Self-Regulated Learning For Time Management And Goal Setting In An Online Platform

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Abstract
The recent moving of education to online platforms has raised the necessity for more Self-Regulated Learning (SRL) ability by students. However, prior studies showed that students face difficulties in online learning because they lack SRL strategies [2]. Researchers suggest that a learning dashboard with rich visualizations is the most used method to improve student's learning outcomes [7]. Thus, this project aims to analyze and design a learning dashboard to support students' goal setting and time management skills. A digital prototype was developed on Figma, based on both qualitative and quantitative research methods that involved students partaking in the Information Visualization course at KTH Royal Institute of Technology. The tool was then evaluated by the students through individual task-based user tests. The prototype received positive feedback and has the potential to be used by the participants once it is publicized.

Author Keywords
Self-Regulated Learning; Online Learning; Information Visualization

CCS Concepts
•**Applied computing** → Computer-assisted instruction; **Learning management systems; •Human-centered computing** → Visual analytics; *Information visualization;*

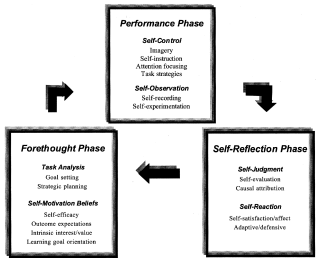

Figure 1: Scheme of the Zimmerman model: each phase of SLR is enclosed in a rectangle and comprises of two sub-phases and several strategies for completing them. The arrows show that this model is circular.

Introduction

In recent times, with the worldwide spread of Covid-19 and the subsequent limitations posed on gatherings of people by many governments, online education has proved to be an invaluable resource for compensating the impossibility of students of any grade and age to attend traditional classes. More and more pupils have been increasingly forced by the circumstances to rely on their own abilities to manage their progress and improvements over time, through a practice referred to as Self-Regulated Learning (SRL). To aid them in this activity, providing a learning analytics tool with the ultimate goal of increasing the quality of their learning is to be considered of utmost importance. Previous research on SRL shows that supporting students in developing skills in this set of practices can improve learning outcomes by 20% and learning support and teaching by 22% [7]. Therefore, providing SRL support to students will help them achieve greater online academic success [8]. The most popular method of doing so is through multiple visualizations (combined in a single dashboard, for example), which ultimately raise students' self-awareness [7].

In this report, we propose a high-fidelity prototype for a web-based, interactive visualization tool meant to support SRL in its strategies with a focus on time management and goal setting in particular. The target users of such an online platform are students partaking the Information Visualization course, held between the months of January and March at KTH Royal Institute of Technology. The primary motivation behind the project, is to replace the time-tracking system currently in use – consisting of a spreadsheet recording all individual students' activity over time, with a more interactive and informative interface designed with the principles of SRL in mind. To achieve this, we have addressed the following research questions:

1. What should the interface of the online tool look like?
2. What features should be implemented?
3. What is the impact of the tool on users' daily learning management activities, focusing in particular on time tracking and goal setting?

In the following paragraphs, an overview of the theoretical background underlying the design phase is presented, alongside a market analysis aimed at taking inspiration from some of the most popular platforms publicly available (Related works). Following, the description of the requirement analysis, design, development and evaluation phases, centered around the prototype we created (Method). Then a summary of the most relevant results from all these phases is presented (Results), followed by a general discussion on such findings and the limitation of our project (Discussion). Finally, conclusions are drawn in a broader perspective, to address the context of online learning as well as the research around SRL (Conclusions).

Related works

The Zimmerman Model

Self-regulation is defined as "the process whereby students activate and sustain cognition, behaviors, and affects that are systematically oriented toward attainment of their goals" [10]. David Zimmerman suggested that the self-regulation process can be thought of comprising three distinguished phases: the forethought phase, the performance phase, and the self-reflection phase. As depicted in Figure 1, each one, in turn, consists of two specific activities to be performed before proceeding onto the subsequent one [9]. The Zimmerman model constitutes the main foundation of the design activity within the context of our project; therefore heavily influencing the architecture and interface of the resulting prototype.

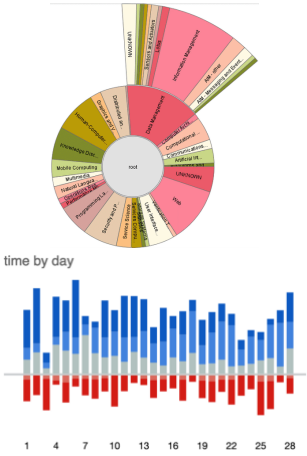

Figure 2: Top: an extended pie chart taken from the Harvest interface. Bottom: a stacked bar chart taken from the RescueTime interface.

