comes to personalizing a diverse number of attributes, *planBar* begins to set itself apart from static SAS. All the responsive components in the application's C section (cf. Figure 4.3) allow users to gain insight into how the overall workload is influenced. The workload can be modified by changing an assignment's status (based on one's task progress), prioritizing tasks over others (DG-4), or by personalizing the amount of time required to complete a task (DG-1). Similarly, components B2 and D allow users to drag future assignments into their current work week, thus, personalizing assignments' start dates and taking into account that students should fill the "dead" time in their schedules so that it is used efficiently (cf. Section 2.2.1, DG-3). Again, the components in the C section of the dashboard respond to this. Users' changes and updates are stored as `AssignmentStatus`, making this class a backend application's centerpiece.

### 4.2.2 Different Granularity of Visualizations (DG-8)

To implement the importance of clear structure to facilitate learning (cf. Section 2.1), follow Meyer et al.'s recommendations (cf. Section 2.3), and meet user's suggestions (cf. Section 3.4) for digital tools, *planBar* aims to provide a high-level overview of all assignments with the ability to drill down into details where necessary.

The application's aggregated semester view (cf. Figure 4.5) serves as a starting point. It provides an overview of all the assessments that have been registered. Color codes indicate the user's preparation status for each assessment. For aesthetic reasons, we preferred this design decision over showing the user's weekly workload through the background color. Another design decision we took is the focus on assessments because they are the most significant source of stress in the educational setting (cf. Section 2.1). The week circled in red in Figure 4.5) (calendar week 17, May 9) is the same as the one shown in the dashboard screenshot (Figure 4.3). The user can navigate to the week view by clicking on a particular week date. Clicking into empty spaces on the semester view is one way which allows the user to add new assignments from this high-level perspective. The application already suggests "correct" date (depending on where the user clicked) and parameters for the assignment. This allows the user to register new assignments swiftly.


**Figure 4.5**: The *planBar* semester view

On the dashboard itself, the workload chart (Figure 4.3, *C2*) illustrates the open workload for the currently selected week (the week can be changed using the navigation buttons in the *A* area). In the chart, all relevant assignments for the work week are distributed across the time that is available. In doing so, the user can see at once whether the available time is sufficient.

Visualizing the users' workload for both students and teachers forms a main goal of our approach. Thus, we also coded status summaries of the currently relevant assignments in the form of the doughnut chart (*C1*) and the progress bars for the current and upcoming weeks (*A2*).

For a more detailed view, the assignments which impact the user's workload are listed in the assignment containers (Figure 4.3, *B1* and *B2*) and in the Kanban-Board-like workboard component (*D*). The workboard component shows all assignments that are due in the selected week. Pending assignments can easily be dragged and dropped into the week (*B2*, DG-3).

Depending on users' personal needs, it seemed necessary to develop all these different components to provide high-level and detailed overviews of what impacts students' workloads.

### 4.2.3 Increasing Productivity through Retrospection (DG-9)

To encourage users to reflect on their work and productivity (cf. Section 2.2.4), we developed several features - some are clearly designed to motivate the user to reflect, while others work more subconsciously.

Since teachers (or *planBar*) provide a suggestion for the time limit for each assignment, it is important to reflect on this aspect (cf. Section 2.2.1). Students need to find out if the time they need to complete an assignment meets the expectations of their teachers. They can do this in a retrospective step. We tried to offer a component that encourages users to gain insight into their achievements. Figure 4.6 illustrates how users can compare their performance. If users want to see more precisely in which subjects their expectations differ from the teachers' suggestions, they can drill down into detail (component *Y*). Users find an overview of all completed assignments (component *Z*, DG-6). They can also display unfinished assignments from the past (cf. Section 2.2.4). In the future, this view could be extended in many ways (e.g., by showing how workload develops throughout the school year or how soon in advance a user completes assignments).

