

Supporting Individualized Study Paths Using an Interactive Study Planning Tool

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Abstract: In addition to various subject-related challenges, students face diverse organizational challenges, including the planning of their own study path while considering individual and organizational circumstances or constraints. While examination regulations usually provide an exemplary study plan, it may only fit as long as no adjustments have to be made. If students fail exams or postpone modules, an individual study plan is needed to keep track of the own study path. With growing enrolment numbers and increasing heterogeneity of study profiles and paths, staff resources in student counselling or mentoring can only provide limited support. As such, this paper presents an interactive, web-based study planning tool, which enables students to plan their individual path using a visual representation of subject areas and modules, while also highlighting module requirements and dependencies. A first evaluation provides positive feedback, a good user experience, but also feature suggestions for further development.

Keywords: Interactive Study Planning, Study Paths, Assistance, User Experience

1 Introduction

When starting at a university in Germany, students usually choose a study program and get presented with a set of compulsory and elective modules to complete over the duration of their studies. Encapsulated in the examination regulations with an accompanied module handbook, students are recommended to follow an exemplary study plan outlining which modules to start with and how to successfully complete a study program in order to get a degree. While this exemplary plan and its adaptations all try to outline suitable paths through the study program, they usually do not account for any kind of deviation. If students fail exams or postpone modules, an individual study plan is needed to keep track of the own study path. Especially with the limitations introduced by module cycles (i.e. modules which are offered only once a year), order requirements (i.e. when module A needs to be passed before module B) or expected workload, study planning can become a challenge as soon as students diverge from the recommended plan. Alongside subject-related challenges, the organizational challenge of planning their own studies may burden students and hinder study success. The question arises of how students can be supported in planning and reflecting on their study paths.

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With growing enrolment numbers and increasing heterogeneity of study profiles and paths, staff resources in student counselling or mentoring can only provide so much support, as time and resources are limited. Meanwhile, students may utilize tools and provided information to plan and reorganize their studies as they see fit. Unfortunately, this approach is error-prone as students can make mistakes, e.g., if they do not consider certain module dependencies when planning their upcoming semesters and cannot take the final exam due to missing requirements. As a solution to both, a digital tool supporting individualized study planning could be considered.

This paper presents an interactive, web-based study planning tool for students in university. The tool enables students to create their individual plan for a study program using a visual representation of the study program's subject areas and modules, while also highlighting module requirements and dependencies. It provides feedback on invalid plans as well as warnings if module dependencies and requirements are violated. In a first user evaluation of the prototype, participants responded with positive feedback, but also feature suggestions for further development.

2 Related Work

When it comes to study plans included in examination regulations, often tabular depictions or list structures are used to visualize an exemplary path towards completing a study program. Figure Fig. 1 shows an excerpt of the sample study plan for a German Bachelor program in Computer Science (CS). It demonstrates that depicting flexibility might result in a more complex plan which is harder to read and understand. The different arrows (blue or red, solid or dashed line) show possible adjustments to the order in which modules can be completed but need a lengthy explanation to be understood the first time. Despite its complexity, the plan still fails to present relevant information on module requirements (e.g., *Proseminar* has to be passed before a student is allowed to take a *Seminar*) or module cycles. This information is often provided in additional documents (e.g., module handbooks), where students have to make sure to use the correct version suitable to their study program's examination regulations. All this specific information gathering and long-term maintenance puts a lot of effort on the students and could instead be supported by a comprehensive tool. Further, given its PDF-format, students cannot use this plan directly to adapt it to their needs but have to use other tools to recreate and adjust the plan (e.g., spreadsheet software). Here, the potential for interactive tool support visualizing module dependencies but also allowing users to adapt the plan to their individual circumstances has not been explored.

To support students in study planning as well as dealing with various organizational issues in their studies, universities often provide academic advisory services or (peer) mentoring systems. As such, counselling sessions, office hours or email services are offered to students for asking questions and getting individual support. With increasing enrolment numbers and limiting personnel, technology is introduced to provide scalable services,

e.g., through the use of intelligent mentoring system [KSI19] or chatbots [KI20]. Furthermore, digital study assistants [Ka21] and recommender systems [We22, Ha22, BRH14] have been introduced to guide students' module choices or the use of learning materials. Related work shows the potential of educational technology supporting these tasks, however, interactive tool support for individual study path planning compared to inflexible exemplary plans in examination regulations has not been presented.