Learning Dashboards Visualizations

As mentioned in the Introduction section, current research suggests that information visualization is the most frequently used approach to support SRL [8]. It enables data analysis for performance assessment as well as self-reflection on one's own learning process, therefore ultimately aiding the knowledge gain of a student [6]. At the same time, it can enhance educators' engagement by allowing them to evaluate the progress of the students from a "meta-educational" perspective, that revolves around their management of the learning activities. In this context, interactive dashboards presenting different visualizations can prove to be useful for users' decision making and goal setting. Sedrakyan et al. [6] provide an in-depth guide to designing dashboard visualizations for online learning, while Lange et al. [5] claim that it is important to employ the right visualization method to reach the maximum efficacy of this approach.

Market survey

In recent years, the market for so-called Massive Online Open Courses (MOOCs) has been growing rapidly and reaching an ever increasing pool of users [1]. The platforms offering these structured courses are nowadays many, and offer content in several different subjects: from computer science to social sciences, the courses available cover all possible degrees of depth, giving beginners as well as experts opportunities to learn more about a specific topic. Two of the most popular platforms in particular, Coursera and Udemy, are known for their online dashboards, which provide the user with visualizations on the courses taken and the progress made within such courses. Alongside these, a timeline displaying the previous, current and upcoming planned study – divided into individual weeks – is presented in the Coursera dashboard. A similar time-tracking feature is often employed by other applications that are more generally focused on recording the time spent on activities of a broader nature (not necessarily related to learning). Two noteworthy examples are Harvest [4] and RescueTime, which make use of pie charts and bar charts (such as the ones in Figure 2) to show the cumulative time spent on every task defined by the user.

Method

We started our work by collecting theory models by reviewing the literature and analysing the current available tools in the market. Next phase is performing a requirement elicitation by distributing an online survey and conducting two semi-structured interviews applying participatory design. Previous students of IVIS were involved. The quantitative survey was completed by ten students while two students took part in the qualitative survey. In order to gather the elicited requirements and speculate on how to address them, a brainstorming session took place to define the guidelines of the project while keeping the principles of SRL in mind.

Afterwhich, a lo-fi prototype was sketched in Miro along with the basics of an interaction flowchart. Based on the feedback from our supervisors, a hi-fi prototype was developed in Figma, along with interactions and improved widgets.

Prototype

The final high fidelity prototype was developed in figma. It was based on our initial design using SRL theory, and was set to achieve the set of goals and features that we had set in previous design meetings. Since the prototype followed the basis of SRL principles, we emphasized each phase of SRL as a separate section, with its own set of functionalities according to its main purpose, this while keeping the cyclical synergy of the SRL Zimmermann model. The main goal of the prototype was to suggest a supportive tool for

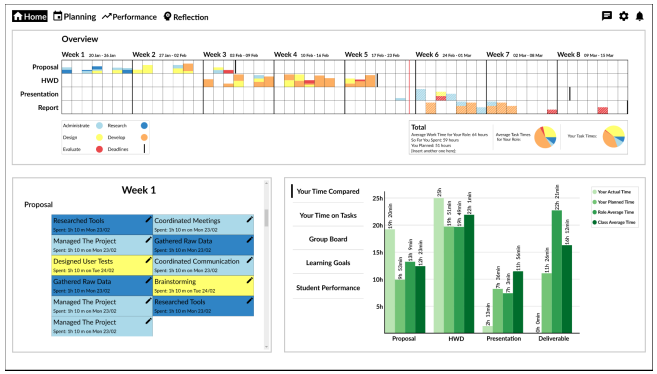

Figure 3: Homepage.