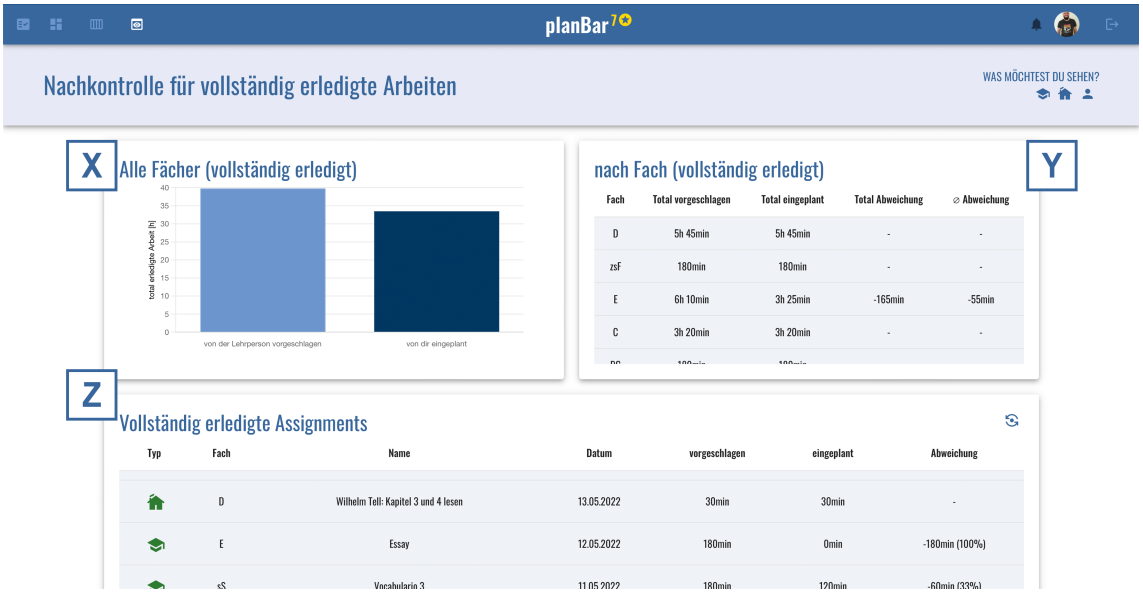


**Figure 4.6**: The *planBar* retrospection view

More intricate elements of reviewing are the option of navigating back to previous work weeks (Figure 4.3), the graphs on the dashboard (Figure 4.3, *A2*), which show how much work has been completed (DG-6), and the number of stars in the middle of the navigation bar (Figure 4.3, *A2*), which represent the number of weeks in which the user has managed to complete all assignments (DG-10). Finally, the workload chart component (Figure 4.3, *C2*) also entails a reflective element: if the workload that still needs to be completed does not fit into the user's work week, there is a warning, and the user should look into it (DG-5, DG-10).

### 4.2.4 Motivating Behavioral Change (DG-10)

Given the widespread phenomenon of school stress, one of the core interests when setting out to develop *planBar* was to provide students with specific, actionable recommendations, motivate them to improve their behavior with regard to planning their workload, and foster trust in themselves that school stress is manageable (cf. Section 2.1). Although we had many ideas about addressing this, putting them into practice (or code) proved to be more complex than expected. Still, we managed to implement three aspects.

First, we implemented Kaluza's priority matrix (cf. Section 2.2.1) almost seamlessly in our *iDo list* component (Figure 4.7). A background text for each priority group and an information button were designed to provide specific, actionable recommendations to motivate behavioral change with respect to how users can prioritize their to-do list items (cf. Section 2.3). The assignments can be moved and removed freely on the component's draggable surface. Changing backgrounds while dragging an assignment enhances the UX.