Semester:	1. (WS)	C	2. (SS)	C	3. (WS)	C	4. (SS)	C	5. (WS)	C	6. (SS)	C	Summe Credits
Praktische Informatik	Programmierung Teil 1 und 2 (V4+U2)	8	Datenstrukturen und Algorithmen (V4+U2)	8	Einführung in die Softwaretechnik (V3+U2)	8	Datenbanken und Informationssysteme (V3+U2)	6					28
Technische Informatik	Technische Informatik (V4+U2)	6	Betriebssysteme und Systemsoftware (V3+U2)	6	Praktikum Systemprogrammierung (P3/P7) (P3)	1	PSP im 4. Sem. dann DataCom ODER DB ins 6. (blaue Pfeile)						26
Theoretische Informatik			Formale Systeme, Automaten, Prozesse (V3+U2)	6	Berechenbarkeit und Komplexität (V3+U2)	7	Datenkommunikation und Sicherheit (V3+U2)	6					20
Mathematik	Diskrete Strukturen (V3+U1)	6	Lineare Algebra für Informatiker (V3+U2)	6			Einführung in die angewandte Stochastik (V3+U2)	6					26
Sonstige Studienleistungen	Analysis für Informatiker (V4+U2)	8	Einführung in das wissenschaftliche Arbeiten (Proseminar) (V1+U2)	3	Nicht-technisches Wahlfach	4	Software-Projektpraktikum (P3)	6	Bachelorarbeit und Kolloquium	15			34
Wahlpflicht	Mentoring	1					Seminar (S2)	5					
							Wahlpflichtmodul (V3+U2)	6					24
							Wahlpflichtmodul (V3+U2)	6					
							Wahlpflichtmodul (V3+U2)	6					

Fig. 1: Sample Study Program Plan

3 Requirements for an Interactive Study Planning Tool

First, some general requirements for the tool were gathered and evaluated with a group of seven students, as they are the primary target group of an interactive study planning tool. In general, the tool should be provided as a web application for easy access and it should integrate into the university's user account system, i.e. authentication via single sign-on. It should store individual study plans as well as the recommended exemplary plan from the examination regulations. The interactivity should be intuitive and a plan's design linked to the tabular form known by most students. Moving modules with the mouse (referring to drag and drop) was directly suggested by students for intuitive ways to rearrange a plan. Besides moving modules between semesters, the tool should allow to add more semesters to the plan if needed.

The tool should be able to manage multiple study plans per student, e.g., when considering to pursue their Master's at the same university. Further, students of combinatorial study programs (e.g., teacher training) need to coordinate individual plans for multiple subjects. Thus, the tool should support to manage multiple concurrent plans and adjust them individually while also tracking some overall reports, e.g., number of credits per semester. Since some study programs have options of specialization (e.g., choosing application areas or elective minors), the tool should also provide support in the selection as well as visualization of options in the planning process. Finally, the tool should visualize a plan's progress, i.e. passed modules should be marked as such and failed or postponed ones should automatically be moved to the next possible semester.

4 Design and Implementation

Most of the tool's functionality is included in the frontend. A database persists the students' plans which can be retrieved via a backend, also taking care of the account management. To ease the development of the powerful frontend and ensure good maintainability, it was decided to use a popular frontend framework. From the most popular ones, Angular was chosen due to its flexibility, high performance and large community. Due to its limited functionality, no special requirements were set on the backend technology. To use the same programming language, Node.js was chosen. More requirements were given for the database. As study plans and paths are quite flexible, a relational database with preset columns was not suitable, and instead, a document-oriented database should be used. Here, MongoDB is the best option, as it performs good on big and often changing data while also allowing to set indices to speed up queries [So21].

The design of the tool aimed at capturing the look of the exemplary plans known by the students. As such, it also uses a tabular form and shows the different modules sorted into their respective module areas and recommended semesters based on the exemplary plan (see Fig. 2). But instead of looking flat and static, modules are displayed in a way that transmits the option to interact with and move them. Working with colors presents an intuitive style communicating what can be done. For example, the first two semesters in Fig. 2 are depicted using grey scale colors as they are in the past and modules cannot be moved there anymore. Current or future semester display modules in various colors, highlighting different module areas of the study program. This way, study progress as well as not yet completed parts of the study plan can be distinguished.