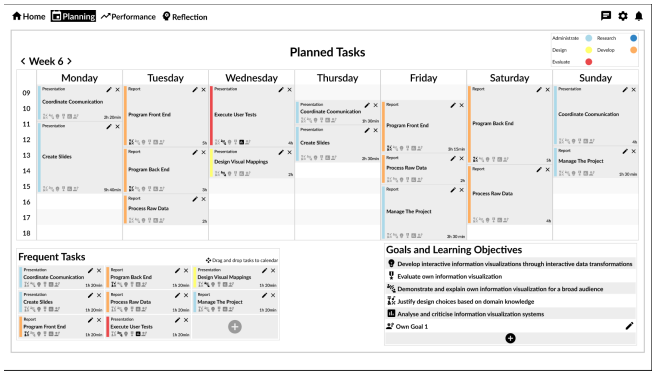

Figure 4: Planning.

the student which, while being easy to use, would help the user to improve their self regulated learning. At the same time, such tool had to be versatile and adapt to different types of students. The prototype was divided into 4 section of one page each: Homepage, Planning, Performance and Reflection:

- Homepage(Figure 3): The first section the users encounter offers an overview of the course and quick access to certain features, such as, time tracking, visualizations on the individual and group performance. The homepage also displays a gantt chart which gives an overview of the entire course, time spent and time planned on tasks, as well as deadlines.
- Planning(Figure 4): The planning section relates to the forethought phase of the Zimmermann model. Here, the user can create tasks that fulfill certain goals, and plan time spent by adding the tasks of each assignment to a calendar. In this section, users can label tasks that help them achieve the course learning objectives and goals, as well as allowing them to create their own goals.
- Performance(Figure 5): In the performance page, users track their ongoing tasks and plan their daily work, using a kanban board. This section also provides users the weekly activity to get an insight of their progress, and adapt accordingly.
- Reflection(Figure 6): The reflection section relates to the self-reflection phase of the Zimmermann model. It includes small surveys of the different assignments of that course, where users can reflect and evaluate their own work. Complementing this, we included graphs on their work on the different assignments that offer greater insight on the students progress and give suggestions for improvement in issues that the system has found compared to other users.

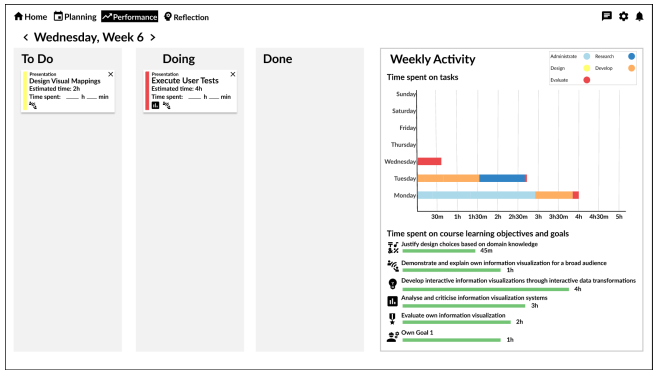

Figure 5: Performance.

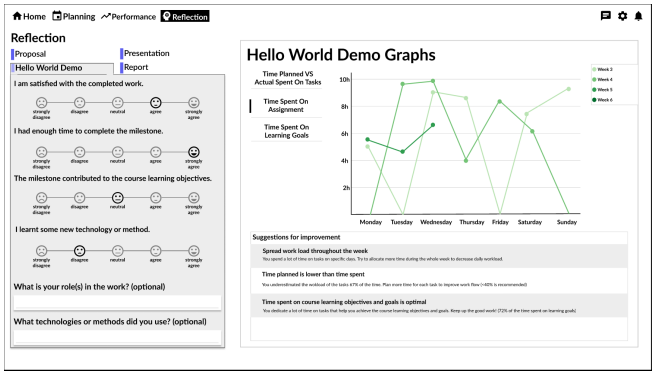

Figure 6: Reflection.

Students have different goals when studying, as some may not be as competitive as others. Based on this we included options for students to define what information they want to share or want to be displayed for them, e.g. graph comparing the progress of the other groups in the course or graph displaying anonymously the grades of past students and their data.

Evaluation

The evaluation of the platform prototype was carried on as a task-based think aloud protocol, heavily based on the guidelines first introduced by Fonteyn et al. in 1993 [3], who define the method as enabling "inferences [...] about the process(es) used while reasoning to problem-solve and make decisions for problem resolution". For the evaluation, five MSc male students (aged 25.4 years on average) from KTH (Stockholm, Sweden) and the University of Udine (Udine, Italy) were recruited as participants; all of them had a medium to high level of computer literacy and all of them had previous knowledge in the field of information visualization, and therefore fit the profile of the target user of the platform. Each participant was interviewed took part in a video call with one investigator that lasted approximately 30 to 40 minutes, where they were asked to share their own screen – which was not screenshot nor recorded at any point during the interview. One of the five interviews was held in Italian, while the other four were held in English. Before starting the interview, they signed a consent form and were briefly introduced to the purpose and target of the developed prototype. They then had a few minutes of time to freely explore the platform on Figma and get accustomed to its structure, before they were assigned three tasks to perform while thinking aloud. The three tasks were the same for each participant, and they were posed as questions so to reflect the three main phases of the SRL process; they were defined as follows:

1. What should I spend my time doing this week?
2. How do I keep track of my current activity and record it?

3. What are the flaws in the planning of my activity so far?

After completing all the tasks and answering any further questions related to them, in a final follow-up interview participants were inquired about some relevant features of the platform that were overlooked during the previous part, e.g. the tabs that were least focused on or the different popup windows (i.e. chat, settings and notifications) linked to the icons on the top right of the interface. In this concluding part of the interviews, the questions differed between participants.

Results

According to the guidelines presented by Fonteyn et al. [3] on how to conduct a Think Aloud Protocol, the notes from the interviews were scanned for relevant phrases expressed and actions performed by the participants, which were then highlighted. During the so-called Referring Phrase Analysis (RPA), the highlighted notes were coded using keywords reflecting the concept of reference. Subsequently, during the Assertional Analysis (AA), to determine how relationships between concepts were formed during problem solving, the type of assertion was assessed for each coded note from the previous step: as defined in the previously mentioned study, *connotative* assertions form relationships of meaning, while *indicative* assertions form relationships of significance and *causal* assertions form relationships of cause and effect. Finally, during the Script Analysis (SA), a set of operators (reasoning processes) explaining the predominant reasoning processes common to all subjects is identified: again, as defined by the authors of the study, the *study* operator "means to consider information carefully", the *choose* operator "means to decide on an action to take", the *explain* operator "means to provide a rational for an action" and the *conclude* operator "means to decide on the significance, value, or meaning of information".

Having defined the types of assertion and the set of operators, the results obtained from this process can be associated to four categories of actions shared my most – if not all – the participants. These are broader themes within the recorded interview notes encompassing relevant aspects of the prototype evaluation, and their definitions alongside the most relevant related results and a few proposed solutions will be briefly presented in the following subsections: correct/incorrect week; correct/incorrect interpretation; correct/incorrect page; critique/appreciation. In addition, several possible improvements have been proposed by some of the participants during the interviews. For instance, Participant 3 claimed that "it would be interesting to have notification settings as well [as the general platform settings]", while Participant 5 during Task 3 proposed to "mark the frequent tasks in the calendar [of the Planning tab] with a star" in order to aid their identification.

Correct/incorrect week

This topic is related to the correct or incorrect identification of the current week as displayed in the platform, especially for the purpose of solving Task 1. Most relevant and frequent results are the correct identification of the current week – which was to be identified with the upcoming week 6 – by four participants, the confusion caused by the week 1 being displayed in the task list to the bottom left of the homepage (which caused Participant 4 to mistake it for the current week), the correct distinction in the homepage timeline between blocked-in past activities and the striped future activities. Additionally, in most of the interviews the participant did not seem to notice the red vertical line denoting the current day within the timeline. Proposed improvements to the current prototype are the highlighting of the above mentioned red line to make it more visible, by animating it

or making it thicker, and scroll the task list in the homepage every time the page is loaded through an animation, so that the current week is focused on but it is still clear that that part of the interface is interactible.

Correct/incorrect interpretation
This topic is related to the correct or incorrect understanding of the meaning of the different elements (widgets, visualizations, interactions and sections) in the platform, as intended by the developers. Most relevant and frequent results are the correct identification during Task 1 of the types of activity to be performed, the correct understanding during Task 2 of how time is tracked in the Performance tab, the in-depth analysis of the graphs presented in the homepage and in the Reflection tab (especially by Participant 2) and the correct but doubtful assessment of the purpose of the self-evaluation form in the Reflection tab (which a few participants initially thought as being meant for the professor). In addition, two participants in particular – Participant 1 and Participant 4 – expressed doubts about whether the whole platform was addressing an individual student or an entire project group; while the former ultimately opted for the first (intended) interpretation, the latter opted for the second (wrong) one. Proposed improvements to the current prototype are displaying a history of past self evaluation forms in the Reflection tab together with further written details about their purpose, as well as display more clues in the interface (such as username, login/logout button, profile picture) to let the user understand who the platform is addressing.