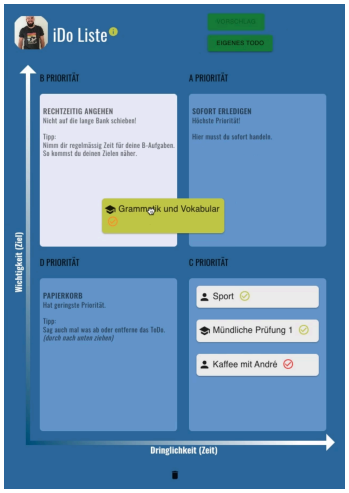


**Figure 4.7**: The *planBar* iDo list component

Another, more intricate, element to encourage users to improve their planning approach is the pop-up message which appears underneath the workload chart when tasks are not planned well enough for users to stay within their time budget (Figure 4.3, *C2*, DG-5). When certain thresholds are reached, such alerts show the user that she or he is not doing well. This adopts user suggestions that came up in both Meyer et al.'s [2017, p. 18] interviews and our initial survey (Section 3.4, Workload and Stress). Similarly, the workboard component (Figure 4.3, *D*) displays subtle but encouraging messages in the background to encourage users to move tasks along the Kanban board towards task completion.

Finally, sound signals were introduced as a motivational feature at the last stages of the application's development. A chime and corresponding snackbar pop-up message announce the completion of an assignment. Users can hear a paper crumpling sound when they move assignments into the wastebasket in the iDo list (Figure 4.7). These minor acoustic changes motivate the students to celebrate the moment when finishing a task [cf. Lohaus et al., 2007b, p. 169] and, thus, encourage such behavior.

# Chapter 5

# Evaluation

During its development, we regularly showed *planBar* to different, randomly selected people, e.g. teaching colleagues or students, in order to test its usability and utility. The feedback helped developing a first prototype. Especially the development of the workload chart (cf. Figure 4.3, Section C2) required repeated feedback and refinements until its current version was produced. Once finished, we tested the prototype usability on a small group of students (N=13) in cognitive walkthrough tests. After some improvement, *planBar* was rolled out to a study group and tested during a period of six weeks. At the end, the participants filled out a questionnaire to evaluate the six-week trial. Through this process, we were able to identify five additional development goals (DG-12 to DG-16) for an approach to help students improve their time management.

## 5.1 Usability Testing: Cognitive Walkthrough

The first *planBar* prototype was presented to a group of four volunteer student (one at a time). We gave them access to the application and started on the dashboard. They were not given any instruction on how the application works but had five minutes to familiarize with it. Following this, the participants had to complete eight tasks like *Create a homework assignment for the subject "English" and a suggested workload of 20 minutes to be completed by Friday of the current week (T5)* or *Change the status of the previously created assignment to "started" (T6)*. [1]. We observed the participants' actions, but did not provide any assistance. Following the actionable tasks, the participants also needed to describe a *planBar* workload chart we had created and to explain how changes to the assignments' attributes would influence the visualization. The results out of the cognitive walkthrough can be summarized as followed:

- The users were able to intuitively navigate through the application, change to different overviews and calendar weeks. (RQ-2 a)
- Solving specific tasks like creating an assignment or changing its attributes was not as intuitive as we had assumed. Once participants familiarized with the system, however, the main tasks for which *planBar* had been developed could be solved by everyone. (RQ-2 a)
- The workboard component turned out to be the most intuitive component to change the status of assignments.
- The workload chart understandably visualizes users' workload and its comparison against the users' actual time budget. The participants' explanations showed that they understand how different changes in an assignment's attributes influence the chart.

[1] A full List of the tasks can be found in the supplementary material [Balsiger and Pfäffli, 2022]

Before rolling out the application to the test group, these results were used to refine the prototype: Creating buttons that look more actionable was one goal, introducing the study participants to the tool at the start of the user test was another conclusion drawn from the cognitive walkthroughs.

## 5.2 Field Study

The user test was designed to investigate research question RQ-2 b and RQ-2 c. All participants were registered into our replicated SAS so that they could use *planBar*. Then, all course relations and assignments, mainly exams registered on the students' actual SAS, were imported into the replicated SAS database so that the students could directly see their workload for the coming weeks.