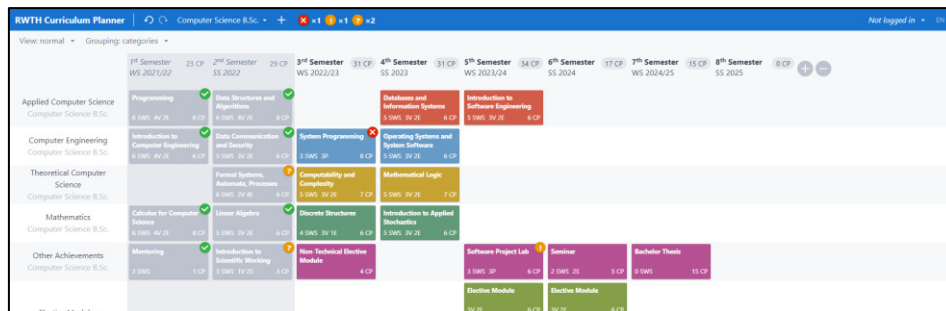


Fig. 2: Cropped screenshot of the interactive study planning tool showing an individual study plan for a Bachelor in Computer Science, first started in the winter semester 2021/22.

To further visualize study progress, green check marks on past modules indicate successful completion while orange question mark icons indicate missing information on the module status. When a student provides the missing information, a module is either completed or moved to the next possible semester while considering module cycle information. To keep track, failed courses are still shown in the related semester but hidden by default.

Two types of indicators are used to display module dependencies: (1) *recommendations* include suggestions to take a module before another one as, e.g., prior knowledge and skills might be recommended but not required, while (2) *requirements* present hard conditions that have to be fulfilled before taking a module. Upon mouse-over on a module, all module recommendations and requirements are depicted using arrows to linked modules. To provide feedback in the planning process, violations are depicted by either an orange exclamation mark icon (for recommendations) or a red cross mark icon (for requirements) as shown for Software Project Lab and System Programming in Fig. 2. Further, all reported violations can be reviewed by a mouse-over on the icons or clicking on the icons in the header tool bar.

5 Evaluation Setup

To evaluate the first version of the interactive study planning tool, with the aim to gather first user feedback and quantify its user experience, we conducted a user study with 12 CS students. After a brief introduction, the participants were first asked to complete two open tasks using the interactive study planning tool:

1. A persona of a CS student in their third semester was described for whom the participants had to create a suitable, adapted study plan while considering the student's study history and a reasonable workload.
2. The participants were asked to model their own studies as well as their future study plans (considering both Bachelor and a consecutive Master study program).

During both tasks, the participants were asked to voice their thoughts, opinions and question according to the think-aloud method. Furthermore, silent observation and screen and voice recording were used to gather user feedback. After completing the tasks, participants were asked to fill out the User Experience Questionnaire³ (UEQ), in order to quantify the perceived attractiveness as well as pragmatic and hedonic qualities of the experience with the tool.

6 Discussion of Results and Future Work

Overall, the idea of providing an interactive, visual representation of a study plan received good feedback: requirement violations are reported, module cycles respected when moving modules to other semesters and the estimated workload based on credits per semester is displayed. These features enable students to plan their course of study on their own without requiring additional staff resources in student counselling or mentoring. Instead, these resources can be used to help students with more in-depth issues.

³ <https://www.ueq-online.org/>, last accessed on 2023-04-02

During the evaluation, minor bugs were detected, that were immediately fixed after the sessions. More noticeable is that some participants had issues selecting the correct year that the course of study was started in task 1, as the winter semester spans beyond New Year's Eve. One participant selected the later year while still being able to fulfill the given task successfully. In terms of user experience feedback, participants reported that they would prefer a list of available elective modules to select from, rather than adding names manually. Besides that, the user experience was perceived as good and the UEQ shows very good results, as both *Attractiveness* and *Pragmatic Quality* received values above 2 and the *Hedonic Quality* a value of 1,45 (all on a scale between -3/worst and 3/best).

Furthermore, a lot of feature suggestions could be collected during the evaluation. Although undo and redo buttons were given, one participant wished for an option to reset the plan to the exemplary one, allowing to start over. Another request was to select multiple modules at once to move them simultaneously. Finally, many participants wished for an automatic planning option, based on some input by them, including past performance, a maximum number of credits per semester and even the desire to align their plan to the plans of their peers.

As for future work, we consider the suggested features and improvements for development and plan on evaluating the tool in both more iterative user evaluation to validate the tool's fit to users' requirements as well as summative evaluation in the field, measuring its acceptance, usage and influence on study progress and success. The ease of creation and management of study plans will be considered to include more study programs and keep their plans up-to-date.

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