Correct/incorrect page
This topic is related to the correct or incorrect identification of the section (i.e. tab) of the platform to start solving the given Task from, which was meant by the investigator to be the Planning tab for Task 1, the Performance tab for Task 2 and the Reflection tab for Task 3. Most relevant and frequent results are the large amount of time spent by most participants on the homepage during different tasks instead of navigating to the intended section of the platform, the sometimes mostly ignored intended tab during various tasks (Participant 1, Participant 4 and Participant 5 in Task 3, Participant 2 in all tasks), the high degree of correct identification of the intended tab. Proposed improvements to the current prototype are instructing users on the purposes and mechanisms of the different sections when first accessing the platform through tutorials and tooltips, and highlighting more the links between the content in the homepage and that in the other tabs.

Critique/appreciation
This topic is related to the any form of criticisms and/or preferences towards particular features or contents within the platform that were expressed by the participants during both the Think Aloud Protocol and the follow-up interview. Most relevant and frequent results on the positive side are: the well received custom and predefined learning goals; the ease of use of the Performance tab; the interesting settings that can be changed. On the negative side: the difficulties in interpreting the scatterplots presented in the homepage; the little clarity of the task list on the bottom left of the homepage, expressed by Participant 2; the initial orientation difficulties when looking for information for the first time; the confusion caused by the great quantity of information displayed in the Planning tab (Participant 5) and in the Reflection tab (Participant 2). Proposed improvements to the current prototype are reducing the number of scatterplots, increasing their size and displaying more labels for each, with the aim of increasing their legibility. In addition, the aforementioned instructions for new users and simplifying the graphic elements in both the Planning and Reflection tabs by showing less relevant information only on demand could help solve some of the criticism points listed

above.

Discussion

In this project, a high-fidelity prototype was developed using Figma and evaluated through a Think Aloud Protocol. The main result was categorized into four topics: correct/incorrect week; correct/incorrect interpretation; correct/incorrect page; critique/appreciation.

Although most participants did not seem to notice the red vertical line denoting the current day, four participants identified the current week of the prototype correctly. One participant mistook the first week as the current week because the top of the task list is week 1. In order to eliminate the confusion, the mentioned red line should be more highlighted and visible and the task list should be loaded to show the current week at the top.

Some incorrect interpretations of different tabs and elements were also noted during the evaluation. The platform is designed for individual students while focusing on their learning process in group projects. One participant mistook that the platform is for a group. One possible improvement is including more clues in the interface such as user name, login/logout button. To develop a workable tool based on the prototype, those elements will be necessary. In addition, some participants initially thought the self-evaluation form in the Reflection tabs being meant for the professor. To help users understand the aim of the Reflection tab, past self-evaluation results can be displayed and the SRL model should be briefly introduced for them to better utilize the platform.

The prototype includes four pages/tabs: Homepage, Planning, Performance, and Reflection. In the evaluation, some tasks are designed to be done on one specific page, while a few participants keep working on the Homepage instead of navigating to the intended page. The navigation tab should be more highlighted and the beginner users should be given an instruction on the purposes and mechanisms of the different pages through tutorials and tooltips.

During the Think Aloud Protocol and the follow-up interview, the participants expressed positively on some parts of the prototype such as predefined learning goals, the ease of use of the Performance tab. While they had some criticisms such as the scatterplots are hard to interpret and the task list is lack of clarity.

Limitations

The aim of this project was to design a tool that can support self-regulation only for students of the Information Visualization course offered at KTH. Therefore, only students of this course were involved in the qualitative and quantitative research methods. Therefore, some of the results may be course-specific. The work provided practical and research methods and results that have the potential to be applied to developing platforms for any other course.

The fact that some parts of the prototype are not interactive (such as entering planned time in the Planning tab) limited the possible tasks for the evaluation. In future work, those parts should be made interactive and more detailed tests and evaluations should be conducted to identify possible UX problems and propose improvements on those parts.

Conclusions

The project provided a learning dashboard to support student's SRL, specifically for students of the Information Visualization course offered at KTH. It is a simple and user-friendly tool designed for individual students in group works. The platform includes features that support planning, performance, and reflection in SRL, as well as a home page. The concept of our learning dashboard with rich visualiza-

tion is well received by the students based on our survey, interview, early prototype as well as final prototype feedback. A Think Aloud Protocol was conducted to evaluate the platform and the four topics were extracted of which the problems and improvements were discussed in the results. It is also of utmost importance to mention that further research is required to address the fact that the tool has the potential to be expanded for other courses other than Information Visualization.

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