To evaluate this phase, we conducted a follow-up survey. Originally, we had intended to investigate whether *planBar* could help students gain higher awareness of their current workload, whether it can facilitate better planning abilities and increase the feeling of being able to cope with stressful situations (RQ-2). Unfortunately, we could only collect a limited amount of data from the field study (cf. Section 5.3 and Section 6.1) and we needed to adjust the goals of the follow-up study. Adapting to the situation, the survey's goal now was to find out why the application was not used regularly and how the participants evaluated the different components.

### Participants

The participants included 13 students (F=10, M=3) aged 17 and 18 (Year 11). All participants attend classes taught by one of the authors. To ensure that the study does not pose any ethical concerns, participating in the user test was voluntary and we informed participants about data storage and anonymous user monitoring. To receive valid quantitative data form this study, an 80% participation rate was targeted. During the field study, it became clear that we could not achieve the necessary participation rate for the user test. The follow-up survey, however, showed a 92.3% participation rate (cf. Chapter 6).

### Method

*planBar* was rolled out with the assignment data we ha been able to export from the participants' SAS. We introuced the tool by showing important functionalities and ideas in a 45-minute workshop. In addition, a communication channel was set up so that the students could immediately report bugs to the researchers. The user test took place from mid-May and the end of June 2022 during the last but still busy part of the academic school year. The participants constantly had access to the application and we encouraged them twice to use the application.

A follow-up survey was conducted at the end of the field study in order to get a final evaluation. The questionnaire consists of open questions like *Please describe why you did not use* planBar *at all / only used it occasionally / used it frequently (Q6)* or *What are the functionalities of* planBar *that help you to better organize your assignments and why? (Q7)*. Besides this, we asked whether the participants would like to use our tool during the next academic school year and whether they were open to help maintaining its content (especially registering homework) in the role of power users (3-point Likert scale).

### Data Collection and Analysis

The data from the user tests was collected through some user monitors that we had built into the application: user actions (login, status changes of assignments, the name of the application component used therefore, and assignment creations) were logged with a timestamp. Furthermore, the users were repeatedly asked for feedback (every five days). The feedback form included open and five-point Likert scale questions about the utility of our approach (e.g. *How does* planBar *help you to improve planning your assignments? Which features of* planBar *have you used to improve planning your assignments? What should be different for you to give the application one more star?*). In these feedback forms, the participants were always asked about their workload of the last seven days as well as whether they had perceived this workload as stressful.

The follow-up survey took place during the last week of the academic school year. The data analysis included the labeling of responses to the open questions and item frequency analysis.

## 5.3 Findings (RQ-2)

### 5.3.1 Usage of the application

The average student login amounted to only 5.46 (min=1, max=19, median=4.0, sd=4.81). Only two students used the application more than once a week (11 and 19 logins). Due to the low participation rate, we only descriptive methods to analyze the data.

The main reason why the application had not been used during the user tests was timing. Participants explained that they had already established their routines for managing tasks earlier in the school year and given the fact that many assessments were due during the test phase, participants felt reluctant to reorganize themselves and test a new tool. Also, they felt like they had already perfected their (mostly analog) organization over the previous 11 school years.

> *I think because we were already in the exam season and because I was able to trust in my task organization the way I usually do it.*

> *I am so used to just opening my homework book and looking at what has to be done. For me personally, changing to using planBar would have meant a lot more effort than just looking at my homework book. Also, it was a bit unfortunate that we got the application in the middle of the school year because by then I had already all my assignments in my homework book.*

The two participants who used the application regularly mainly referred to its ability to provide high-level overviews over their workload as a reason for using it.

> *This way I was always able to see what I still had to complete. [...]*

> *[planBar] provided me with a good overview over my upcoming assignments.*

A total of 129 status changes were registered (123 exam, 12 homework, and 4 personal assignments). 74 (57.4%) of these changes were performed by the two people who used the application regularly. Status changes were mainly performed in the workboard (55.8%) and assignment list (43.4%) components. Only once (0.775%) the iDo list was used for this purpose.

The feedback form was completed by only three students, making quantitative analysis impossible. However, it was mentioned twice that some kind of explanation (info page, feature description) would help to use the application more efficiently.

Despite these low figures in usage, nine out of 12 participants (75.0%) would like to be able to use *planBar* at the beginning of the new school year, the other three would not mind. When it comes to maintaining the application, taking on the role of a power user who feeds the application with new assignments conscientiously was not a popular idea: two out of the 12 participants state that they do not want to take on such a role, while the others (83.3%) could be encouraged to do so only if necessary.

### 5.3.2 Component evaluation

Three components particularly stand out as highly appreciated by the participants: First, the workload chart in connection with the personal work week was mentioned. It provides users with "a good overview of when you have to do more for school than you normally do and where you still have unused time slots." Second, the workboard offers users a "well structured" and "simple way to modify the status of an assignment". Third, the feature allowing users to enter homework assignments for the entire course was considered useful for collaboration among students.

One component did not meet its intended effect: the iDo list. It seemed to confuse users because they did not have any "unimportant" assignments during the user test period.[2] Another reason could also be, that the users were not familiar with this priorization technique (see also Section 5.3.4).

The follow-up study further revealed three features that are missing in the application. Firstly, there is one common desire among the participants: customization. Participants wish to be able to set, modify, and save assignment filters and where the different components are placed on the application's dashboard. Secondly, planning suggestions: Being able to personalize one's work week, work status and the time needed to complete an assignment, some participants suggested that *planBar* should automatically come up with a suggestion on how to spread out the assignments intelligently across the user's work week. Thirdly, a more feasible suggestions was the introduction of pop-up reminders or push notifications for pending assignments with a significant workload if these assignments have not yet been tackled. From the above, we were able to identify three additional development goals:

**DG-12** Users can save their filter preferences.

**DG-13** Users can personalize the dashboard layout and the visibility of different components.

**DG-14** Users can enable push notifications in order to get reminders and summaries.

### 5.3.3 Usability (RQ-2 a)

#### Mobile first

During the first week of the user test, a common feedback from participants was that a mobile application would help them use the tool more regularly since smartphones, as opposed to laptops, were always close at hand. Based on this feedback, the web application was extended to

[2]Notice that the data we had imported from the participants' SAS data only included assessments.

a Progressive Web Application (PWA) and installed together with the interested participants on their mobile phones. However, no increase in logins could be observed compared to the period before. Still, the participant's feedback allowed us to identify another development goal:

**DG-15** The application is accessible as a progressive web application.

### Providing intuitive functionalities

"Drag and drop" is a functionality that can be found in a lot of modern applications. Therefore, users are used to this. Especially *planBar*'s workboard seems to be an intuitive component to change the status of the assignments by dragging them to the appropriate category.

### Giving an introduction to the app's features

The cognitive walkthrough shows, that *planBar*'s features are probably less intuitive than initially expected and cannot be used efficiently without a refined introduction. Providing this introduction, the cognitive walkthrough as well as the feature evaluation within the follow-up study show, that the application can be used for its intended purpose. Given that any students should be able to use the application, an additional development goal is derived from the above and from specific suggestions by the participants:

> *It would be nice if the application gave some kind of introduction. Maybe a small icon (info) to describe components and how to use them.*

Therefore, a final development goal for an approach to help students improve their time management was identified:

**DG-16** The application explains key functionalities and introduces new concepts in a tutorial.

## 5.3.4 Utility (RQ-2 b, RQ-2 c)

Unfortunately, despite all efforts and repeated reminders, *planBar* was not used regularly. Thus, RQ-2 (c) could not be answered. However, most participants (76.9%) had logged in three or more times and at least tried the application. Although the participants had not adopted *planBar* for planning their daily school life, they gained an overview over its features. This way, the different components provided by the application could still be studied to some degree in terms of their utility. The major findings are listed below:

### Roll-out timing and efforts

The roll-out timing of a new tool for organizing school assignments is essential. The impact that changing established routines when the school year is well on its way is too significant because:

- Students' focus at the end of a school year is on performing academically.
- the participants have already tested and gotten used to a personal system that allows them to get by.
- the participants have already registered assignments.

By changing their system, students would run the risk failing (the new planning tool might not work as promised), and on the other hand they would have to make an additional effort by transferring their data to *planBar*.

Therefore, a roll-out at the start of a school year and selecting a slightly younger participant group for testing, i.e. students who have not yet developed and refined their personal planning skills, might be more effective.

### Providing visualization

The participants stated that they like the fact that the color of the assignments adapts when they change the assignment status. Similarly, visualizations like the workload chart provide the user with a good overview and reflection tool:

> *[The workload chart] spreads the workload throughout the week and tells you when you have a lot to do.*

> *I like the feature where I set my work week and then I can see where it doesn't add up with my assignments that I need to accomplish. I think this gives a good overview over when we need to do more than we typically do for school and where I would still have some free space.*

To sum up, it can be said that *planBar*'s workload chart and other visualizations like color adaptions help users gain higher awareness of their current workload.

### Providing an interactive overview

*planBar*'s workboard was the main feature used for assignment status changes. It not only seems to be the simplest way to change assignments' status but also motivates users:

> *I like the workboard because I think it is the most organized component and I always get motivated when I can move something.*

> *[In the workboard,] where you can drag and drop the exams, you get a good overview and you get the feeling that you are doing something.*

### Thinking about introducing unknown concepts

The priority matrix taken on board from the related literature (Fig. 2.2) did not meet its intended effect. Besides what has been mentioned above, it also needs to be mentioned that users did not register a great number of additional assignments (besides the assessments added by the researchers). As a consequence, there were hardly any "unimportant" assignments featured in the application and prioritizing different assessments over one another posed a conundrum. Although there had already been an information button in this component, showing to the users more clearly why certain organizational techniques might be worth the while is something that can be improved.

# Chapter 6

# Discussion and Conclusion

This chapter discusses the paper's findings and their value as well as the process which lead to them. First, we discuss why RQ-2 could not be investigated more thoroughly. Second, we look at how Meyer et al.'s [2017] design recommendations need to be adapted for the context of a time management tool for high school students. Third, we consider the difference between student expectations and subject-related literature or educational goals. Finally, this will allow us to highlight possible effects and limitations of our approach are discussed and conclude with an outlook on the future of *planBar*.

## 6.1 Field Study: Participants, Group Size, Timing

Although some answers to RQ-2 (a) and (b) could be found with a qualitative analysis of the cognitive walkthrough and the follow-up survey, RQ-2, RQ-2 (c) in particular, could not be answered quantitatively in this paper.

There are several reasons why our application was not used as intended during the user tests. One of them was frequently mentioned by the participants:

> *I think because we were already in the exam season and because I was able to trust in my own task organization the way I usually do it.*

Testing an application during a busy time of the school year and when most future assignments had already been registered by the participants' individual organization methods was not ideal. Students were reluctant to commit to an unknown system and risk potential failure. Such a tool should be tested at the beginning of a school year when students' workload is still low. This could have provided more data and results. Since the participants were Year 11 students, most of them had already defined their individual time management strategies. Considering a younger participant group might also have influenced the outcome.

Having said this, and given the small scope of our user study, the size of the test group and quantitative methods need to be discussed. We experienced that getting participants to use an application regularly is not easy. The two users who regularly used the application in the user test can be interpreted as a success. Thus, for a project like ours, a small but motivated user group might have been a more promising approach.

Another aspect worth discussing lies in the nature of the relationship between the people involved in the study. All test users take classes taught by one of the authors. It turned out to be difficult to constantly remind and ask our students to actually use the application. We refrained from doing so for ethical concerns. Besides, we felt that too many reminders could have influenced the results too. With a retrospective view, push-notifications could have subtly reminded the participants to use the application. In hindsight, push notifications could have supported the user test outcome while also being a very useful (and wished by the participants) feature.

## 6.2 Adapting Design Recommendations

We adopted four development goals (DG-7 to DG-10) from Meyer et al.'s [2017] design principles for self-monitoring tools at work. These goals can also be considered as our four key development goals since others (DG-1 to DG-6 and DG-11 to DG-16) relate to them. Yet, it needs to be discussed how Meyer et al.'s design principles can also be used for planning tools in the educational context.

Users in the cognitive walkthroughs and in the follow-up study appreciated the granularity of visualization (DG-8) as well as the diverse (individual) measurements (DG-7). While different visualizations and visualization levels provide high-level overviews and detailed information about what users currently have to accomplish, diverse measurements enable them to see their workload. Thus, it makes sense to consider these recommendations when developing an approach to help students manage their time.

Regarding retrospection (DG-9), however, we have experienced that students usually dislike reviewing their work. This is not only our experience as teachers, but our surveys showed that only one out of the 33 study participants actually apply this technique in their study routines. One participant even stated that follow-up inspection was *"a waste of time"*. This is interesting because it goes against various studies that highlight the positive effect of retrospection on time management, planning, and personal success [Kaluza, 2015, p. 256] (cf. Chapter 2). However, if students do not apply this technique, it does not mean it will not help them. School stress is a reality, and this by itself shows students' planning strategies are not flawless. A better insight into how students work might help them improve how they experience and judge stressful situations. Self-awareness strengthens one's coping ability and this, in turn, seems like a plausible argument why providing features that enable retrospection (without causing any time efforts for the user) should be considered in an approach to help students improve their time management. Especially in the educational context, young people need to be encouraged to foster their self-awareness and gain a deeper understanding of how they work as individuals [Pascoe et al., 2020]. Whether an approach that asks users to fill in periodic self-reports like *how much time did you spend on school work outside classes* will actually work with students (cf. Meyer et al.'s [2017] approach) remains to be seen.

The last design principle adopted from Meyer et al. [2017] was providing specific, actionable recommendations to motivate behavioral change (DG-10). As of this point, our approach implemented some motivational features. This, however, does not cover the original idea completely. Providing more specific actionable recommendations that actively engage with the user could help students work more regularly and, therefore, tackle the issue of procrastination. This part can and should still be developed further.

All in all, our project has shown that it is worth considering these four design principles (DG-

7 to DG-10) when developing an approach to help students improve their time management. Creating such a tool is in some points comparable to creating a self-monitoring tool, as studied by Meyer et al. [2017].

## 6.3 Student Expectations vs. Educational Goals

Although prioritizing to-do list items is recommended by experts in the field of time management [Kaluza, 2015] and although more than 60% of study participants mentioned in the initial survey that they actually use to-do lists and prioritize their assignments (cf. Section 3.4), our follow-up study showed that the iDo list component was the least popular feature in our approach (cf. Section 5.3).

> *[The] iDo list is not necessary because you have to do everything anyway. In addition, it is unclear and not everything is listed automatically.*

Although this is interesting and valuable feedback, it might be worth pointing out that the participants in the user tests slightly misinterpreted the idea of a "D-Priority" due to its misleading background information text. The wording "wastebasket" (Papierkorb), as suggested by Kaluza [2015], may have caused some confusion. Given the fact that the application was hardly used in the user test (personal (N=2) and homework (N=3) assignments), less important obligations were not registered by the participants. Of course, there are no assessments that are not worth completing. Besides this, all the registered assessments concerned the end of the academic school year, so they were all "urgent". It remains to be seen if components like the iDo list manage to showcase their purpose once the application can mirror users' overall workload, which is generated by all sorts of obligations, more realistically.

Another request mentioned by the participants was that an approach like ours should suggest a weekly schedule, i.e., "on which day should the user work on which assignments". Obviously, this would support the users' time management and a distribution algorithm could be programmed. Structure is important for learning [Kaiser et al., 2021; Meyer, 2014] and, at first glance, this looks like a good idea. However, some arguments speak against this: First, users would have to feed the application with all the necessary data for such a feature to actually work. Second, and more importantly, improving self-awareness over planning skills and taking responsibility are fundamental educational goals in education (cf. Kanton Bern [2017, "Überfachliche Kompetenzen"]). Leaving young people with the ordeal of learning how to plan and organize tasks seems important.

Both aspects discussed above exemplify things commonly experienced when working in education: Firstly, students sometimes need to be encouraged to try new techniques to find out if they are worthwhile. Secondly, developing educational tools not only needs to consider users' perspectives and expectations but also educational considerations. Sometimes the two conflict with one another.

## 6.4 Possible Effects and Limitations

RQ-2 aimed to investigate the effect of using *planBar* to gain higher awareness of the users' current workload (RQ-2 b) and lower their negative perception of stressful situations (RQ-2 c). We have already explained why RQ-2 (c) could not be answered. While the user studies showed qualitatively that a planning tool like *planBar* could help students gain higher awareness of their

workload, it remains to be discussed if it can also help reduce students' negative perception of school stress.

Active time management, structured task management, and reflection on the work process are essential to avoid the negative perception of stressful situations and are a central element for learning [cf. Lohaus et al., 2007d; Pascoe et al., 2020]. Thus, it remains to be investigated if using a planning tool like *planBar* can enable students to do so. *planBar* is a structured time management tool with possibilities to reflect on the work process, but, at the end of the day, it does not "learn" for the student.

An approach like *planBar* can address the issue of uneven workload distribution throughout a school year. This is mainly caused by poor planning. By introducing exam types, considering the element of time, and visualizing the effect of different assignments, all players involved in shaping students' workload can work toward a practical solution this problem.

## 6.5 Conclusion

This paper provides a starting point for researchers and developers interested in developing an approach to help students improve their time management. First, it provides a questionnaire to identify high school students' time management problems and which coping strategies they employ. One of our major findings is that an unevenly distributed workload challenges high school students throughout the school year.

Furthermore, we identified 16 development goals worth considering when developing such an application: Among these, we identified four key goals (DG-7 to DG-10):

**DG-1** Users can set time limits for assignments.

**DG-2** Users can register personal obligations from outside school.

**DG-3** Users themselves can define when they want to start working on an assignment.

**DG-4** Users are encouraged to sort assignments into different priority groups.

**DG-5** Users are warned when there is not enough time to complete their assignments.

**DG-6** Users can follow up on their work progress to see how well tasks have been completed.

**DG-7** The application presents diversity in the set of workload-related measurements.

**DG-8** The application offers granularity in the visualization of workload.

**DG-9** The application allows users to fill in brief and periodic self-reports.

**DG-10** The application makes specific, actionable recommendations to motivate behavioral change.

**DG-11** The application builds on existing data from the school administration software.

**DG-12** Users can save their filter preferences.

**DG-13** Users can personalize the dashboard layout and the visibility of different components.

**DG-14** Users can enable push notifications in order to get reminders and summaries.

**DG-15** The application is accessible as a progressive web application.

**DG-16** The application explains key functionalities and introduces new concepts in a tutorial.

We showed that new tools implementing these development goals should be tested early in an academic year. Also, providing a fully responsive version of the application that can be installed on mobile phones is important when developing a digital planning tool for adolescents. The use of *planBar* may not be limited to high school students. Nevertheless, its features have to be evaluated for the use within other school levels.

As a lot of effort went into the development of *planBar*, we are motivated to continue developing this approach. We will try to negotiate the required open API from current school administration software and roll out the application at our schools. Hopefully, *planBar* will be useful time management tool to many future high school students.

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